SIEMENS

Numerical Line and Motor Protection with Control Functions

SIPROTEC 7SJ531 V3.3

Instruction Manual Order No. C53000−G1176−C114−2

Figure 1 Illustration of the numerical line and motor protection with control functions SIPROTEC 7SJ531 (in flush mounting case)

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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 as defined in EN 50081.

The device is designed in accordance with the international standards of IEC 255 and the German standards DIN 57 435 part 303 (corresponding to VDE 0435 part 303).

Contents

1 Introduction

1.1 Application

The relay SIPROTEC 7SJ531 is used as a protection, control and supervision device for bus−bar systems on the distribution voltage level, in particular for industrial application. The relay contains all necessary functions, which are normally required for protection, monitoring of the breaker and disconnector positions, and circuit breaker control for a feeder of a single or double bus−bar on the distribution voltage level.

The basic function is an overcurrent time protection. This inverse or definite time overcurrent protection with 4 stages (each two current/time stages for phase and earth currents) is complemented by supplementary functions like distance−to−fault location, circuit breaker failure protection, undervoltage and overvoltage protection, unbalanced load protection and thermal overload protection with start−up time monitor and restart lockout for use on motors.

Dependent on the ordered version, additional functions are available like a directional overcurrent time protection, a highly sensitive earth fault protection and a single and multi−shot auto−reclosing feature (for overhead lines).

Throughout a fault in the network the instantaneous values are stored for a period of max. 5 seconds 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 IEC 60870−5−103 and VDEW/ZVEI is used. The device can therefore be incorporated in Localized Substation Automation networks (LSA).

1.2 Features

- Processor system with powerful 16−bit−microprocessor;
- complete digital measured value processing and control from data acquisition and digitizing of the measured values up to the trip and close decisions for the circuit breaker;
- complete galvanic and reliable separation of the internal processing circuits from the measurement, control and supply circuits of the system, with screened analog input transducers, binary input and output modules and d.c./d.c. converter;
- complete scope of functions required for protection and control of a high voltage feeder of a bus−bar;
- insensitive against d.c. components, inrush or charging and high frequency transients in the measured currents;
- circuit breaker operation test facility by test trip−close cycle (models with auto−reclosure) or test trip of the breaker;
- comprehensive supplementary functions;
- continuous calculation of operational measured values and indication on the front display;
- simple setting and operation using the integrated operation panel or a connected personal computer with menu−guided software;
- switch−over facility for use of two different sets of function parameters;
- storage of fault data, storage of instantaneous values during a fault for fault recording;
- communication with central control and storage devices via serial interfaces is possible via optional optical fibre connection;
- continuous monitoring of measured values as well as hardware and software of the unit.

1.3 Implemented functions

SIPROTEC 7SJ531 contains 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 delay timers,
- 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 delay timer,
- 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,
- for phase currents, selection can be made of three standardized characteristics according to IEC or of eight standardized characteristics according ANSI/IEEE of inverse time overcurrent protection,
- for earth current, selection can be made of four standardized characteristics according to IEC or of eight standardized characteristics according ANSI/IEEE of inverse time overcurrent protection,
- alternatively, a user specified current time characteristic can be defined.

Directional overcurrent time protection [1])

- directional high−set phase current stage I>> with phase segregated fault detection and phase segregated delay timers,
- directional high−set earth current stage I_E>> with individual delay timer,
- directional inverse time phase overcurrent stage I_p with phase segregated fault detection and phase segregated delay timers,
- alternatively directional definite time phase overcurrent stage I> with phase segregated fault detection and phase segregated delay timers,
- directional inverse time earth overcurrent stage I_{Ep} with individual delay timer,
- alternatively directional definite time earth overcurrent stage I_E> with individual delay timer,
- different current time characteristics can be set for phase currents and earth current,
- for phase currents, selection can be made of three standardized characteristics according to IEC or of eight standardized characteristics according ANSI/IEEE of inverse time overcurrent protection,
- for earth current, selection can be made of four standardized characteristics according to IEC or of eight standardized characteristics according ANSI/IEEE of inverse time overcurrent protection,
- alternatively, a user specified current time characteristic can be defined,
- operation direction individually selectable for each of these stages, forwards or reserve,
- the normal overcurrent time stages remain effective as back−up stages.

Earth fault detection

- displacement voltage detection for earth fault annunciation and optional trip,
- detection of the earth−faulted phase when used in isolated or compensated systems.

[1]) only for model 7SJ531★−★★★★**2**−★★★★

The following features of earth fault detection only in model 7SJ531★−★★★★**2**−★★★★:

– two−stage earth current detection; high−value stage I_{EE}>> and low−value stage I_{EE}>,
– can be set independent of the overcurrent time protection stages for highly sensitive earth fault detection (smallest pick−up value 0.003 A),
– low−value stage with inverse time lag or (selectable) definite time lag,
– a user defined inverse time characteristic can be defined,
– each stage can be set directional forwards or reverse or non−directional,
– adjustable directional characteristic,
– can be set to trip or to alarm only,
– compensation of current transformer angle error when used in compensated systems.

Dead−fault protection

– provides high speed operation when switching manually onto a bolted fault.

Automatic reclose function [1])

– single or multi−shot (e.g. RAR and DAR),
– with separately allocated action times for RAR (rapid AR for first shot) and DAR (delayed AR for further shots),
– with separately allocated dead times for RAR (rapid AR for first shot) and DAR (delayed AR for further shots), individually after single−phase fault and after multi−phase faults,
– selection can be made which of the overcurrent and earth fault stages do operate with AR, and which do not.

Distance−to−fault location [1])

– can be started by fault detection of overcurrent time protection, trip command or by external command,
– calculation of the fault distance and output of the fault distance in Ohms (secondary) an kilometers or miles.

Circuit breaker failure protection

– current monitoring and/or processing of the breaker auxiliary contacts,
– initiation by each of the integrated protection functions which lead to trip,
– initiation possible from external protection device via binary input,
– initiation possible from integrated breaker control.

Unbalanced load protection [1])

– processing of the negative sequence component of the currents,
– two−stage trip characteristic.

Thermal overload protection

– provides thermal replica of the current heat losses (with total memory),
– true r.m.s. measurement of all three conductor currents,
– adjustable thermal warning stage,
– adjustable current warning stage,
– adjustable cooling−down factor possible for use on motors.

Start−up time monitor for use on motors [1])

– current dependent trip time by processing of the start−up current of the motor,
– current independent delay time when the rotor is locked.

Restart lockout for motors (optional)

– approximation of the rotor temperature rise,
– release of restart of the motor only below a selectable restart limit,
– consideration of the shut−down procedure and reduced cooling effect during stand−still,
– lockout can be avoided for emergency run−up of the motor.

[1]) only for model 7SJ531★−★★★★**2**−★★★★

Undercurrent supervision [1])

– alarm when the operational current falls below a selectable value (e.g. for motors).

Voltage protection

– two–stage undervoltage protection with additional start–up threshold,

– optional current criterion provides additional release condition,

– independent overvoltage detection.

Control of switching devices

– Manual closing and opening of switching devices via separate operating keys, via binary inputs, via the system interface (e.g. from LSA) or via the operation interface (by means of a personal computer and the communication program DIGSI®),

– feedback of the switching states via the switches' auxiliary contacts,

– indication of the momentary switching state of all switching devices in a feeder mimic diagram.

User definable annunciations

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

– each user defined annunciation can be optionally allocated to trip relays.

Trip circuit supervision [1])

– detection of interruptions or short–circuits in the trip circuit, detection of fault in the mechanical system of the breaker and control voltage failure.

The standard functions also include:

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

– measurement and test routines under normal load conditions:
measurement of load currents and operating voltages,
measurement of power, calculation of power factor and frequency,
metering of active and reactive energy,
calculation of thermal overload,
phase sequence checks,

– annunciation storage and transmission of the last eight network faults, with real time clock,

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

– spontaneous fault indications in the front display after a system fault,

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

– counting of tripping and closing commands,

– elapsed–hour meter [1]): metering the operating time of the protected object under load,

– active status indications of the device or the plant can be read off in the display (status indications),

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

[1]) only for model 7SJ531★–★★★★**2**–★★★★

1.4 Survey of application facilities

The following survey is to ease the application of the various functions of the relay with its maximum complement (Table 1.1). Dependent on the ordered relay model, one or the other function may be missing.

Relay functions which are not used can be de−configured (see Section 5.4.2). The associated setting parameters and annunciations are then invisible. The related sections of this manual can be bypassed.

Protection function	Protected object			Setting addresses		Section
	Overhead line	Cable Transf.	Motor	from...	to	of this manual
Phase overcurrent time protection	yes	yes	yes	1200 ···	1230	6.3.4
Earth overcurrent time protection	yes	yes	yes	1300 ···	1330	6.3.5
Directional phase overcurrent time prot.[1][4]	yes	yes	no	1400 ···	1430	6.3.6
Directional earth overcurrent time prot[1][4]	yes	yes	no	1500 ···	1530	6.3.7
Undervoltage protection	yes	yes	yes	1600 ···	1621	6.3.8
Overvoltage protection	yes	yes	yes	1700 ···	1711	6.3.9
Unbalanced load protection [1]	yes	yes	yes	1800 ···	1805	6.3.10
Startup time supervision [1]	no	no	yes	2100 ···	2104	6.3.11
Thermal overload protection	no	yes	yes	2700 ···	2710	6.3.12
Restart lockout [1]	no	no	yes	2800 ···	2808	6.3.13
Highly sensitive earth fault detection [2]	yes	yes	yes	3000 ...	3030	6.3.15
Automatic reclosure [3]	yes	no	no	3400 ···	3447	6.3.16
Trip circuit supervision [1]	yes	yes	yes	3700 ...	3702	6.3.17
Fault location [1]	yes	yes	no	3800 ...	3802	6.3.18
Breaker failure protection	yes	yes	yes	3900 ...	3907	6.3.19

[1] only for model 7SJ531⋆−⋆⋆⋆⋆2−⋆⋆⋆⋆
[2] only for model 7SJ531⋆−⋆⋆⋆⋆⋆−0⋆⋆⋆ and −1⋆⋆⋆
[3] only for model 7SJ531⋆−⋆⋆⋆⋆⋆−0⋆⋆⋆ and −2⋆⋆⋆
[4] only for model 7SJ531⋆−⋆⋆⋆⋆⋆−⋆⋆⋆1

Table 1.1 Assignment of protection functions and protected objects

2 Design

2.1 Arrangements

All protection and control functions including dc/dc converter are accommodated on three plug−in modules of Double Europa Format. The modules are installed in a housing 7XP20, interconnected by means of a ribbon cable and provided with a common front plate. The following types of housing can be delivered:

– **7SJ531⋆−⋆B⋆⋆⋆−** in housing 7XP2030−1 for **panel surface mounting** [1])

  The housing has full sheet−metal covers, as well as a removable front cover made of plastic profiles.

  Inside the casing there are rail mats for mounting and fixing of the printed circuit boards. The inner part of the casing is free from enamel and thus functions as a large contact plane with solid electrical conductivity for the earthing blades of the modules. 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.

  The optional interface to a central control and storage unit (7SJ531⋆−⋆⋆⋆⋆⋆−⋆**C**⋆⋆) is led to a module with 2 F−SMA connectors for optical fibre connection with 820 nm wave length.

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

– **7SJ531⋆−⋆E⋆⋆⋆−** in housing 7XP2030−2 for **panel flush mounting** or **cubicle installation**

  The housing is built of a tube of German silver with a device−specific rear plate, a front−plate and a removable (fixed by screws) front cover made of plastic profiles.

  Inside the casing there are rail mats for mounting and fixing of the printed circuit boards. The inner part of the casing is free from enamel and thus functions as a large contact plane with solid electrical conductivity for the earthing blades of the modules. 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. 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. Care must be taken to ensure proper strain relief and the permissible bending radius.

  The heavy duty current plug connectors provide automatic shorting of the c.t. circuits whenever the module is withdrawn. This does not release from the care to be taken when c.t. secondary circuits are concerned.

  The optional interface to a central control and storage unit (7SJ531⋆−⋆⋆⋆⋆⋆−⋆**C**⋆⋆) is led to a module with 2 F−SMA connectors for optical fibre connection with 820 nm wave length.

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

  Degree of protection for the housing is IP 51, for the terminals IP 21. For dimensions please refer to Figure 2.3.

[1]) only for model 7SJ531⋆−⋆⋆⋆⋆**2**−⋆⋆⋆⋆

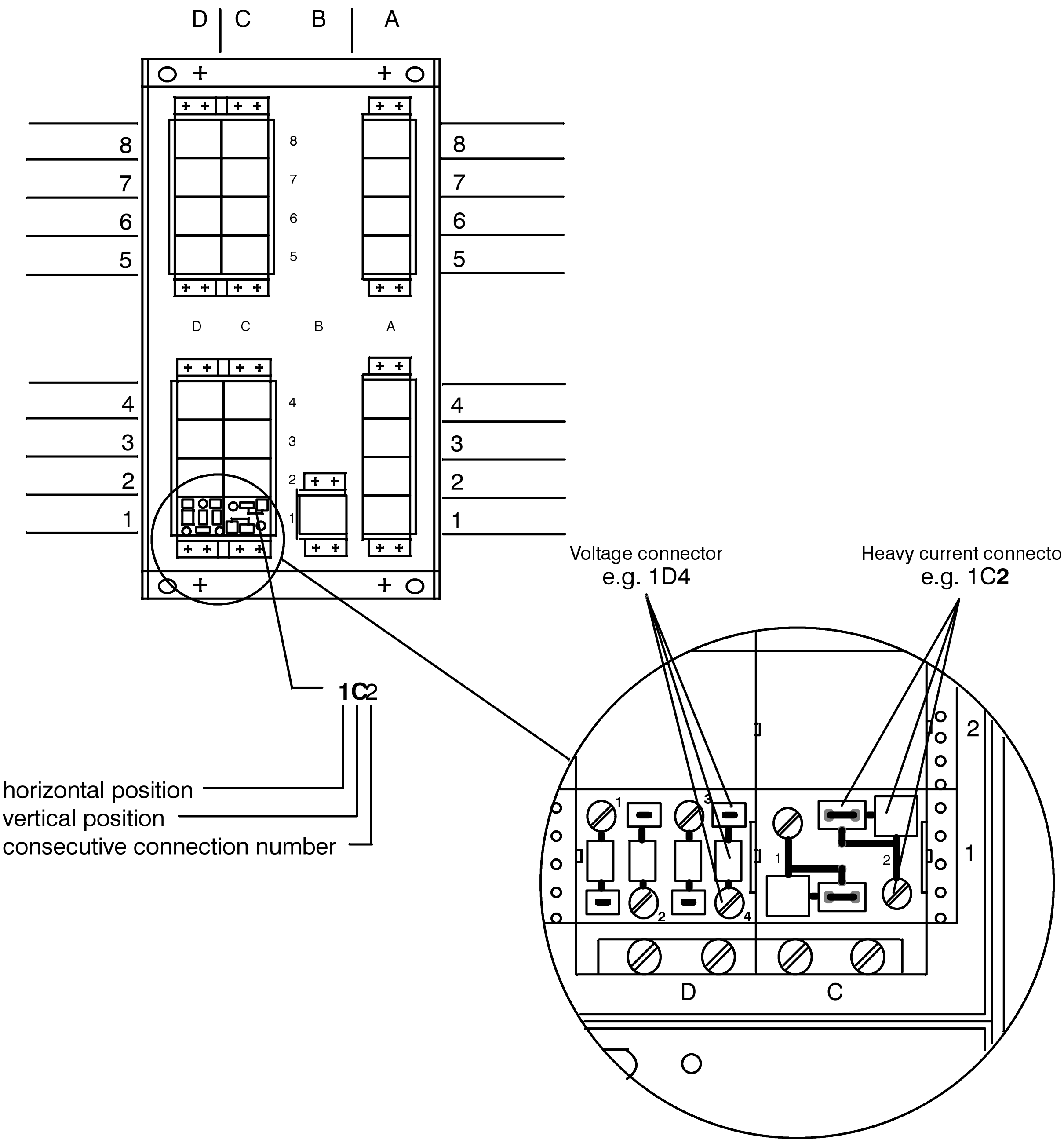
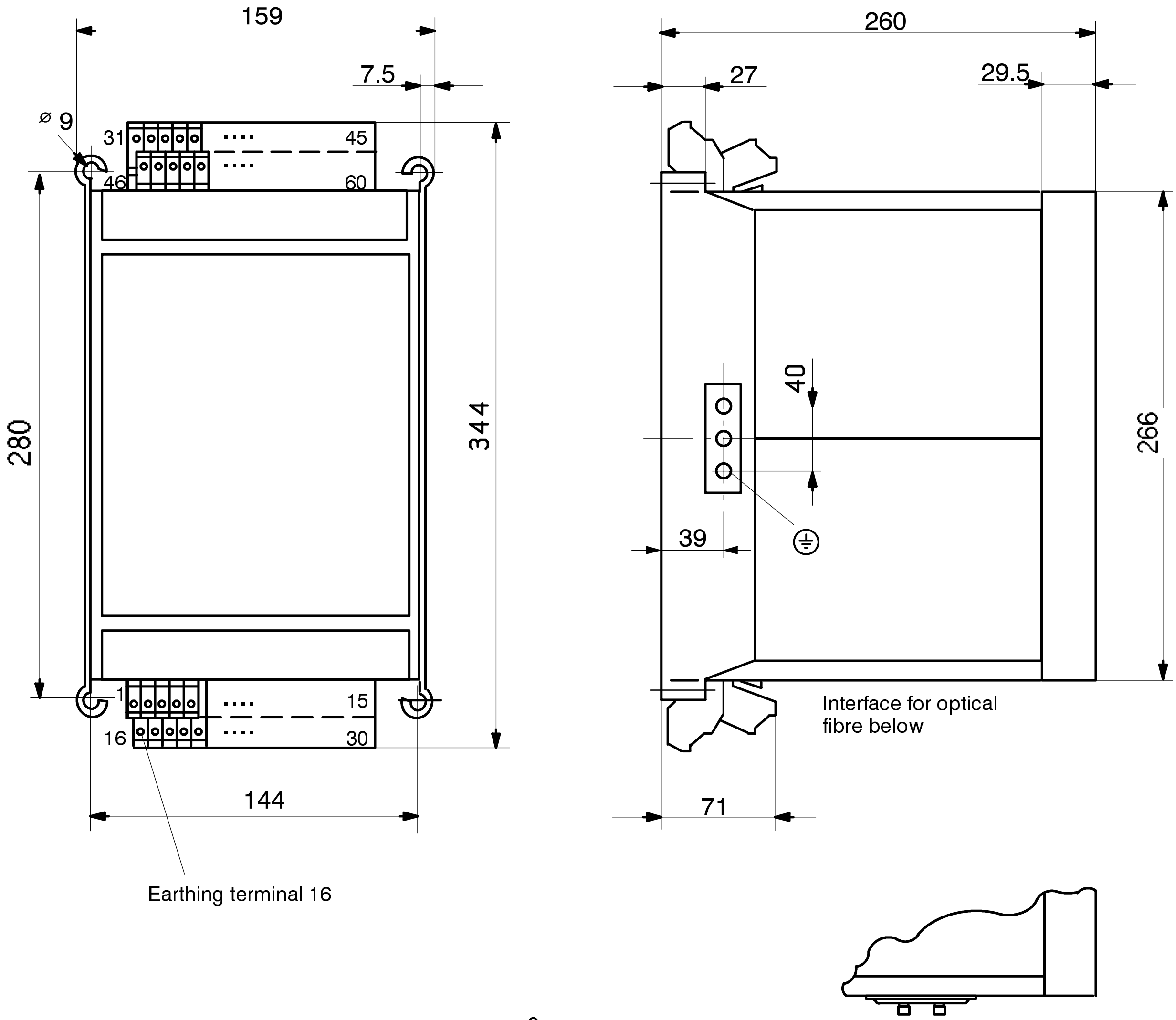


Figure 2.1 Connection plugs (rear view) – housing for flush mounting – example

2.2 Dimensions

7SJ531 Housing for **panel surface mounting** 7XP2030−1



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

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

Dimensions in mm

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

7SJ531 Housing for **panel flush mounting** or **cubicle installation** 7XP2030−2

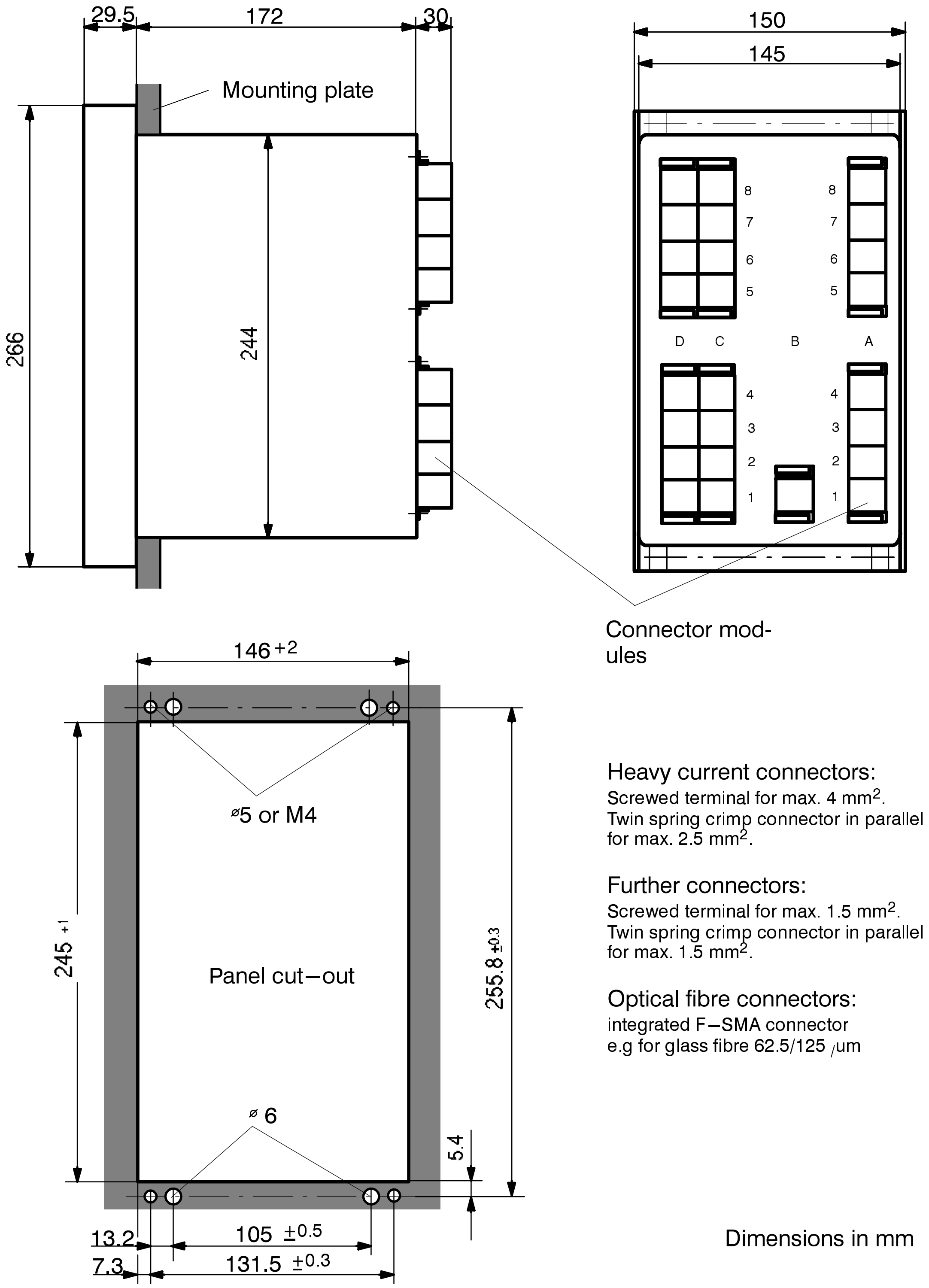


Figure 2.3 Dimensions for housing 7XP2030−2 for panel flush mounting or cubicle installation

2.3 Ordering data

Numerical Line and Motor Protection Relay with Control Functions 7 S J 5 3 1 [7.] – [8.] [9.] [10. A] [11.] [12.] – [13.] [14.] [15. A] [16.]

Rated current; rated frequency (7.)

1 A; 50/60 Hz 1

5 A; 50/60 Hz 5

Rated auxiliary voltage (8.)

24/48 V dc 2

60/110/125 V dc 4

220/250 V dc 5

Construction (9.)

in housing 7XP2030−1 for panel surface mounting .... B

in housing 7XP2030−2 for panel flush mounting
or for cubicle installation (without glass front) .... E

Operating language (11.)

German, English 0

German, French 1

German, Polish 2

Version (12.)

Firmware version 3.1 (only with ”E” at the 9th digit and ”0” at the 11th, 13th, and 16th digit) 0

Firmware version 3.2 2

Complement (13.)

with highly sensitive earth fault protection (U_0, direction), with auto−reclosure 0

with highly sensitive earth fault protection (U_0, direction), without auto−reclosure 1

without highly sensitive earth fault protection, with auto−reclosure 2

without highly sensitive earth fault protection, without auto−reclosure 3

Serial interface for coupling to a control centre (14.)

without serial interface .... A

with serial interface for optical fibre connection C

Additional functions (16.)

without direction determination 0

with direction determination 1

3 Technical data

3.1 General data

3.1.1 Inputs/outputs

Measuring circuits

Rated current I_N	1 A or 5 A
Rated voltage U_N	100 V to 125 V (settable)
Rated frequency f_N	50 Hz or 60 Hz (settable)
Burden: c.t. circuits per phase and residual path	
– at I_N = 1 A	$\leq$ 0.1 VA
– at I_N = 5 A	$\leq$ 0.5 VA
– for highly sensitive earth fault detection at 1 A[1])	approx 0.3 VA
Burden: v.t. circuits at 100 V	$\leq$ 0.5 VA
Overload capability c.t. circuits, phases and earth	
– thermal (r.m.s.)	100 $\times I_N$ for 1 second
	20 $\times I_N$ for 10 seconds
	4 $\times I_N$ continuous
– dynamic (impulse)	250 $\times I_N$ (half cycle)
Overload capability c.t. circuit for highly sensitive earth fault detection [1])	
– thermal (r.m.s.)	300 A for 1 second
	100 A for 10 seconds
	15 A continuous
Overload capability v.t. circuits	
– thermal (r.m.s.)	140 V continuous

Auxiliary d.c. supply

Auxiliary d.c. voltage supply via integrated d.c./d.c. converter

Auxiliary voltage U_H	24/48 V dc	60/110/125 V dc	220/250 V dc
Operating ranges	19 to 56 V dc	48 to 144 V dc	176 to 288 V dc

Superimposed ac voltage, peak–to–peak	$\leq$ 12 % at rated voltage $\leq$ 6 % at the limits of the voltage ranges
Power consumption quiescent	approx 6 W
picked up	approx 13 W
Bridging time during failure/short–circuit of auxiliary dc voltage	$\geq$ 50 ms at U $\geq$ 110 V dc

[1]) only for model 7SJ531★–★★★★**2**–★★★★

Heavy duty (trip) contacts

	7SJ531★−★★★★**0**−	7SJ531★−★★★★**2**−
Trip relays, number	2	4

Contacts per relay		2 NO or 1 NO
Switching capacity	MAKE	1000 W/VA
	BREAK	30 W/VA
Switching voltage		250 V
Permissible current		5 A continuous
		30 A for 0.5 s

Signal contacts

Signal relays, number		5
Contacts per relay		1 CO
Switching capacity	MAKE/BREAK	20 W/VA
Switching voltage		250 V
Permissible current		1 A

Binary inputs, number 11

Voltage range 24 to 250 V dc

pick−up threshold reconnectable by solder bridges in 3 ranges:

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

Pick−up time/drop−off time	approx 2 ms
Current consumption	approx 1.7 mA, independent on operating voltage

Serial interfaces

Operator terminal interface	non−isolated
− Connection	at the front, 9−pole subminiature connector according ISO 2110 for connection of a personal computer or similar
− Transmission speed	as delivered 9600 Baud; min. 1200 Baud; max. 19200 Baud
Interface for data transfer to a control centre	isolated (optional)
− Protocol	according to VDEW/ZVEI and IEC 870−5−103
− Transmission speed	as delivered 9600 Baud; min. 1200 Baud; max. 19200 Baud
− Transmission security	Hamming distance d = 4
− Connection optical fibre	integrated F−SMA connector for direct optical fibre connection, with ceramic post, e.g. glass fibre 62.5/125 µm for flush mounted housing: at the rear
Optical wave length	820 nm
Permissible line attenuation	max. 8 dB
Transmission distance	max. 1.5 km
Normal signal position	reconnectable; factory setting: ”light off”

3.1.2 Electrical tests

Insulation tests	
Standards:	IEC 255−5
− High voltage test (routine test) except d.c. voltage supply input	2 kV (r.m.s.), 50 Hz
− High voltage test (routine test) only d.c. voltage supply input	2.8 kV dc
− Impulse voltage test (type test) all circuits, class III	5 kV (peak); 1.2/50 μs; 0.5 J; 3 positive and 3 negative shots at intervals of 5 s
EMC tests; immunity (type tests)	
Standards:	IEC 255−6, IEC 255−22 (product standards) EN 50082−2 (generic standard) VDE 0435 /part 303
− High frequency IEC 255−22−1, class III	2.5 kV (peak); 1 MHz; τ =15 μs; 400 shots/s; duration 2 s
− Electrostatic discharge IEC 255−22−2 class III and IEC 1000−4−2, class III	4 kV/6 kV contact discharge; 8 kV air discharge; both polarities; 150 pF; R_i = 330 Ω
− Radio−frequency electromagnetic field, non−modulated; IEC 255−22−3 (report) class III	10 V/m; 27 MHz to 500 MHz
− Radio−frequency electromagnetic field, amplitude modulated; IEC 1000−4−3, class III	10 V/m; 80 MHz to 1000 MHz; 80 % AM; 1 kHz
− Radio−frequency electromagnetic field, pulse modulated; IEC 1000−4−3/ENV 50204, class III	10 V/m; 900 MHz; repetition frequency 200 Hz; duty cycle 50 %
− Fast transients IEC 255−22−4 and IEC 1000−4−4, class III	2 kV; 5/50 ns; 5 kHz; burst length 15 ms; repetition rate 300 ms; both polarities; R_i = 50 Ω; duration 1 min
− Conducted disturbances induced by radio−frequency fields, amplitude modulated IEC 1000−4−6, class III	10 V; 150 kHz to 80 MHz; 80 % AM; 1 kHz
− Power frequency magnetic field IEC 1000−4−8, class IV IEC 255−6	 30 A/m continuous; 300 A/m for 3 s; 50 Hz 0.5 mT; 50 Hz
EMC tests; emission (type tests)	
Standard:	EN 50081−⋆ (generic standard)
− Conducted interference voltage, aux. voltage CISPR 22, EN 55022, class B	150 kHz to 30 MHz
− Interference field strength CISPR 11, EN 55011, class A	30 MHz to 1000 MHz

3.1.3 Mechanical stress tests

Vibration and shock during operation	
Standards:	IEC 255−21 and IEC 68−2
− Vibration IEC 255−21−1, class 1 IEC 68−2−6	sinusoidal 10 Hz to 60 Hz: ± 0.035 mm amplitude; 60 Hz to 150 Hz: 0.5 g acceleration sweep rate 1 octave/min 20 cycles in 3 orthogonal axes
− Shock IEC 255−21−2, class 1	half sine acceleration 5 g, duration 11 ms, 3 shocks in each direction of 3 orthogonal axes
− Seismic vibration IEC 255−21−3, class 1 IEC 68−3−3	sinusoidal 1 Hz to 8 Hz: ± 3.5 mm amplitude (hor. axis) 1 Hz to 8 Hz: ± 1.5 mm amplitude (vert. axis) 8 Hz to 35 Hz: 1 g acceleration (hor. axis) 8 Hz to 35 Hz: 0.5 g acceleration (vert. axis) sweep rate 1 octave/min 1 cycle in 3 orthogonal axes
Vibration and shock during transport	
Standards:	IEC 255−21 and IEC 68−2
− Vibration IEC 255−21−1, class 2 IEC 68−2−6	sinusoidal 5 Hz to 8 Hz: ± 7.5 mm amplitude; 8 Hz to 150 Hz: 2 g acceleration sweep rate 1 octave/min 20 cycles in 3 orthogonal axes
− Shock IEC 255−21−2, class 1 IEC 68−2−27	half sine acceleration 15 g, duration 11 ms, 3 shocks in each direction of 3 orthogonal axes
− Continuous shock IEC 255−21−2, class 1 IEC 68−2−29	half sine acceleration 10 g, duration 16 ms, 1000 shocks each direction of 3 orthogonal axes

3.1.4 Climatic stress tests

− Permissible ambient temperature

during service	−5 °C to +55 °C
during storage	−25 °C to +55 °C
during transport	−25 °C to +70 °C

Storage and transport with standard works packaging!

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

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

3.1.5 Service conditions

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

– All contactors and relays which operate in the same cubicle or on the same relay panel as the digital protection equipment should, as a rule, be fitted with suitable spike quenching elements.

– All external connection leads in sub–stations from 100 kV upwards should be screened with a screen capable of carrying power currents and earthed at both sides. No special measures are normally necessary for sub–stations of lower voltages.

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

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

3.1.6 Design

Housing	7XP20; refer to Section 2.1
Dimensions	refer to Section 2.2
Weight	
– in housing for surface mounting	approx. 7.5 kg
– in housing for flush mounting	approx. 6 kg
Degree of protection acc. to EN 60529	
– Housing	IP 51
– Terminals	IP 21

3.2 Definite time overcurrent protection

Setting range/steps

Overcurrent pick−up I> (phases)	I/I_N	0.10 to 25.00 (steps 0.01) or ∞ (infinite, no pick−up)
Overcurrent pick−up I_E> (earth)	I/I_N	0.05 to 25.00 (steps 0.01) or ∞ (infinite, no pick−up)
Overcurrent pick−up I>> (phases)	I/I_N	0.10 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)

The set times are pure delay times

Times

Pick−up times for I>, I>>, I_E>, I_E>>	
− at 2 x setting value, without meas. repetition	approx 33 ms
− at 2 x setting value, with meas. repetition	approx 43 ms
− at 5 x setting value, without meas. repetition	approx 25 ms
− at 5 x setting value, with meas. repetition	approx 35 ms

Reset times

I>, I>>, I_E>, I_E>>	approx 33 ms
Reset ratios	approx 0.95 for $I/I_N \geq 0.3$
Overshot time	approx 33 ms

Tolerances

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

Influence variables

− Auxiliary voltage in range $0.8 \leq U_H/U_{HN} \leq 1.15$	1 %
− Temperature in range $0\ °C \leq \vartheta_{amb} \leq 55\ °C$	0.5 %/10 K
− Frequency in range $f_N \pm 5$ Hz	1 %
− Harmonics up to 10 % of 3rd harmonic up to 10 % of 5th harmonic	 1 % 1 %

3.3 Inverse time overcurrent protection

Setting range/steps

Overcurrent pick−up I_p> (phases)	I/I_N	0.10 to 4.00 (steps 0.01) or ∞ (infinite, no pick−up)
Overcurrent pick−up I_{Ep}> (earth)	I/I_N	0.05 to 4.00 (steps 0.01) or ∞ (infinite, no pick−up)
Time multiplier T for I_p, I_{Ep}	(IEC−characteristic)	0.05 s to 3.20 s (steps 0.01 s); or ∞
Time multiplier D for I_p, I_{Ep}	(ANSI−characteristic)[1]	0.50 to 15.00 (steps 0.01); or ∞
Overcurrent pick−up I>> (phases)	I/I_N	0.10 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 255−3 and BS 142 (refer to Figure 3.1)

Normal inverse (IEC 255−3 type A)
$$t = \frac{0.14}{(I/I_p)^{0.02} - 1} \cdot T_p$$

Very inverse (IEC 255−3 type B)
$$t = \frac{13.5}{(I/I_p)^{1} - 1} \cdot T_p$$

Extremely inverse (IEC 255−3 type C)
$$t = \frac{80}{(I/I_p)^{2} - 1} \cdot T_p$$

Additionally for earth current (refer Figure 3.2):

Long time inverse (IEC 255−3 type B)
$$t = \frac{120}{(I/I_p)^{1} - 1} \cdot T_p$$

where:

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

In model 7SJ531★−★★★★2−, one additional user specified characteristic can be set.

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

Drop−off threshold approx. $1.05 \cdot I_p$

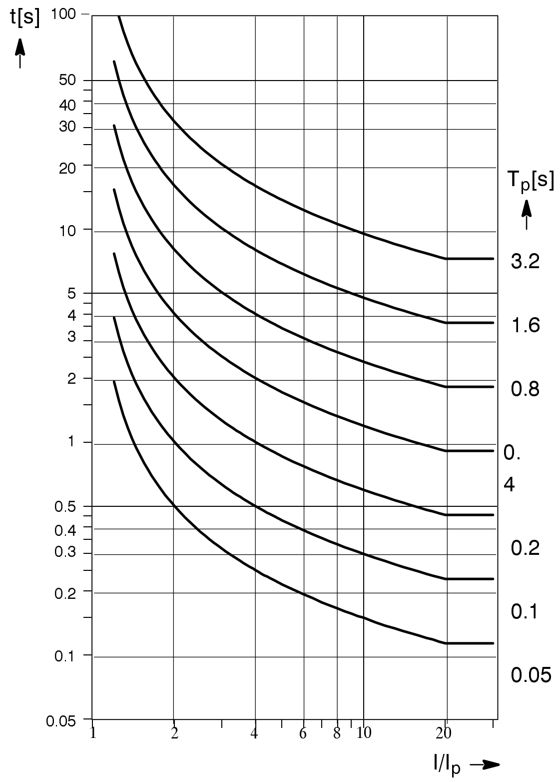
Tolerances

− Pick−up values I>>, I_E>>, I_p, I_{Ep}	3 % of setting value
− Delay time for $2 \leq I/I_p \leq 20$	5 % of setting value additionally 2 % current tolerance or 30 ms

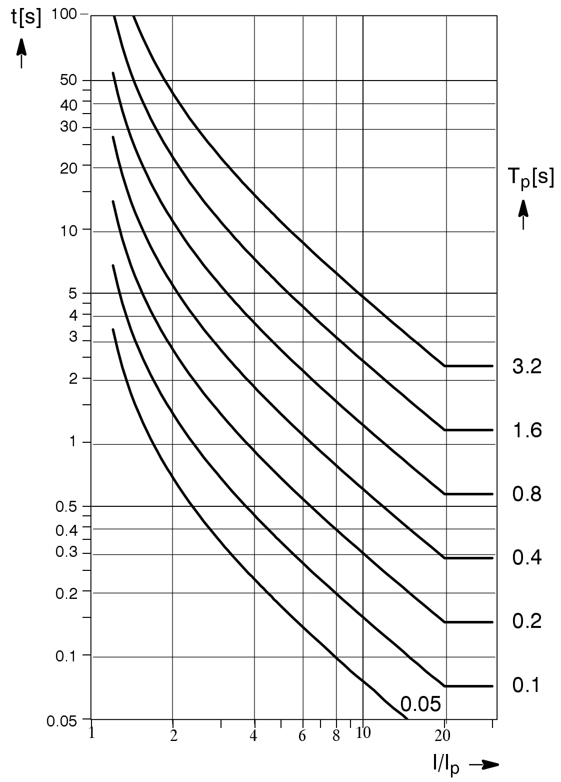
Influence variables

− Auxiliary voltage in range $0.8 \leq U_H/U_{HN} \leq 1.15$	1 %
− Temperature in range $0\ °C \leq \vartheta_{amb} \leq 40\ °C$	0.5 %/10 K
− Frequency in range $f_N \pm 5$ Hz	1 %

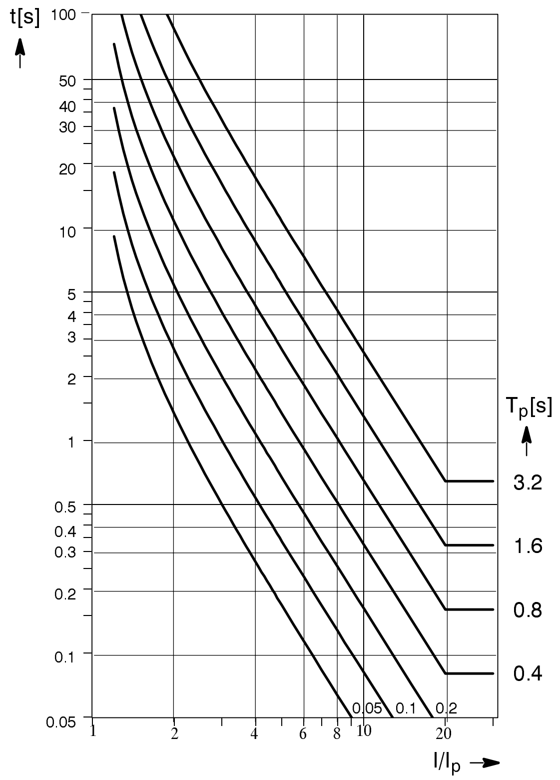
[1]) only for model 7SJ531★−★★★★**2**−★★★★



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



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

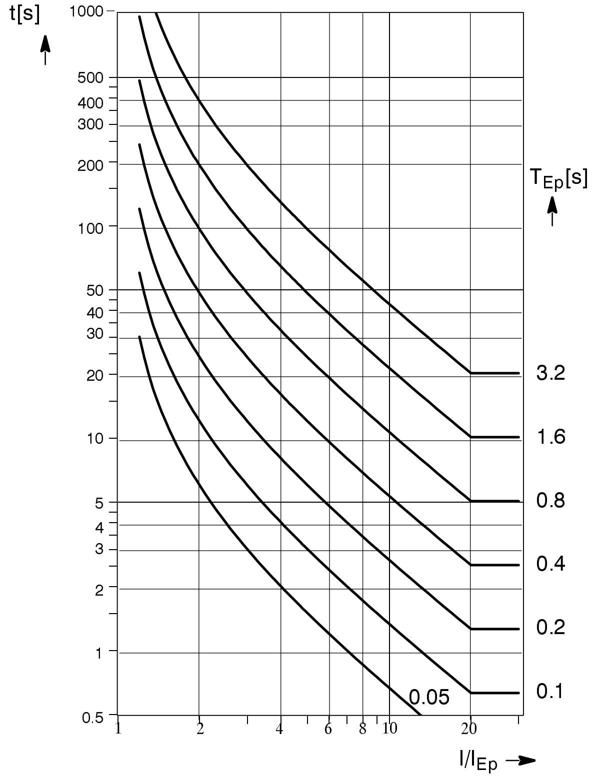


Extremely inverse: $t = \dfrac{80}{(I/I_p)^2 - 1} \cdot T_p \; [s]$

t tripping time
T_p set time multiplier
I earth fault current
I_p set earth fault pick−up value

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

Figure 3.1 Trip time characteristics of inverse time overcurrent protection, according IEC



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

t trip time
T_{Ep} set time multiplier
I Fault current
I_{Ep} Set pick−up current

Figure 3.2 Trip time characteristic of inverse time overcurrent protection, according IEC (for earth faults only)

Note concerning the characteristics Figure 3.2:

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

Trip time characteristics acc. ANSI/IEEE (in model 7SJ531★−★★★★2− only)

(refer to Figures 3.3 and 3.4)

Inverse

$$t = \left(\frac{8.9341}{(I/I_p)^{2.0938} - 1} + 0.17966 \right) \cdot D$$

Short inverse ("short inverse")

$$t = \left(\frac{0.2663}{(I/I_p)^{1.2969} - 1} + 0.03393 \right) \cdot D$$

Long inverse ("long inverse")

$$t = \left(\frac{5.6143}{(I/I_p) - 1} + 2.18592 \right) \cdot D$$

Moderately inverse ("moderately inv")

$$t = \left(\frac{0.0103}{(I/I_p)^{0.02} - 1} + 0.0228 \right) \cdot D$$

Very inverse ("very inverse")

$$t = \left(\frac{3.922}{(I/I_p)^{2} - 1} + 0.0982 \right) \cdot D$$

Extremely inverse ("extremely inv")

$$t = \left(\frac{5.64}{(I/I_p)^{2} - 1} + 0.02434 \right) \cdot D$$

definite inverse ("definite inv")

$$t = \left(\frac{0.4797}{(I/I_p)^{1.5625} - 1} + 0.21359 \right) \cdot D$$

I−squared−t ("I−squared−T")

$$t = \frac{50.7 \cdot D + 10.14}{(I/I_p)^2}$$

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

Validity range $1.1 \leq I/Ip \leq 20$; trip times do not reduce beyond $I/Ip \geq 20$.

Pick−up threshold approx. $1.10 \cdot I_p$

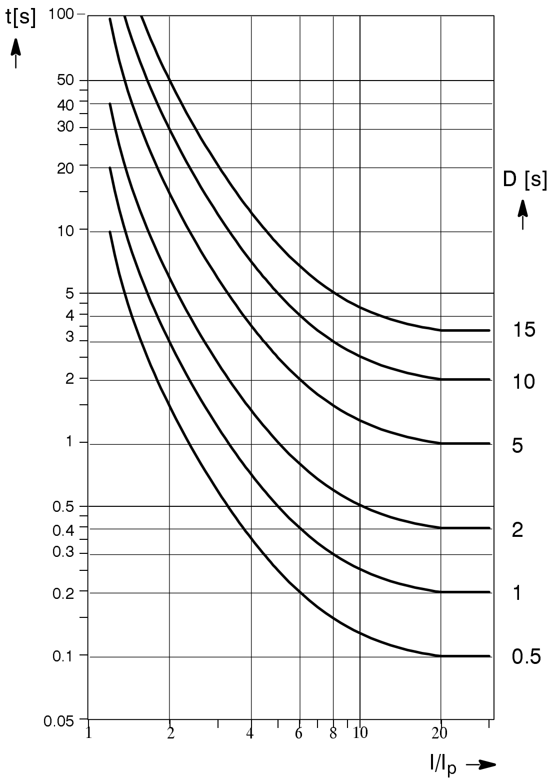
Drop−off threshold approx. $1.05 \cdot I_p$

Tolerances

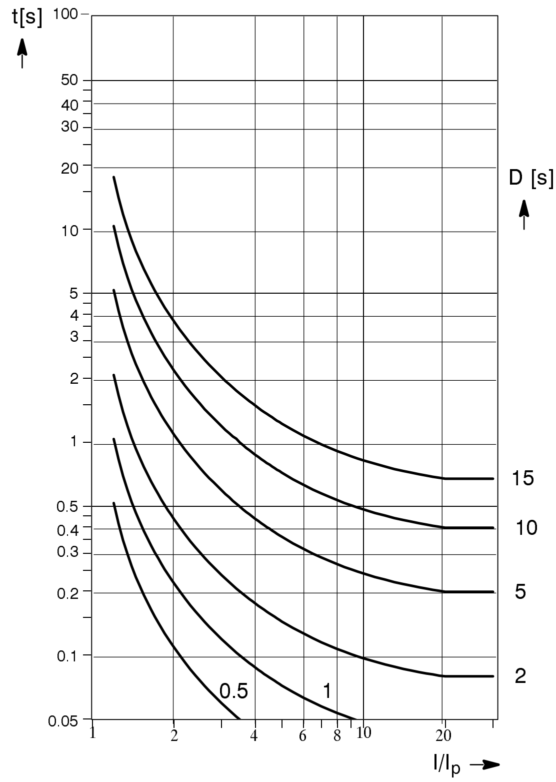
− Pick−up values	5 %
− Delay time for $2 \leq I/I_p \leq 20$ and $0.5 \leq I/I_N \leq 25$	5 % of theoretical value ± 2 % current tolerance; at least 30 ms

Influence variables

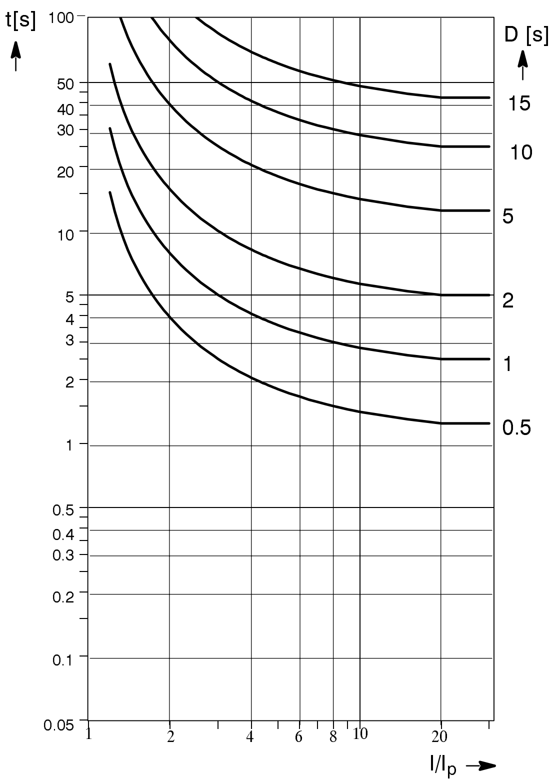
− Auxiliary voltage in range $0.8 \leq U_H/U_{HN} \leq 1.2$	$\leq$ 1 %
− Temperature in range $-5\ °C \leq \vartheta_{amb} \leq 40\ °C$	$\leq$ 0.5 %/10 K
− Frequency in range $0.95 \leq f/f_N \leq 1.05$	$\leq$ 1 % referred to theoretical time value



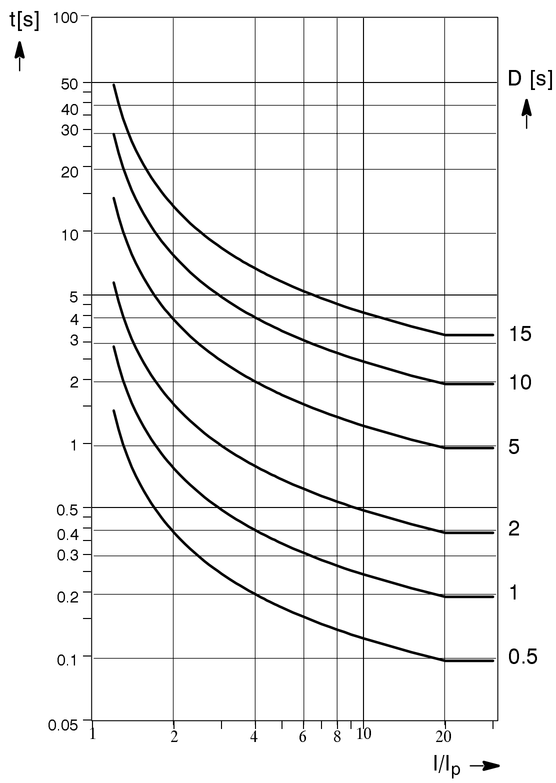
Inverse: $t = \left(\frac{8.9341}{(I/I_p)^{2.0938} - 1} + 0.17966 \right) \cdot D$ [s]



short inverse: $t = \left(\frac{0.2663}{(I/I_p)^{1.2969} - 1} + 0.03393 \right) \cdot D$ [s]

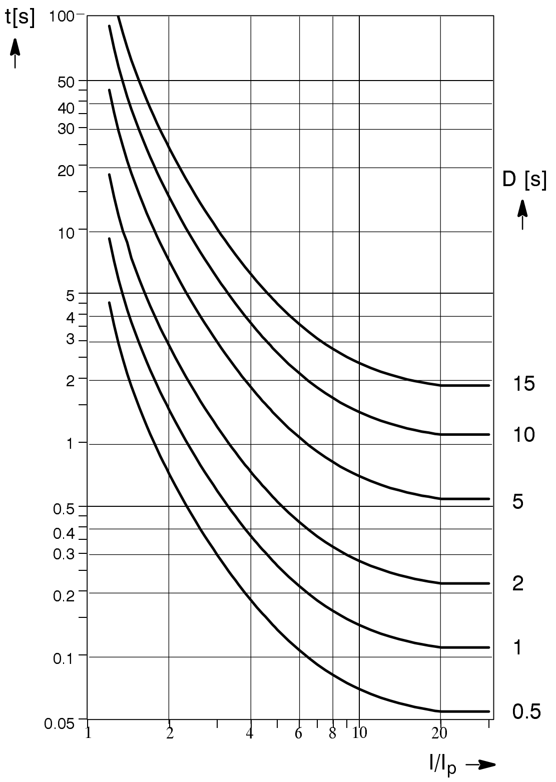


long inverse: $t = \left(\frac{5.6143}{(I/I_p) - 1} + 2.18592 \right) \cdot D$ [s]

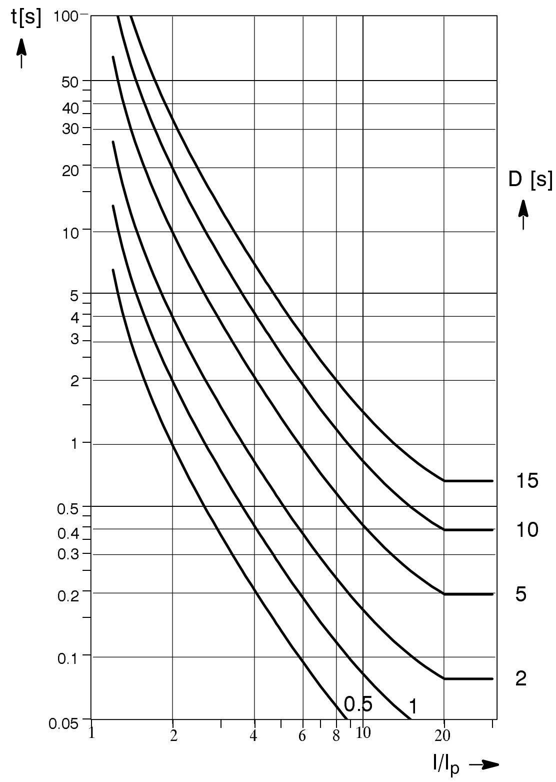


moderately inverse: $t = \left(\frac{0.0103}{(I/I_p)^{0.02} - 1} + 0.0228 \right) \cdot D$ [s]

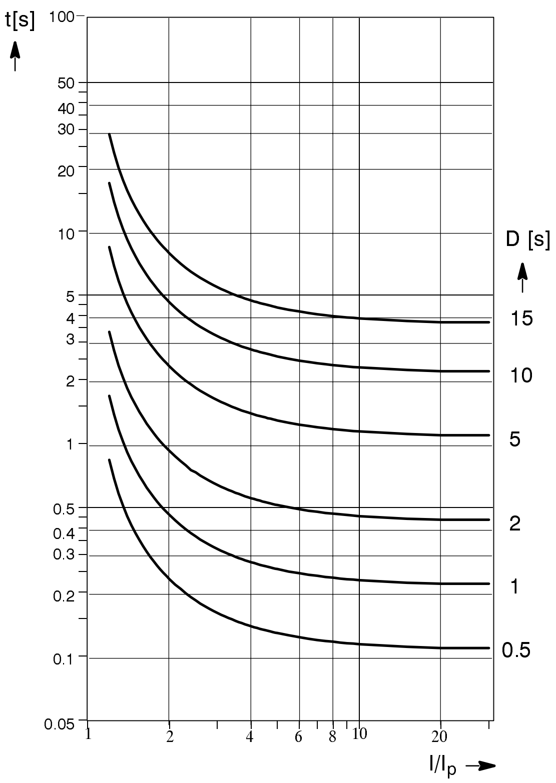
Figure 3.3 Trip time characteristic of inverse time overcurrent protection, according ANSI/IEEE (in model 7SJ531★−★★★★2− only)



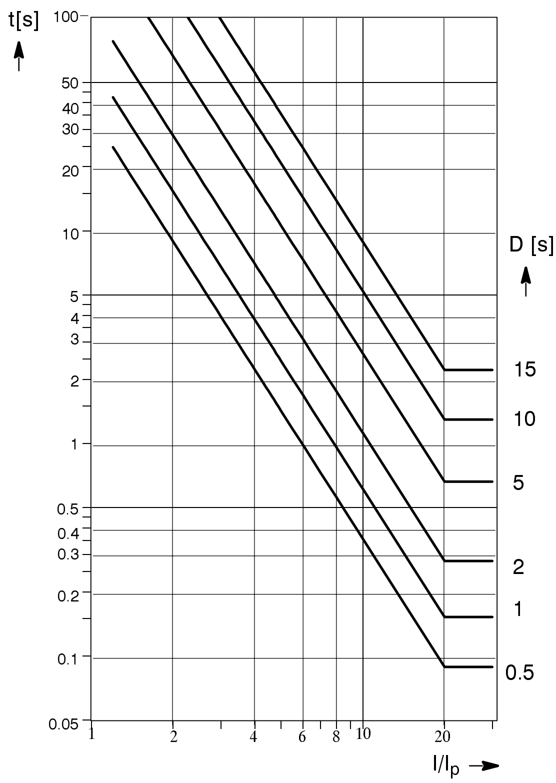
very inverse: $t = \left(\frac{3.922}{(I/I_p)^2 - 1} + 0.0982\right) \cdot D\ [s]$



extremely inverse: $t = \left(\frac{5.64}{(I/I_p)^2 - 1} + 0.02434\right) \cdot D\ [s]$



definite inverse: $t = \left(\frac{0.4797}{(I/I_p)^{1.5625} - 1} + 0.21359\right) \cdot D\ [s]$



i−squared−t: $t = \frac{50.7 \cdot D + 10.14}{(I/I_p)^2}\ [s]$

Figure 3.4 Trip time characteristic of inverse time overcurrent protection, according ANSI/IEEE (in model 7SJ531★−★★★★2− only)

3.4 Directional definite time overcurrent protection (optional [1])

Setting range/steps

Overcurrent pick–up I> (phases)	I/I_N	0.10 to 25.00 (steps 0.01) or ∞ (infinite, no pick–up)
Overcurrent pick–up I_E> (earth)	I/I_N	0.05 to 25.00 (steps 0.01) or ∞ (infinite, no pick–up)
Overcurrent pick–up I>> (phases)	I/I_N	0.10 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)

The set times are pure delay times

Times

Pick–up times for I> DIR., I>> DIR., I_E> DIR., I_E>> DIR.

– at 2 x setting value	approx 49 ms
– at 5 x setting value	approx 39 ms

Reset times

I> DIR., I>> DIR., I_E> DIR., I_E>> DIR.	approx 33 ms
Reset ratios	approx 0.95 for $I/I_N \geq 0.3$
Overshot time	approx 33 ms

Tolerances

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

Influence variables

– Auxiliary voltage in range $0.8 \leq U_H/U_{HN} \leq 1.15$	1 %
– Temperature in range $0\ °C \leq \vartheta_{amb} \leq 55\ °C$	0.5 %/10 K
– Frequency in range $f_N \pm 5$ Hz	1 %
– Harmonics up to 10 % of 3rd harmonic up to 10 % of 5th harmonic	 1 % 1 %

[1]) only for model 7SJ531⋆–⋆⋆⋆⋆**2**–⋆⋆⋆⋆

Direction determination for phase faults

Measurement method	phase current polarized with quadrature voltages; with memorized voltage (memory depth 2 a.c. periods) if polarizing voltages too small
”Forwards” area	−41° to +131° (if quadrature voltage is rectangular with respect to the fault voltage)
Directional sensitivity	unlimited for single−phase and two−phase faults for three−phase faults dynamically unlimited, steady−state approx. 7 V phase−to−phase

Direction determination for earth faults

Measurement method	earth current polarized with displacement voltage
”Forwards” area	−41° to +131°
Directional sensitivity	approx. 1 V displacement voltage

Tolerances and influencing variables

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

3.5 Directional inverse time overcurrent protection (optional [1])

Setting range/steps

Overcurrent pick−up I_p> (phases)	I/I_N	0.10 to 4.00	(steps 0.01) or ∞ (infinite, no pick−up)
Overcurrent pick−up I_{Ep}> (earth)	I/I_N	0.05 to 4.00	(steps 0.01) or ∞ (infinite, no pick−up)
Time multiplier T for I_p, I_{Ep}	(IEC−characteristic)	0.05 s to 3.20 s	(steps 0.01 s); or ∞
Time multiplier D for I_p, I_{Ep}	(ANSI−characteristic)	0.50 to 15.00	(steps 0.01); or ∞
Overcurrent pick−up I>> (phases)	I/I_N	0.10 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 255−3 and BS 142 (refer to Figure 3.1)

Normal inverse (IEC 255−3 type A)

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

Very inverse (IEC 255−3 type B)

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

Extremely inverse (IEC 255−3 type C)

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

Additionally for earth current (refer Figure 3.2):

Long time inverse (IEC 255−3 type B)

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

where:

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

In model 7SJ531★−★★★★2− a user specified characteristic can be set.

Pick−up threshold approx. 1.1 · I_p

Drop−off threshold approx. 1.05 · I_p

Tolerances

− Pick−up values I>>, I_E>>	3 % of setting value
− Delay time for $2 \leq I/I_p \leq 20$	5 % of setting value additionally 2 % current tolerance or 30 ms

Influence variables

− Auxiliary voltage in range $0.8 \leq U_H/U_{HN} \leq 1.15$	1 %
− Temperature in range $0\ °C \leq \vartheta_{amb} \leq 40\ °C$	0.5 %/10 K
− Frequency in range $f_N \pm 5$ Hz	1 %

[1]) only for model 7SJ531★−★★★★**2**−★★★★

Trip time characteristics acc. ANSI/IEEE (refer to Figures 3.3 and 3.4)

Inverse

$$t = \left(\frac{8.9341}{(I/I_p)^{2.0938} - 1} + 0.17966 \right) \cdot D$$

Short inverse ("short inverse")

$$t = \left(\frac{0.2663}{(I/I_p)^{1.2969} - 1} + 0.03393 \right) \cdot D$$

Long inverse ("long inverse")

$$t = \left(\frac{5.6143}{(I/I_p) - 1} + 2.18592 \right) \cdot D$$

Moderately inverse ("moderately inv")

$$t = \left(\frac{0.0103}{(I/I_p)^{0.02} - 1} + 0.0228 \right) \cdot D$$

Very inverse ("very inverse")

$$t = \left(\frac{3.922}{(I/I_p)^{2} - 1} + 0.0982 \right) \cdot D$$

Extremely inverse ("extremely inv")

$$t = \left(\frac{5.64}{(I/I_p)^{2} - 1} + 0.02434 \right) \cdot D$$

definite inverse ("definite inv")

$$t = \left(\frac{0.4797}{(I/I_p)^{1.5625} - 1} + 0.21359 \right) \cdot D$$

I–squared–t ("I–squared–T")

$$t = \frac{50.7 \cdot D + 10.14}{(I/I_p)^2}$$

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

Validity range $1.1 \leq I/Ip \leq 20$; trip times do not reduce beyond $I/Ip \geq 20$.

Pick–up threshold	approx. $1.10 \cdot I_p$
Drop–off threshold	approx. $1.05 \cdot I_p$

Tolerances

– Pick–up values	5 %
– Delay time for $2 \leq I/I_p \leq 20$ and $0.5 \leq I/I_N \leq 25$	5 % of theoretical value ± 2 % current tolerance; at least 30 ms

Influence variables

– Auxiliary voltage in range $0.8 \leq U_H/U_{HN} \leq 1.2$	≤ 1 %
– Temperature in range $-5\ °C \leq \vartheta_{amb} \leq 40\ °C$	≤ 0.5 %/10 K
– Frequency in range $0.95 \leq f/f_N \leq 1.05$	≤ 1 % referred to theoretical time value

Direction determination for phase faults

Measurement method	phase current polarized with quadrature voltages; with memorized voltage (memory depth 2 a.c. periods) if polarizing voltages too small
”Forwards” area	−41° to +131° (if quadrature voltage is rectangular with respect to the fault voltage)
Directional sensitivity	unlimited for single−phase and two−phase faults for three−phase faults dynamically unlimited, steady−state approx. 7 V phase−to−phase

Direction determination for earth faults

Measurement method	earth current polarized with displacement voltage
”Forwards” area	−41° to +131°
Directional sensitivity	approx. 1 V displacement voltage

Tolerances and influencing variables

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

3.6 Voltage protection

Setting ranges/steps

Undervoltage (phase–to–earth or phase–to–phase)	U<	30 V to 120 V	(steps 1 V)
reset ratio for U< stage reset threshold	r (ph–ph and ph–e)	1.05 to 3.00 max. 130 V	(steps 0.01)
current criterion for start–up active time for start–up	SC $I</I_N$ T–SC	0.05 to 1.00 0.00 s to 60.00 s	(steps 0.01) (steps 0.01 s)
Undervoltage (phase–to–earth or phase–to–phase)	U<<	30 V to 120 V	(steps 1 V)
Overvoltage (phase–to–earth or phase–to–phase)	U>	40 V to 130 V	(steps 1 V)
current criterion for U>/U<</U>	BRK CLOSED $I>/I_N$	0.04 to 1.00	(steps 0.01)
time delays	T(U<, U<<, U>)	0.00 s to 60.00 s or ∞ (ineffective)	(steps 0.01 s)

The set times are pure delay times.

Pick–up times		
– undervoltage	U<, U<<	< 45 ms
– overvoltage	U>	< 45 ms

Drop–off times		
– undervoltage	U<, U<<	< 50 ms
– overvoltage	U>	< 50 ms
Reset ratios		
– undervoltage	U<<	1.05
– overvoltage	U>	0.95

Tolerances

– voltage thresholds		3 % of set value
– delay times	T	1 % or 10 ms

Influence variables

– Auxiliary voltage in range $0.8 \leq U_H/U_{HN} \leq 1.15$	1 %
– Temperature in range $0\ ^\circ C \leq \vartheta_{amb} \leq 35\ ^\circ C$	0.5 %/10 K
– Frequency in range $f_N \pm 5$ Hz	1 %
– Harmonics	
up to 10 % of 3rd harmonic	1 %
up to 10 % of 5th harmonic	1 %

3.7 Unbalanced load protection [1])

Setting ranges/steps

Tripping stage $I_2>$	5 % to 80 % of I_N	(steps 1 %)
Tripping stage $I_2\gg$	5 % to 80 % of I_N	(steps 1 %)
Time delays $T(I_2>)$, $T(I_2>>)$	0.00 s to 60.00 s	(steps 0.01 s)

Lower function limit — at least one phase current $\geq 0.1 \cdot I_N$
Upper function limit — all phase currents $\leq 4 \cdot I_N$

Pick–up times	at f_N = 50 Hz	at f_N = 60 Hz
– Tripping stage $I_2>$, tripping stage $I_2>>$	25 ms to 35 ms	21 ms to 32 ms

Reset times	at f_N = 50 Hz	at f_N = 60 Hz
– Tripping stage $I_2>$, tripping stage $I_2>>$	approx. 35 ms	approx. 35 ms

Reset threshold
– Tripping stage $I_2>$, tripping stage $I_2>>$ — approx. 0.9 – 0.01 · I_N

Tolerances

– pick–up values $I_2>$, $I_2>>$ current $I/I_N \leq 1.5$	± 1 % of I_N ± 5 % of set value
– stage delay times $T(I_2>)$, $T(I_2>>)$	± 1 % but min. 10 ms

Influence variables

– Auxiliary d.c. voltage in range $0.8 \leq U_H/U_{HN} \leq 1.2$	$\leq$ 1 %
– Temperature in range $-5\ ^\circ C \leq \vartheta_{amb} \leq +40\ ^\circ C$	$\leq$ 0.5 %/10 K
– Frequency in range $0.95 \leq f/f_N \leq 1.05$	$\leq$ 1 % of I_N

[1]) only for model 7SJ531★–★★★★**2**–★★★★

3.8 Start−up time monitoring for motors [1])

Setting ranges/steps

Permissible start−up current	I−STRT−MAX/I_N	1.00 to 16.00	(steps 0.01)
Pick−up threshold	I−STRT−DET	0.60 to 10.00	(steps 0.01)
Permissible start−up time	T−STRT−SUP	1.0 s to 180.0 s	(steps 0.1 s)
permissible rotor locking time	T−LOCK−ROT	0.5 s to 120.0 s or ∞ (stage ineffective)	(steps 0.1 s)

Tripping characteristic

$$t = \left(\frac{I_{start}}{I_{rms}}\right)^2 \cdot T_{-STRT-SUP} \quad \text{for } I_{rms} > I_{-STRT-DET}$$

Where:

I_{start}	startup current of the motor
I_{rms}	actual current (r.m.s.)
$I_{-STRT-DET}$	pick−up threshold for startup detection
$T_{-STRT-SUP}$	trip time at startup current I_{start}
t	actual trip time at actual current

Reset ratio $I_{rms}/I_{-STRT-DET}$ approx 0.95

Tolerances

Pick−up value	3 %
Delay time	5 % of setting value or 30 ms

Influence variables

− Auxiliary voltage in range $0.8 \leq U_H/U_{HN} \leq 1.15$	1 %
− Temperature in range $0\ °C \leq \vartheta_{amb} \leq 35\ °C$	0.5 %/10 K
− Frequency in range $f_N \pm 5$ Hz	1 %
− Harmonics up to 10 % of 3rd harmonic up to 10 % of 5th harmonic	 1 % 1 %

[1]) only for model 7SJ531★−★★★★**2**−★★★★

3.9 Thermal overload protection

Setting ranges/steps

Factor k according to IEC 255−8		0.10 to 4.00	(steps 0.01)
Time constant	τ	1.0 to 999.9 min	(steps 0.1 min)
Thermal warning stage	$\Theta_{warn}/\Theta_{trip}$	50 to 100 % referred to trip temperature rise	(steps 1 %)
Current warning stage	I_{warn}/I_N	0.10 to 4.00	(steps 0.01)
Prolongation factor at motor stand−still $k\tau$−FACTOR [1])		1.0 to 10.0 referred to the time constant at running machine (steps 0.1)	

Trip time characteristic

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

for $(I / k \cdot I_N) \leq 8$

t	trip time
τ	time constant
I	load current
I_{pre}	preload current
k	factor according to IEC 255−8 refer also to Figures 3.5 and 3.6

Reset ratios	
Θ / Θ_{trip}	reset below Θ_{warn}
Θ / Θ_{warn}	approx. 0.99
I/I_{warn}	approx. 0.97

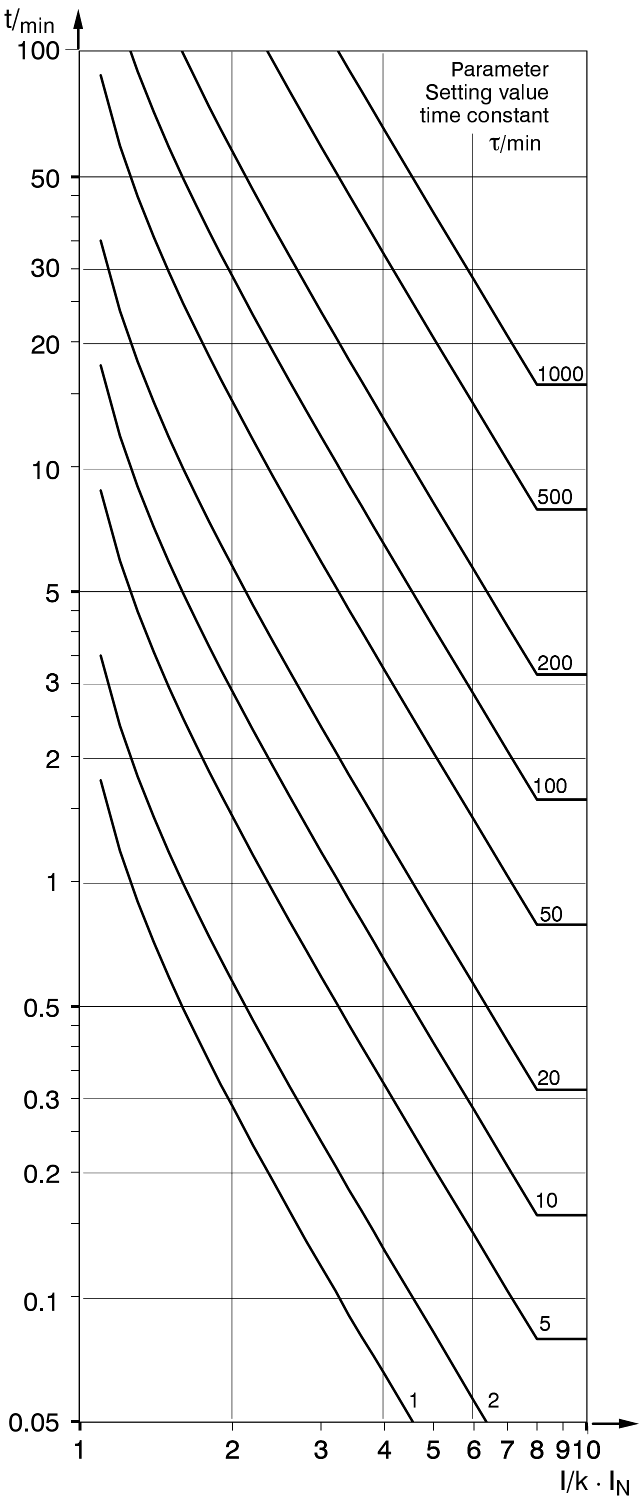
Tolerances

− referring to $k \cdot I_N$	5 %	class index according to IEC 255−8
− referring to trip time	5 % ± 2 s	class index according to IEC 255−8

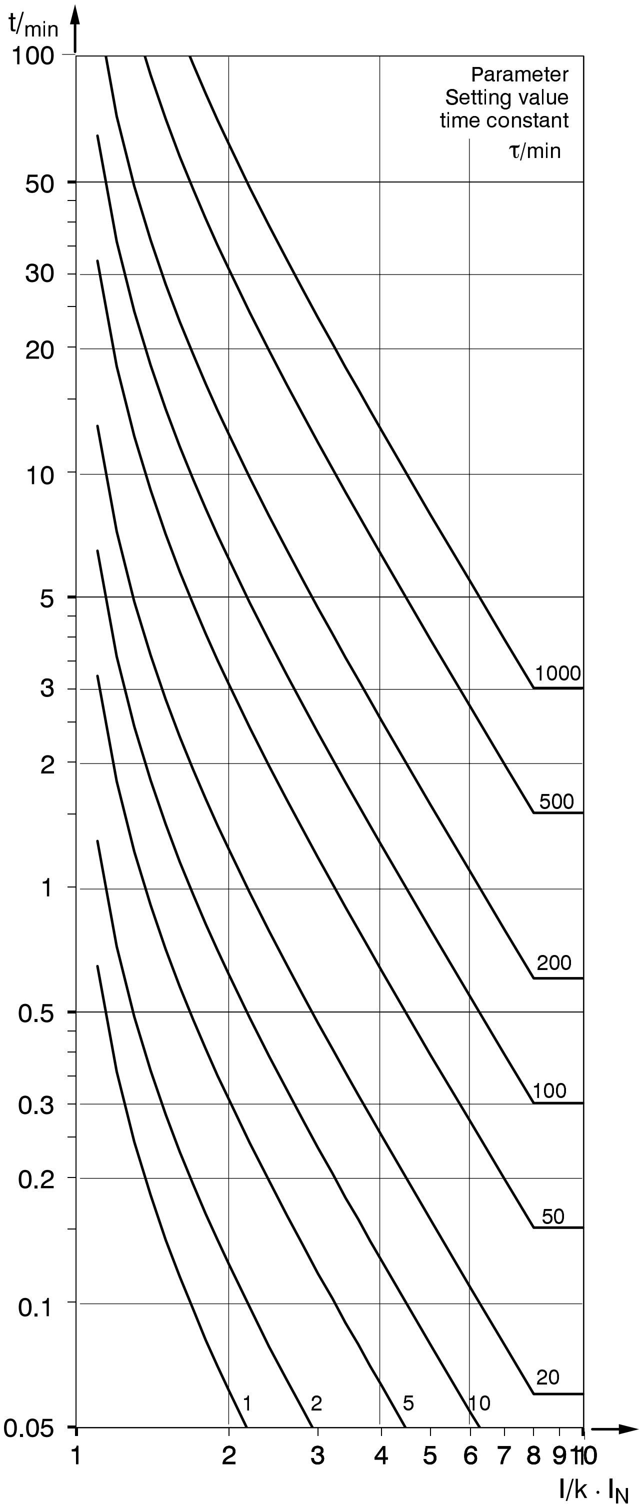
Influence variables referred to $k \cdot I_N$

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

[1]) only for model 7SJ531★−★★★★**2**−★★★★



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



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

with 90 % preload

Figure 3.5 Trip time characteristic of overload protection – without preload –

Figure 3.6 Trip time characteristic of overload protection – with 90 % preload –

3.10 Restart lockout for motors [1])

Setting ranges/steps

Permissible start−up current	I_{start}/I_B	3.0 to 10.0	(steps 0.1)
Ratio rated motor current/rated c.t. current	I_B/I_N	0.2 to 1.2	(steps 0.1)
Permissible start−up time	$T_{STRT\ MAX}$	3 s to 320 s	(steps 1 s)
Time of thermal equilibrium of the rotor	T_{EQUAL}	0.0 min to 320.0 min	(steps 0.1 min)
max. permissible number of hot starts	n_w	1 to 4	(steps 1)
difference between hot starts and cold starts	$n_c - n_w$	1 to 2	(steps 1)
Prolongation factor at rotor stand−still	$k\tau$−FACTOR	1 to 10	(steps 1)

Restart threshold

$$\Theta_{restart} = \Theta_{R\ max} \cdot \frac{n_c - 1}{n_c}$$

Where:

$\Theta_{restart}$	temperature rise below which restart is possible
$\Theta_{R\ max}$	max. permissible rotor temperature rise (= 100 % of value Θ_R/Θ_{Rtrip})
n_c	number of permissible startups from the cold state

The higher the startup current referred to the base current I_{start}/I_B and the smaller the permissible number of startups from the cold state n_c, the higher is the accuracy of the thermal replica of the startup lockout function. The following table indicates, for which pairs of values the accuracy is ensured as specified below. These pairs of values are marked with an ”x” and shaded in the table:

For $(n_c - n_w) = 1$

I_{start}/I_B \ n_K	1	2	3	4	5
1.00	–	–	–	–	–
2.00	–	–	–	–	–
3.00	x	–	–	–	–
4.00	x	x	–	–	–
5.00	x	x	x	–	–
6.00	x	x	x	x	x
7.00	x	x	x	x	x
8.00	x	x	x	x	x
9.00	x	x	x	x	x
10.00	x	x	x	x	x

For $(n_c - n_w) = 2$

I_{start}/I_B \ n_K	1	2	3	4	5
1.00	–	–	–	–	–
2.00	x	–	–	–	
3.00	x	x	–	–	–
4.00	x	x	x	–	–
5.00	x	x	x	x	x
6.00	x	x	x	x	x
7.00	x	x	x	x	x
8.00	x	x	x	x	x
9.00	x	x	x	x	x
10.00	x	x	x	x	x

Tolerances 5 % for pairs of values as stated in the table above

[1]) only for model 7SJ531★−★★★★**2**−★★★★

3.11 Earth fault detection

Displacement voltage detection for all earth faults

displacement voltage, measured	U_e> meas.	1.8 V to 130.0 V	(steps 0.1 V)
displacement voltage, calculated	U_e> cal.	6.0 V to 130.0 V	(steps 0.1 V)
Measurement time		approx. 50 ms	
delay time	T−E/F	0.04 s to 320.00 s or ∞	(steps 0.01 s)
additional trip delay time	T−UE	0.10 s to 40000.00 s; or ∞ (ineffective)	(steps 0.01 s)
Reset value		0.95 or (pick−up value − 0.6 V)	
measuring tolerance		5 % of set value or 3 % of measured voltage phase−earth	
time tolerances		1% of set value or 10 ms	

The set times are pure delay times

Faulted phase determination

measuring principle	voltage measurement phase to earth	
U< (faulted phase)	10 V to 100 V	(steps 1 V)
U> (unfaulted phases)	10 V to 100 V	(steps 1 V)
Measuring tolerance	5 % of set value or 1 V	

Earth current detection [1]) for all earth faults

High−level earth current pick−up	I_{EE}>>	0.003 A to 1.500 A	(steps 0.001 A)
Delay time	$T_{IEE>>}$	0.00 s to 320 s or ∞ (ineffective)	(steps 0.01 s)
Low−level earth current pick−up	I_{EE}> (definite time)	0.003 A to 1.500 A	(steps 0.001 A)
Delay time (definite)	$T_{IEE>}$	0.00 s to 320.00 s or ∞ (ineffective)	(steps 0.01 s)
Measurement time (definite time)		approx. 60 ms approx. 75 ms	(non−directional) (directional)
Low−level earth current pick−up	I_{EEp} (inverse time)	0.003 A to 1.400 A	(steps 0.001 A)
Time multiplier (inverse time)	T_{IEEP}	0.00 to 4.00 or ∞ (ineffective)	(steps 0.01)

[1]) only for model 7SJ531★−★★★★**2**−★★★★

Characteristics (inverse time)	user specified characteristic (defined by max. 20 pairs of values of current and delay time)
Measuring tolerance according VDE 0435 part 303	
– definite time	5 % of set value
– inverse time	pick–up at $1.05 \leq I/I_p \leq 1.15$
Time tolerances	
– definite time	1 % of set value or 10 ms
– inverse time within linear range	7 % of theoretical value for $2 \leq I/I_{EEp} \leq 20$ + 2 % current tolerance; at least 70 ms
Drop–off ratio	approx. 0.80

Note: Due to the high sensitivity of this protection function, the measured current input has restricted linearity range of 0.003 to 1.5 A. The function will reset above 1.6 A.

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

Directional determination [1])

Measurement	with I_E (= $3 \cdot I_0$) and U_E (= $\sqrt{3} \cdot U_0$)
Measuring principle	measurement of active and reactive power
Measurement release $I_{EE\ DIREC}$	0.003 A to 1.200 A (steps 0.001 A)
Directional characteristic	$I_E \cdot \cos \varphi$ or $I_E \cdot \sin \varphi$, additional phase shifting ± 45° possible
CT angle error correction of summation c.t. for compensated systems	0.0° to 5.0° (steps 0.1°) for 2 operating points of the c.t. characteristic
Measuring tolerance according VDE 0435 part 303	10 % of set value for $I_E < 0.45$ A
Angle tolerance (if U_{en} voltage connected)	2° for I_E = 0.2 A to 1.2 A 7° for $I_E < 0.2$ A
Angle tolerance (if U_{en} voltage not connected)	10°

Note: Due to the high sensitivity of this protection function, the measured current input has restricted linearity range of 0.003 to 1.5 A. No correct directional decision is ensured for currents above 1.5 A at this current input.

[1]) only for model 7SJ531★–★★★★**2**–★★★★

3.12 Auto−reclosure (optional)

Max. number of possible shots	1 RAR (first shot) up to 9 DAR (further shots)	
Auto−reclose modes	three−pole	
Action times	0.01 s to 320.00 s or ∞	(steps 0.01 s)
RAR dead time (separate single−phase/multi−phase)	0.01 s to 320.00 s	(steps 0.01 s)
DAR dead times (separate single−phase/multi−phase)	0.01 s to 1800.00 s	(steps 0.01 s)
Reclaim time	0.50 s to 320.00 s	(steps 0.01 s)
Lock−out time	0.50 s to 320.00 s or ∞	(steps 0.01 s)
Duration of RECLOSE command	0.01 s to 32.00 s	(steps 0.01 s)
breaker supervision time	0.10 s to 320.00 s	(steps 0.01 s)

3.13 Fault location [1])

Output of fault distance	in Ω secondary in km or in miles line length [2])
Start−to−measure command	by trip signal or by drop−off of fault detection or by external command via binary input
Setting reactance per unit line length (secondary*)	0.010 Ω/mile to 5.000 Ω/mile (steps 0.001 Ω/mile) or 0.005 Ω/km to 6.215 Ω/km (steps 0.001 Ω/km)
Measuring tolerances according VDE 0435 part 303 sinusoidal quantities	≤ 2.5 % of line length (without intermediate infeed) for $30^\circ \leq \varphi_{sc} \leq 90^\circ$ and $U_{sc}/U_N \geq 0.1$

*) Secondary values are related on I_N = 1 A; for I_N = 5 A the values are to be divided by 5.
2) Output of fault distance in km or miles only for homogeneous lines!

1) only for model 7SJ531★−★★★★**2**−★★★★

3.14 Circuit breaker failure protection

Setting ranges/steps

Pick−up value of current stage (BRK CLOSED)	I/I_N	0.04 to 1.00	(steps 0.01)
Time stage	$T_{B/F}$	0.06 s to 60.00 s ∞	(steps 0.01 s)

Times

pick−up time	
− with internal start	included in O/C pick−up time
− with start by manual control	included in O/C pick−up time
− with external start	included in O/C pick−up time
Reset time	approx 25 ms

Tolerances

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

3.15 Switchgear control

Setting ranges/steps

feeder mimic library		27 stored feeder mimic diagrams	
control supervision time (max time between keypad entries)	T_{ENTRY}	5 s to 30 s	(steps 1 s)
command feed−back time supervision	$T_{FB\ CB}$	1 s to 600 s or ∞	(steps 1 s)
command extension time	$T_{EXT\ CB}$	0.0 s to 10.0 s	(steps 0.1 s)
supervision time (for intermediate state alarm)	T_{DWI}	0 s to 60 s or ∞	(steps 1 s)

3.16 Ancillary functions

Operational measured values

– operational current values	I_{L1}; I_{L2}; I_{L3}; I_E in A (kA) primary and in % I_N
measurement range	0 % to 240 % I_N
tolerance	typical 2 % of I_N for $I \leq I_N$, 2 % of measured value for $I > I_N$
– operational voltage values (phase–to–earth if connected)	U_{L1-E}, U_{L2-E}, U_{L3-E}, U_E in kV primary
measurement range	0 % to 120 % of $U_N/\sqrt{3}$
tolerance	typical 3 % of $U_N/\sqrt{3}$
– operational voltage values (phase–to–phase)	U_{L1-L2}, U_{L2-L3}, U_{L3-L1} in kV primary and in V secondary
measurement range	0 V to 140 V
tolerance	1 V for U < 20 V typical 3 % measured value for 20 V $\leq$ U $\leq$ 140 V
– operational power values	P, Q (active and reactive power with sign) in kW (MW or GW) and kVAR (MVAR or GVAR) primary
measurement range	0 % to 120 % S_N
tolerance	typical 5 % of S_N for $I > 0.5\ I_N$, $U > 0.5\ U_N$ with $S_N = \sqrt{3} \cdot U_N \cdot I_N$
– operational power factor	cos φ
measurement range	−1 to 1
tolerance	typical 0.02 for cos $\varphi \geq 0.8$
– operational frequency	FREQ. in Hz
measurement range	$f_N \pm 5$ Hz
tolerance	0.1 Hz
– energy metering values	W_p, W_q (active and reactive work) in kWh (MWh or GWh) and in kVARh (MVARh or GVARh)
measurement range	6 digits for each direction
tolerance	typical 5 % for $I > 0.5\ I_N$, $U > 0.5\ U_N$, cos $\varphi \geq 0.8$
– last date of counter setting	DD.MM.YY (day, month, year)
– calculated values of overload protection and restart lockout (calculated temperature rises)	Θ/Θ_{trip} L1 Θ/Θ_{trip} L2 Θ/Θ_{trip} L3 Θ/Θ_{trip} Θ_R/Θ_{Ltrip}
measurement range	0 % to 400 %
tolerance	class 5 % acc. IEC 255–8

Operational measured values of high−sensitivity earth current detection	I_{EEa}; I_{EEr} (active and reactive current) in mA secondary and in A (kA) primary
− measurement range	0.01 A to 2000 A
− tolerance	typical 2 %
− bar graph of max. phase current in the basic diagram of the display	I_{max}
measurement range	0 % to 120 % I_N
resolution	2 % of I_N

Measured values plausibility checks

− sum of currents	phases and earth
− sum of voltages	phase−to−phase (if connected)

Steady−state measured value supervision

− current unbalance	I_{max}/I_{min} > symmetry factor as long as I > I_{limit}
− voltage unbalance	U_{max}/U_{min} > symmetry factor as long as U > U_{limit}
− phase sequence (currents)	clockwise phase rotation
− phase sequence (voltages)	clockwise phase rotation
limit value supervision	I_{L1} > limit value I_{L1} I_{L2} > limit value I_{L2} I_{L3} > limit value I_{L3} I_E > limit value I_E
	I_L < low value limit of smallest load current IL cos φ < low value limit of cos φ P > upper limit of active power P Q > upper limit of reactive power Q

Fault event data storage

− storage of annunciations of the eight last fault events
− storage of annunciations of the three last earth faults

Real time clock

− resolution for operational annunciations	1 ms
− resolution for fault event annunciations	1 ms
− max. time deviation	0.01 %
− buffer battery	Lithium−Battery 3 V/1 Ah, Type CR 1/2 AA Self−discharge time > 5 years Annunciation ”`Fail. Battery`” in case of discharged battery

Data storage for fault recording	max. 7 fault events saved by back−up battery
− storage period	5 s total, selectable pre−trigger and post−fault time
− sampling rate at 50 Hz − sampling rate at 60 Hz	1 instantaneous value per 1.25 ms 1 instantaneous value per 1.04 ms

Operation statistics	
− number of stored trip events	up to 9 decimal digits
− number of stored reclose events	up to 9 decimal digits, separate for RAR and DAR
− last date of counter setting	DD.MM.YY (day, month, year)
− last interrupted current	up to 4 decimal places, separate for each breaker pole

Hour meter	
− display range criterion	up to 6 decimal digits, load current greater than set value BRK CLOSED

Annunciations via binary input	
− 4 user definable annunciations	for annunciation processing

Trip circuit supervision	with one or two binary inputs

Commissioning

Phase sequence test

Circuit breaker test
− with live trip
with trip/reclose cycle (models with auto−reclosure)

Storage of a test record

4 Method of operation

4.1 Operation of complete unit

The numerical line and motor protection relay SIPROTEC 7SJ531 is equipped with a powerful and proven 16−bit microprocessor. This provides fully digital processing of all functions from data acquisition of measured values to the trip signals for the circuit breakers.

Figure 4.1 shows the basic structure of the unit.

The transducers of the measured value input section ME transform the currents and voltages from the measurement transformers of the switch−gear and match them to the internal processing level of the unit (phase voltage inputs may be connected phase−earth or phase−phase). Apart from galvanic and low−capacitance 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.

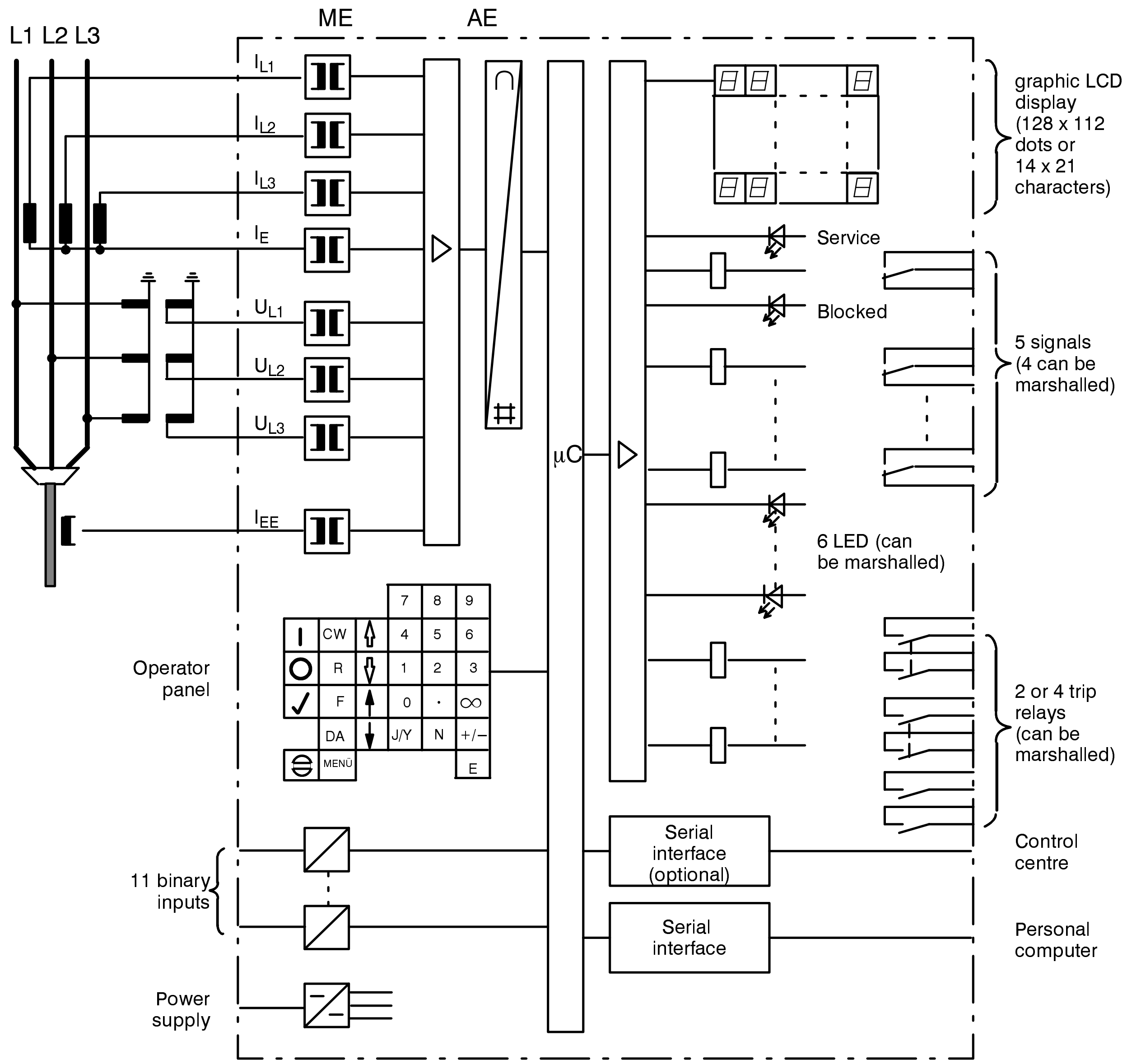


Figure 4.1 Hardware−structure of protection, control, and supervision device 7SJ531 − example

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 and measurement functions. These include in particular:

- filtering and formation of the measured quantities,
- continuous calculation of the values which are relevant for fault detection, control, and supervision,
- determination of the fault direction (models with direction determination),
- calculation of the negative sequence current for unbalanced load detection,
- calculation of the true r.m.s. values for the thermal replica of the overload protection,
- calculation of the earth fault data,
- scanning of limit values and time sequences,
- decision about trip and close commands,
- calculation of the active and reactive components of the power,
- metering of active and reactive energy,
- determination of the system frequency,
- 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. position of the circuit breaker) or from other equipment (e.g. blocking signals). Outputs include, in particular, trip and close commands to the circuit breaker, signals for remote signalling of important events and conditions as well as visual indicators (LEDs), and a graphic display on the front.

An integrated membrane keyboard in connection with a built−in graphic 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 operating interface on the front plate by means of a personal computer.

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

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

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 255−3 or eight characteristics according to ANSE/IEEE as well as a further user specified characteristic are available for inverse time mode. An additional ”long earth fault” characteristic is available for earth current processing. The trip time characteristics and the applied formulae are given in the Technical data, refer to Figures 3.1 to 3.4, Sections 3.3 and 3.5.

The selected overcurrent time characteristics is 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 may be used, or a separate summation current transformer may be connected.

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

4.2.2 Definite time overcurrent protection

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

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

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

The logic diagram of the high−current stage is shown in Figure 4.2, the logic diagram of the definite time overcurrent protection stage is shown in Figure 4.3.

4.2.3 Inverse time overcurrent protection

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

When the high−set overcurrent stage I>> (phases) or I_E>> (earth) has picked up, the associated timer is started which is independent of the set inverse time characteristic for I_p or I_{Ep}. After the associated time T−I>> or T−IE>> has elapsed, trip command is given. Figure 4.2 is valid.

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 4.4.

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

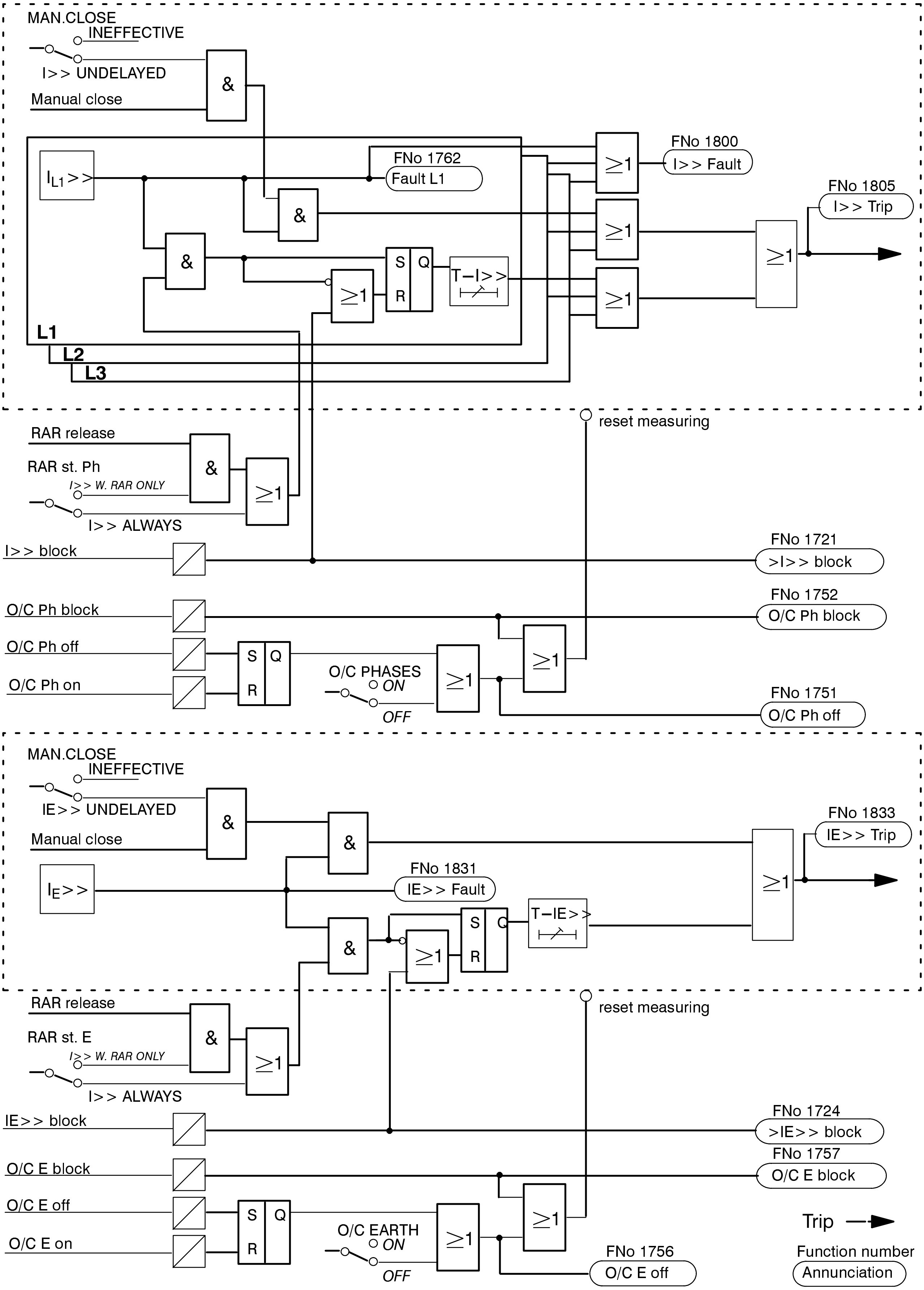


Figure 4.2 Logic diagram of the high−current stages I>> (phase currents) and I_E>> (earth current)

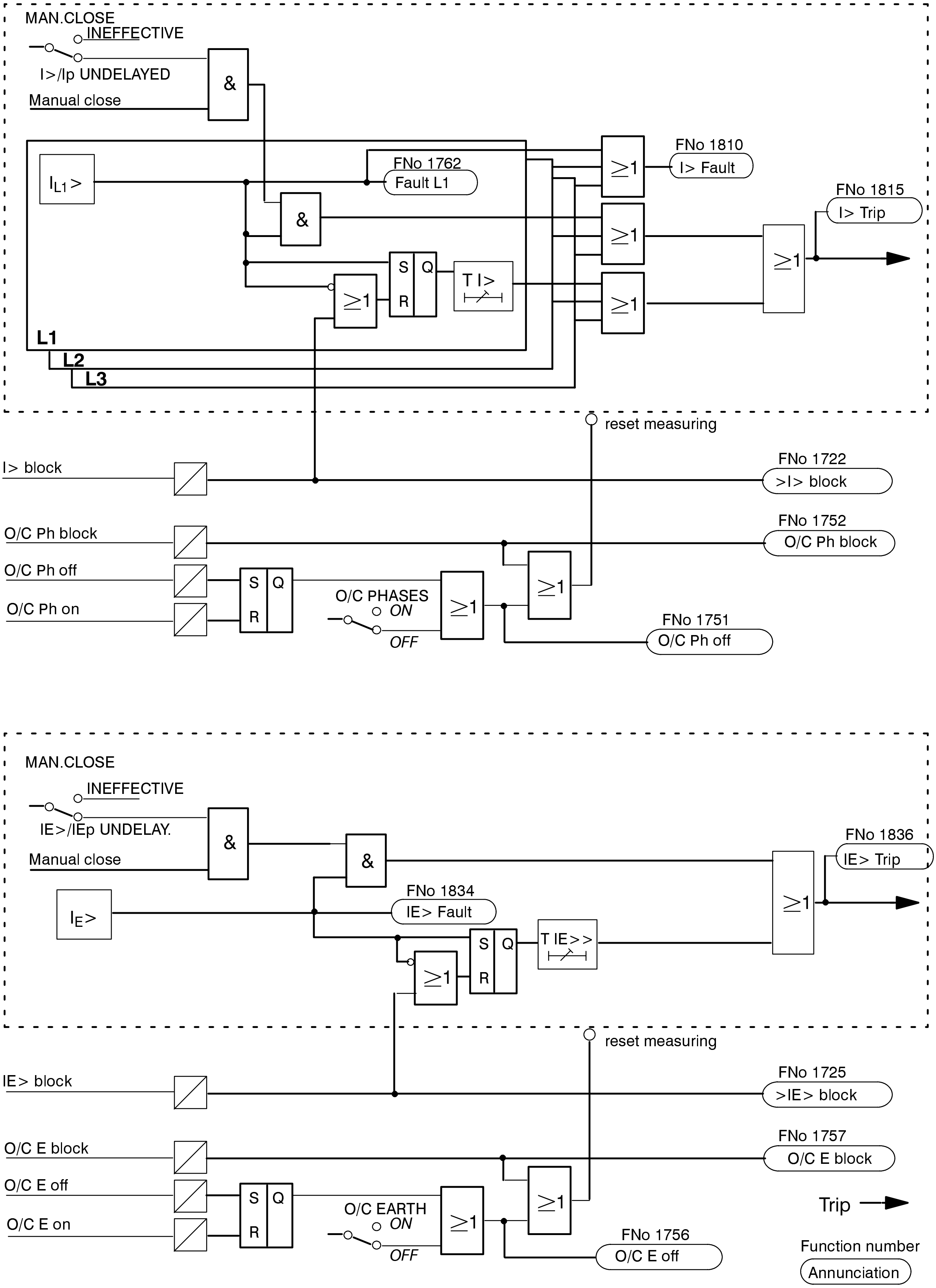


Figure 4.3 Logic diagram of the definite time overcurrent protection

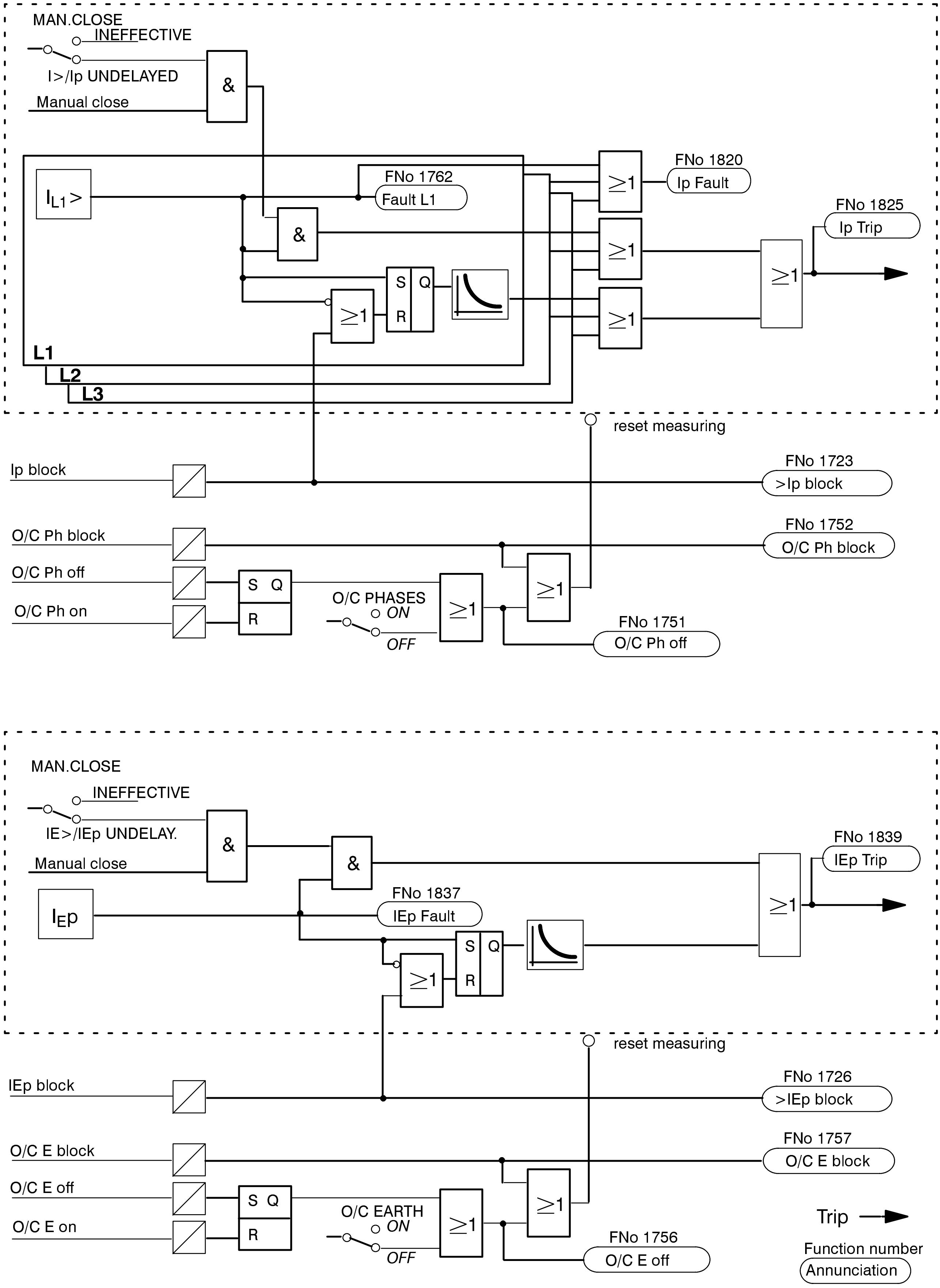
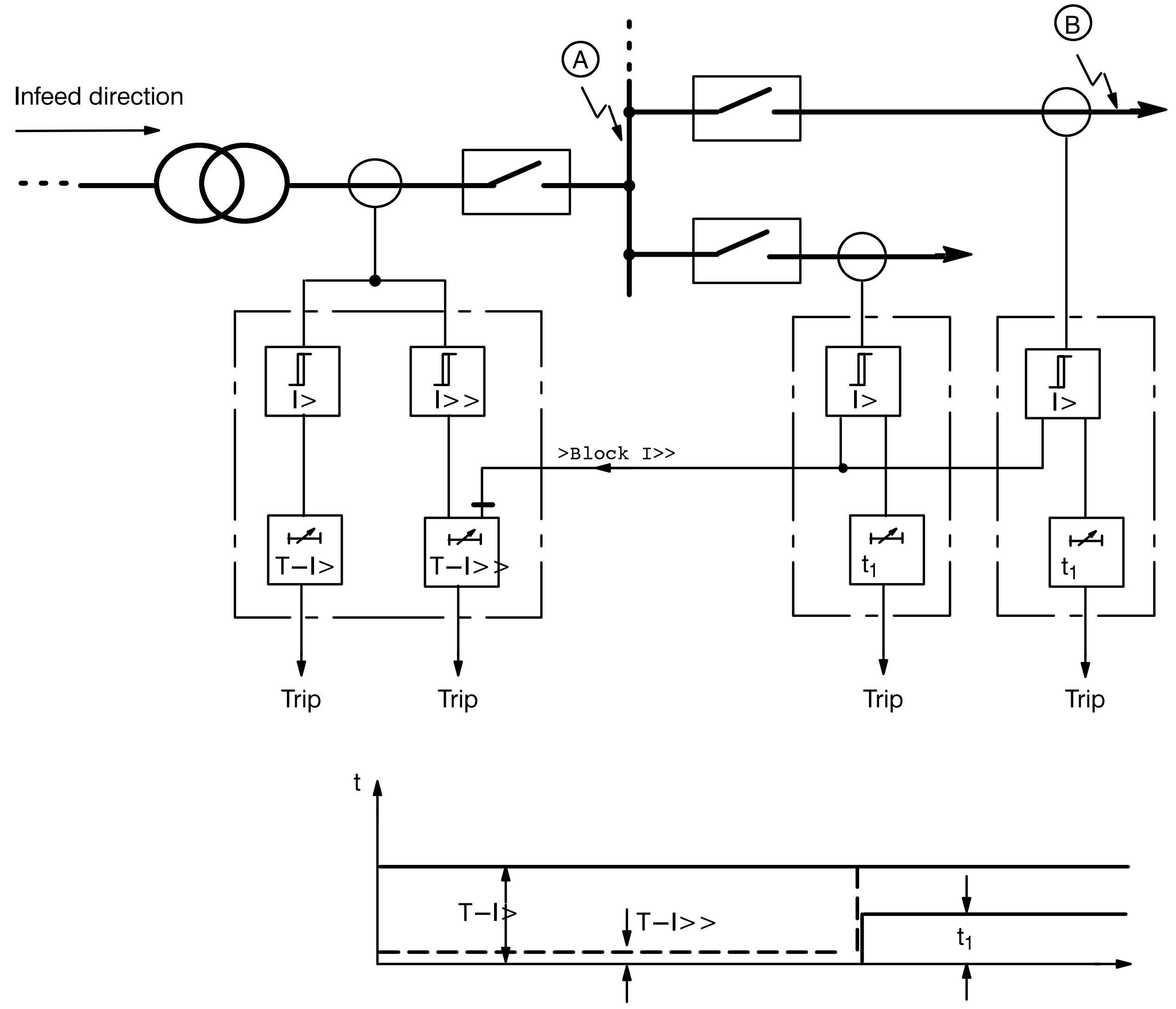


Figure 4.4 Logic diagram of the inverse time overcurrent protection

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 4.5).

”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 not blocked by pick−up of one of the next downstream overcurrent time relays (Figure 4.5). 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.



Fault location (A): tripping time T−I>>

Fault location (B): tripping time t_1
back−up time T−I>

Figure 4.5 Busbar protection using reverse interlocking principle

4.3 Directional overcurrent time protection (optional)

4.3.1 General

SIPROTEC 7SJ5131provides, dependent of the ordered model, a directional overcurrent time protection. Thus, it can be used in systems where the direction of energy flow to the fault location is required as a further criterion, besides the overcurrent criterion, in order to achieve selectivity.

For parallel lines or transformers, which are fed from one side (refer to Figure 4.6), a fault on one branch (I) can result in the other branch (II) being disconnected unless the tripping of the circuit breaker in the parallel (healthy) branch is prevented by a directional measuring element (at B). Therefore, a **directional** overcurrent scheme must be installed at the points indicated by the directional arrow in Figure 4.5. It must be noted that the ”forwards” direction of the directional relay is the direction to the protected object. This is not normally identical with the direction of the normal load flow as can be seen in the figure.

Also in networks with infeed from both sides or in ring networks, the overcurrent time protection must have a directional criterion. Figure 4.7 shows a ring network as a development; in the actual ring network the two infeeds shown in the figure merge into a single infeed.

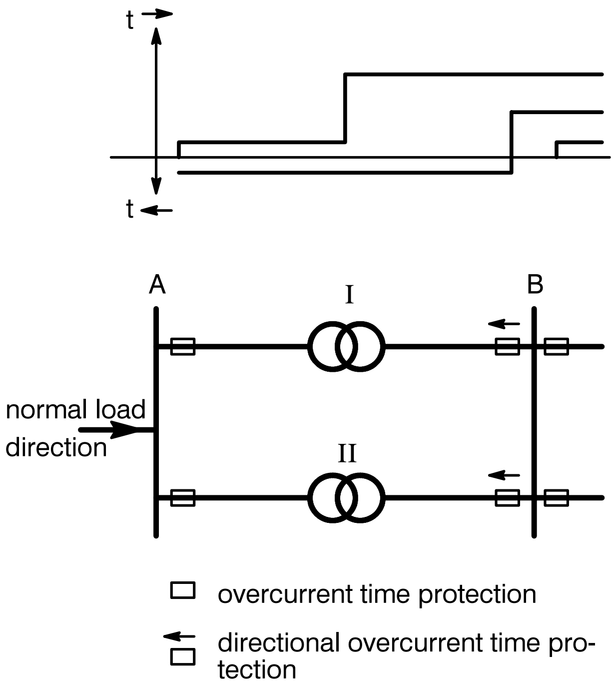


Figure 4.6 Overcurrent time protection for parallel transformers

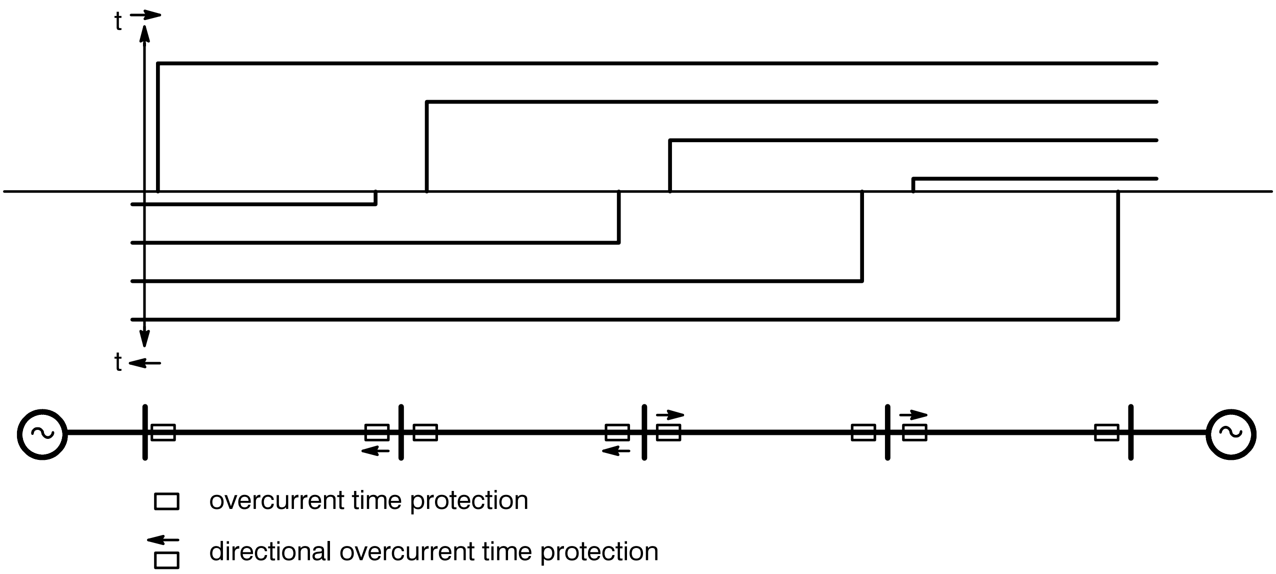


Figure 4.7 Double end fed line or ring feeder

SIPROTEC 7SJ531 provides an additional directional overcurrent time stage for each of the phase currents and for the earth current. The (non−directional) overcurrent time stages as described in Section 4.2 can either be used as superimposed back−up stages, or made ineffective, or individual non−directional stages can be used in connection with the directional overcurrent time stages (e.g. the I>> phase current stage and/or the I_E>> stage).
The directional overcurrent time protection can be used − as the non−directional − as definite time or inverse time overcurrent protection. For inverse time mode, selection can be made from the same characteristics, whereby different characteristics can be chosen for phase currents as well as for the earth current.

4.3.2 Direction determination

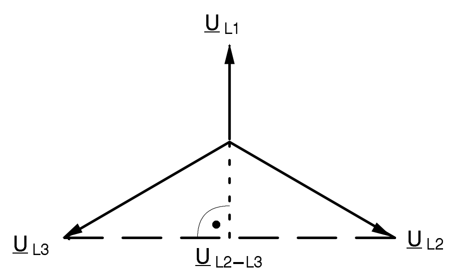
The direction of the current flow is determined in four logically independent measuring elements, one for each of the phases and one for earth faults.
The phase related measuring elements use the assigned current and a sound voltage. This ensures correct and reliable directional decision to be made even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

The earth related measuring element operates with the zero sequences quantities: $I_E = -3 \cdot I_0$ and $U_E = \sqrt{3} \cdot U_0$. This ensures high sensitivity in case of earth fault even when the assigned phase measuring element does not pick up. The displacement voltage U_E can be calculated when the relay is connected to three star−connected voltage transformers. When only phase−to−phase voltages are fed to the relay, displacement voltage calculation is, of course, not possible. In this case, the directional earth overcurrent time protection is inoperative and no settings are possible.

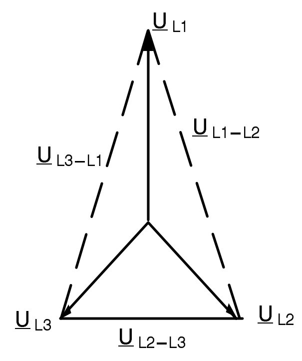
A short−circuit between two phases is processed by two phase measuring elements, namely those which are related to the two affected phases. An earth fault is processed by the earth fault measuring element and by the concerned phase element provided the fault current is sufficient for pick−up of the phase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

For single−phase faults, the quadrature voltages for the phase measuring elements are at right angles to the short−circuit voltages (Figure 4.8). This is considered in the calculation of the directional vector. For phase−phase faults, the shape of the directional characteristic may be displaced, dependent of the magnitude of the fault voltage.

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



a) Loop phase−earth (L1−E)



b) Loop phase−phase (L2−L3)

Figure 4.8 Reference voltages for directional determination

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

Table 4.1 Measured values for directional determination

The theoretical directional line is shown in Figure 4.9, in the complex R−X−diagram (solid line a). In practice, the position of the directional characteristic is dependent upon the source impedance as well as the load current carried by the line immediately before fault inception.

Since the unfaulted voltage is influenced by the magnitude of the fault voltage, for two−phase faults (refer also to Figure 4.8 b), the actual directional characteristic may differ from the theoretical characteristic. When, for example, a two−phase fault L2−L3 has occurred, the directional characteristic of the measuring element L2 appears to be displaced in mathematically positive sense (broken line b in Figure 4.9), whereas the the directional characteristic of the measuring element L3 appears to be displaced in mathematically negative sense (broken line c in Figure 4.9). In practice, this is irrelevant because the fault impedance vector can be located only in the first or third quadrant of the complex plane.

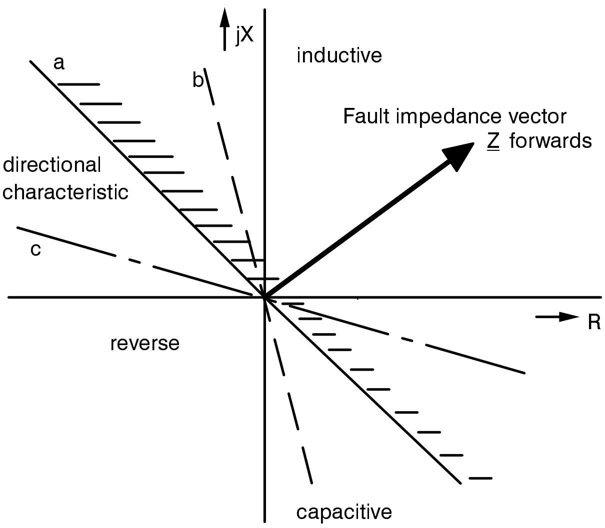


Figure 4.9 Directional characteristics

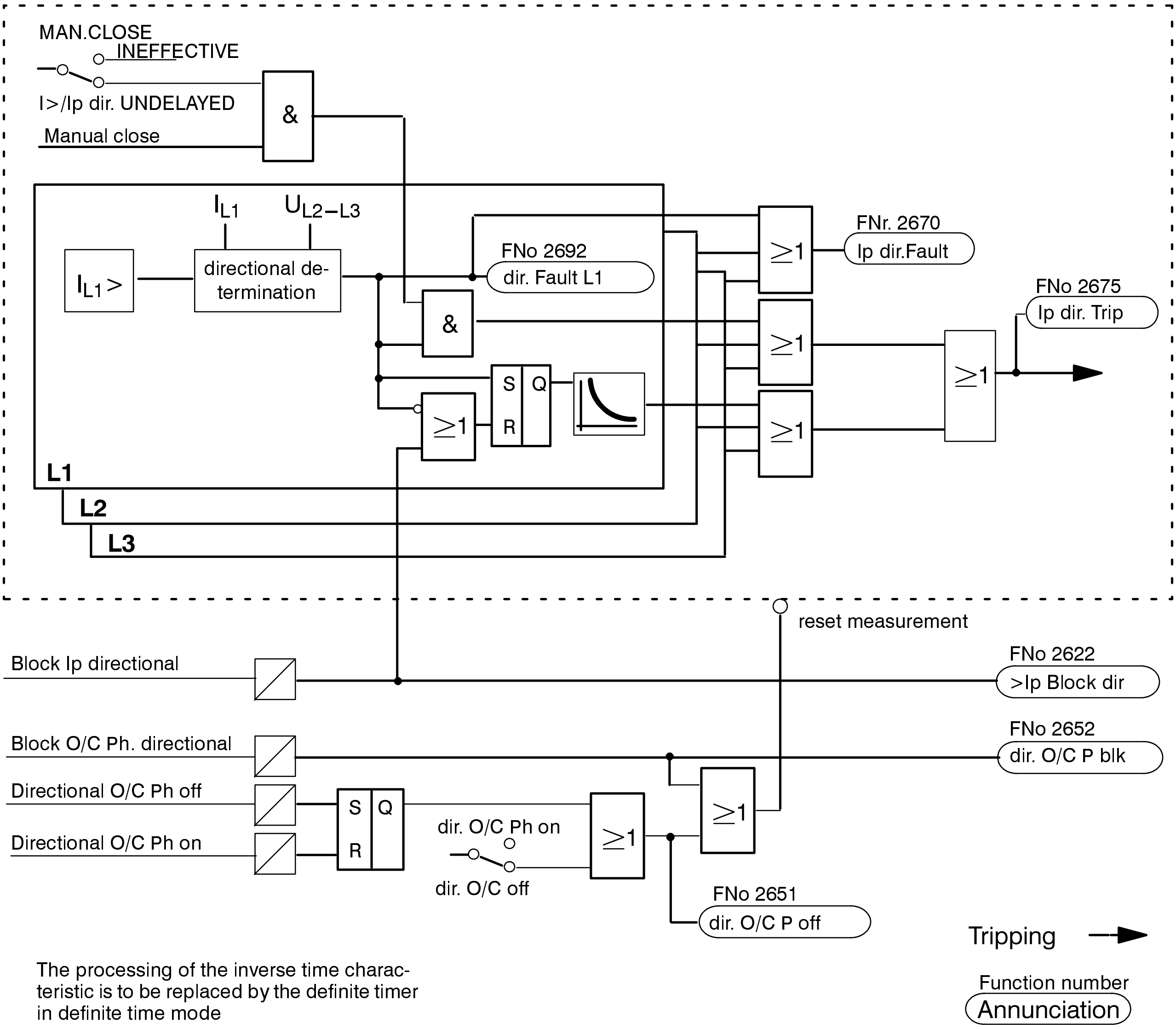


Figure 4.10 Logic diagram of the directional overcurrent time protection, example with inverse time mode

4.3.3 Reverse interlocking on double−end fed lines

The principle of reverse interlocking can also be used on lines with infeed from both sides or in ring networks. This results in fast tripping of faults at any location without the need to wait for delay according to the time grading plan, as e.g. in Figure 4.7. The distances between the substations should be not too long so that the interlocking signal can be transmitted via a d.c. link. A pair of wires must be available for each direction.

The principle is shown in Figure 4.11. The non−directional stages I> are set to a slight delay (e.g. 50 ms), a waiting margin for safe detection of the interlock signal. It is essential that the complete chain of line and busbar sections is included in the interlocking scheme. A relay that detects a fault in reverse direction blocks the non−directional stage of the relay at the opposite line end. A relay which detects a fault in forward direction blocks the non−directional stage of the relay in reverse direction, i.e. on the next line at the same busbar. The directional stages of all relays remain as backup protection with normal time grading.

7SJ531 generates the necessary signals for this purpose as shown in Figure 4.12. When the transmission link is disturbed, the relay can be informed via binary inputs. The disturbance is then annunciated with a delay of 10 s. When the interlocking signal is transmitted via a normally closed d.c. circuit, the d.c. link can easily be monitored by an auxiliary relay.

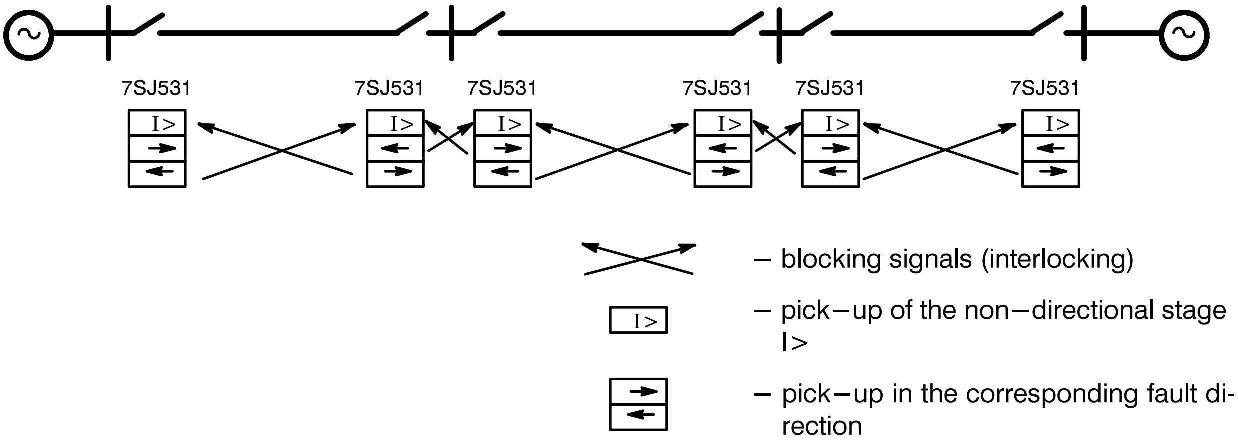


Figure 4.11 Fast protection by reverse interlocking

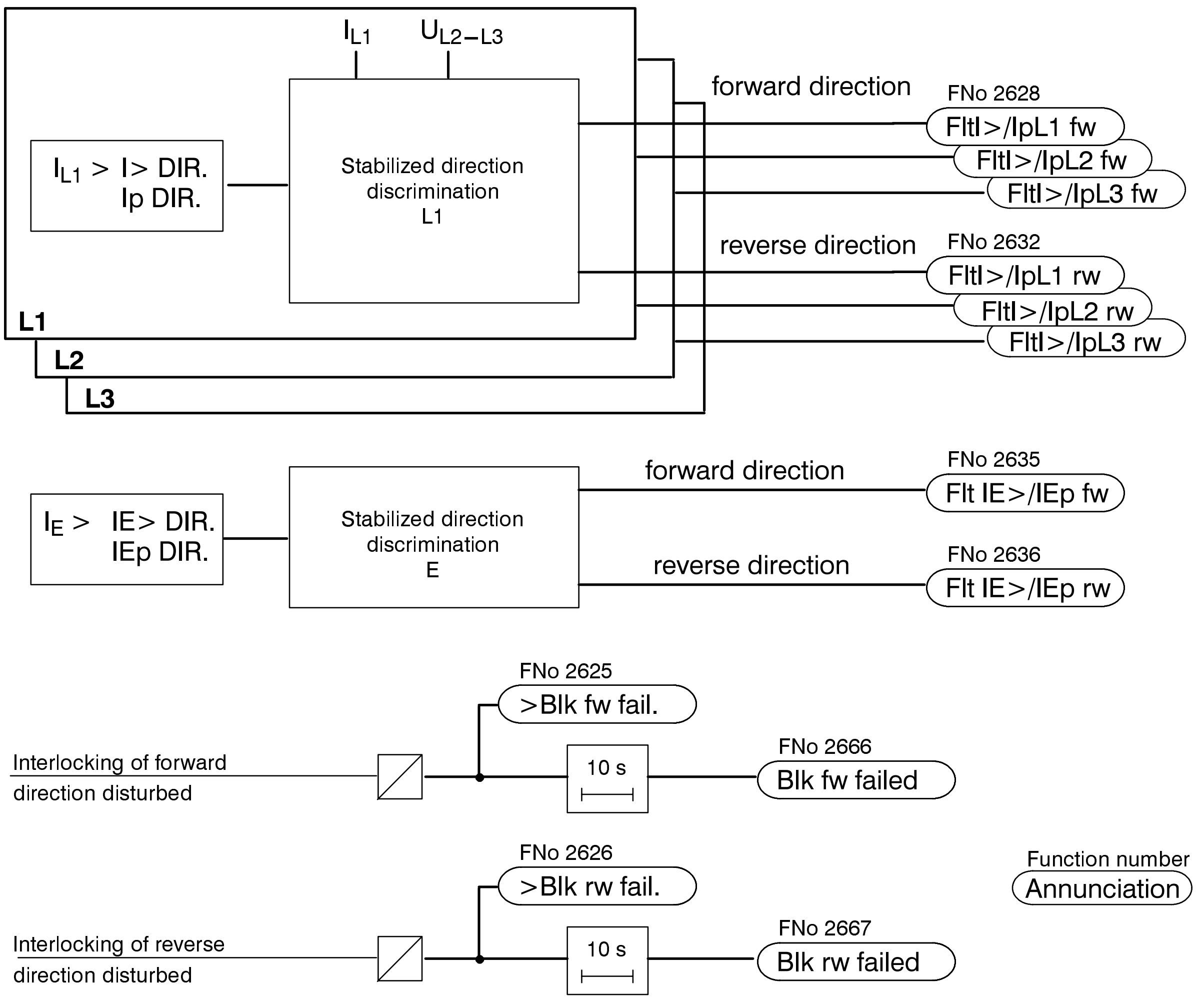


Figure 4.12 Logic diagram of annunciations for interlocking and pilow wire supervision

4.4 Voltage protection

4.4.1 Measured value formation

The voltage protection can either be fed by the three phase−to−earth voltages U_{L1-E}, U_{L2-E}, U_{L3-E} or by the phase−to−phase voltages U_{L1-L2}, U_{L2-L3}, U_{L3-L1}. The latter can be used for processing by the voltage protection even if from the switchgear only the phase−to−earth voltages are available, because the relay is able to calculate the phase−to−phase voltages from the phase−to−earth voltages. This option between phase−to−earth and phase−to−phase voltages allows either to evaluate (phase−to−earth) unbalanced voltages (e.g. caused by an earth fault) or disregard them (phase−to−phase).

It is also possible to connect two phase−to−earth voltages and the displacement voltage U_E; the relay then calculates the missing voltage from those which are connected.

The fundamental waves of the three fed−in voltages are filtered out by a Fourier analysis and then processed in the following way: after forming the absolute values, the smallest of the three voltages is assigned to the undervoltage protection and the highest voltage to the overvoltage protection.

The frequency adaptation in the relay is designed for the system frequency ±5 Hz. Beyond these limits the measuring error increases, bearing the risk of overfunction of the undervoltage protection. For this reason pick−up of the protection is inhibited outside the frequency adaptation range. An already existing pick−up, however, will not be cancelled when leaving this range.

Depending of the switchgear design, the voltage transformers can be connected at the incoming (bus−bar) or the outgoing (feeder) side. These different configurations result in a different reaction by the protection relay to a fault. Whereas the voltage persists on the incoming side after a trip command and opening of the circuit breaker, the voltage on the outgoing side is switched off. When the voltage is switched off, pick−up of the undervoltage protection is maintained. If reset of the undervoltage pick−up is required, then the current can be used as an additional criterion (current criterion CC). Thus the undervoltage pick−up is maintained only, when together with the undervoltage condition a minimum current (address 1160, BRK CLOSED) is exceeded. This current value can be parameterized. If the current drops below this threshold after the opening of the breaker, the pick−up resets.

4.4.2 Undervoltage protection

The undervoltage protection recognizes voltage drops on transmission lines and in electrical machines and avoids impermissible operation conditions and a possible loss of stability.

The undervoltage protection has two stages (U< and U<<), so that a time−graded tripping depending of the degree of the voltage drop can be achieved. Voltage limits and time delays can be selected individually for both stages.

The U< stage furthermore offers the option to parameterize the reset ratio r and to switch over from the normal pick−up threshold to an individual start−up threshold depending on a start−up criterion SC. Reset is effected together with reset of the pick−up threshold. The pick−up value of the start−up threshold is $^1/_{1.05}$ times the reset value. Switching over to the start−up threshold may become necessary when the load is mainly composed of motors. While, under normal operating conditions, the motors with system frequency can cope with an undervoltage, the same undervoltage is insufficient for a motor start−up from standstill (rotating speed = 0). This is taken into consideration by the start−up criterion. The start−up criterion is triggered by a corresponding binary input (>U< SC) or by the current magnitude. Figure 4.13 shows a typical fault curve for voltage transformers connected to the **incoming** (bus−bar) **side** and with activated start−up criterion SC. The current criterion CC described under 4.4.1 is not required in this case, because the voltage persists after opening of the circuit breaker:

With a voltage decrease below the pick−up threshold, tripping is effected after the time delay T−U<. reclosing is locked as long as the voltage remains below the reset threshold. Only after fault clearance, i.e. when the voltage becomes higher than the reset threshold, the pick−up resets and closing is released.

The activated start−up criterion SC additionally monitors the current. When all three phase currents are below the set limit (SC I<), a start−up condition is assumed and switch−over from the pick−up threshold U< to the start−up threshold U< SC is effected. When the start−up condition has ended, the start−up threshold is maintained for a time T−SC, which can be parameterized. After this time has elapsed, it is assumed that the motors have run up and that the regular pick−up threshold is applicable.

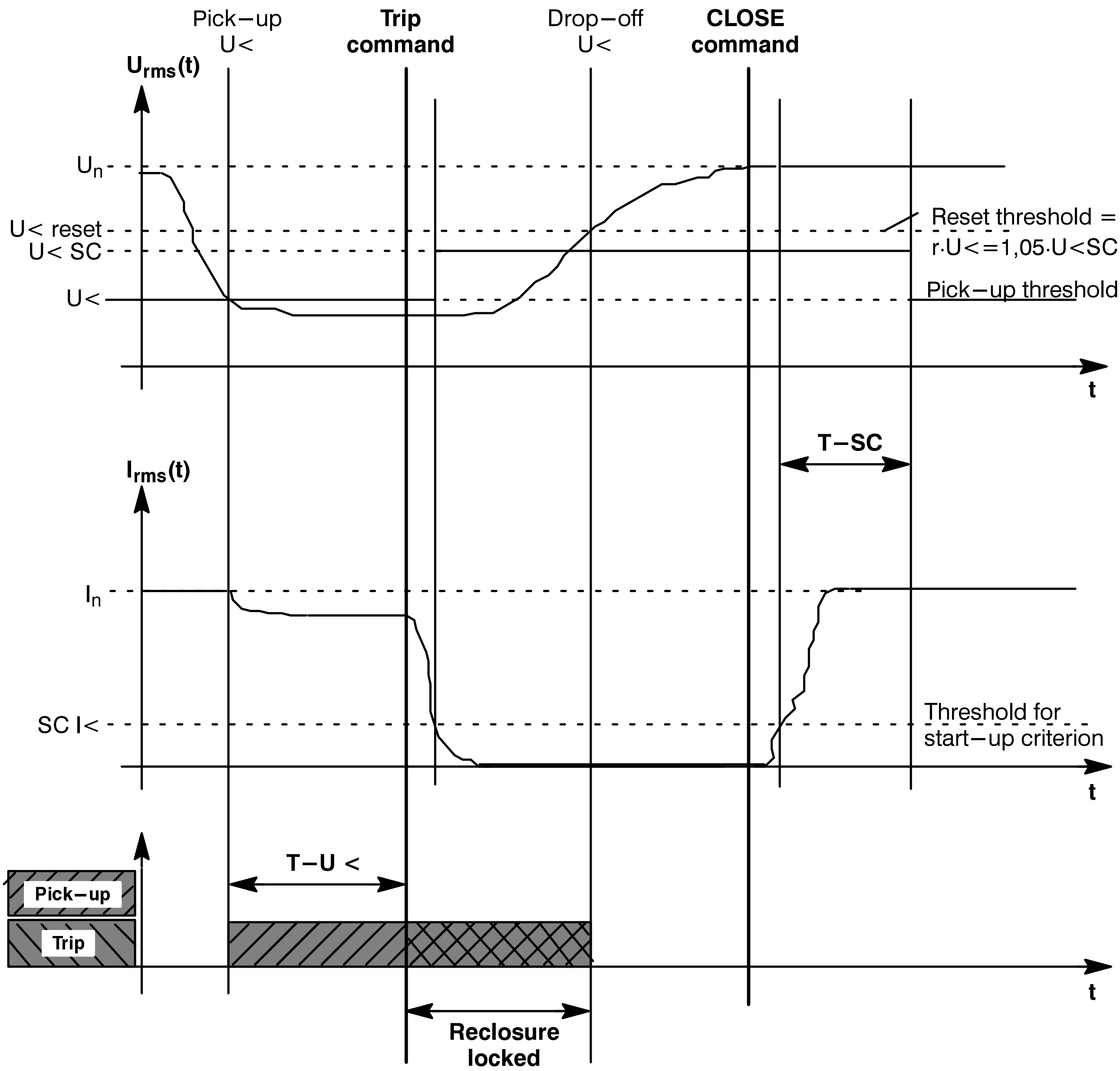


Figure 4.13 Typical fault sequence with voltage transformers installed at the bus−bar side

The general current criterion CC mentioned under 4.4.1 applies equally to both undervoltage stages. With an activated current criterion, the protection picks up only when together with the undervoltage condition also the release condition of the current criterion CC is fulfilled. This also means that for undervoltage without release from the current criterion the protection pick−up resets.

In order to avoid maloperation in case of a secondary voltage failure (e.g. by operation of the voltage transformer miniature circuit breaker), the protection can be blocked via a binary input for both undervoltage stages together or separately for U< and U<< via two binary inputs. When blocking becomes effective during a pick−up condition, the pick−up resets, as well as the started delay times are reset, too.

Figure 4.14 shows a fault curve when the voltage transformers are connected at the **outgoing** (feeder) side. Here the current criterion (CC I>) is used for reset of the pick−up after opening of the circuit breaker. The start−up criterion is also active in this example:

With a voltage decrease below the pick−up threshold, tripping is effected after the time delay T−U<. With the opening of the circuit breaker the voltage drops to zero, while the undervoltage pick−up persists. The current also drops to zero and, as soon as it falls below the release threshold (CC I>), causes reset of the current criterion. By the AND−logic of the voltage and current criterion also the protection pick−up resets, so that reclosing is possible after the minimum command time has expired.

When the circuit breaker is closed, then the current criterion CC I> is delayed for a short time. If the voltage criterion resets during this time T−CC (= 20 ms), the protection does not pick up. This ensures that breaker closing under no−fault condition does not provoke creation of a fault event. This means on the other hand, that breaker closing onto an undervoltage condition brings the then required protection pick−up not before the current criterion's time delay T−CC is expired.

Figure 4.15 shows the logic diagram of the undervoltage protection.

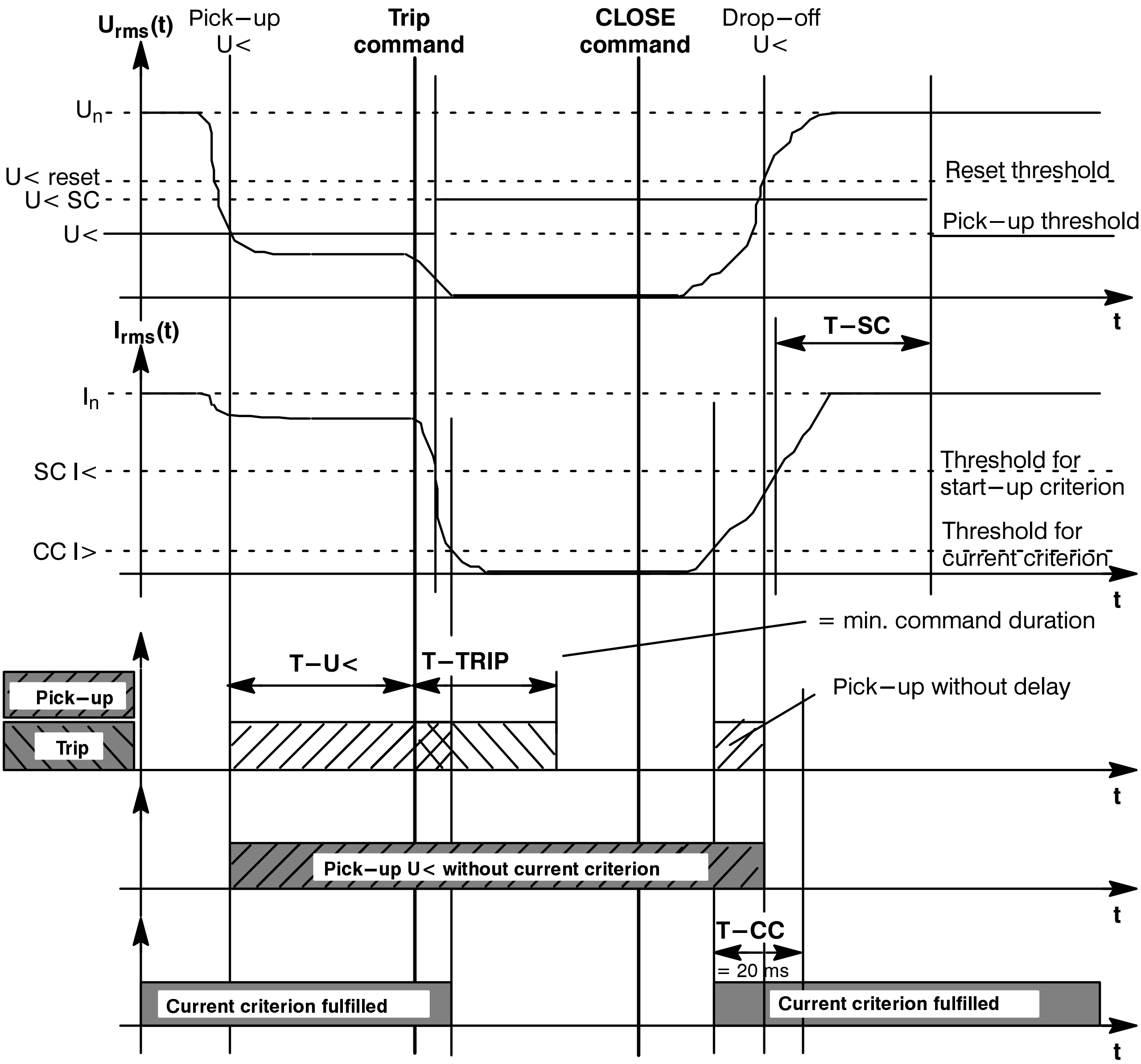


Figure 4.14 Typical fault sequence with voltage transformers installed at the feeder side, current and start−up criterion effective

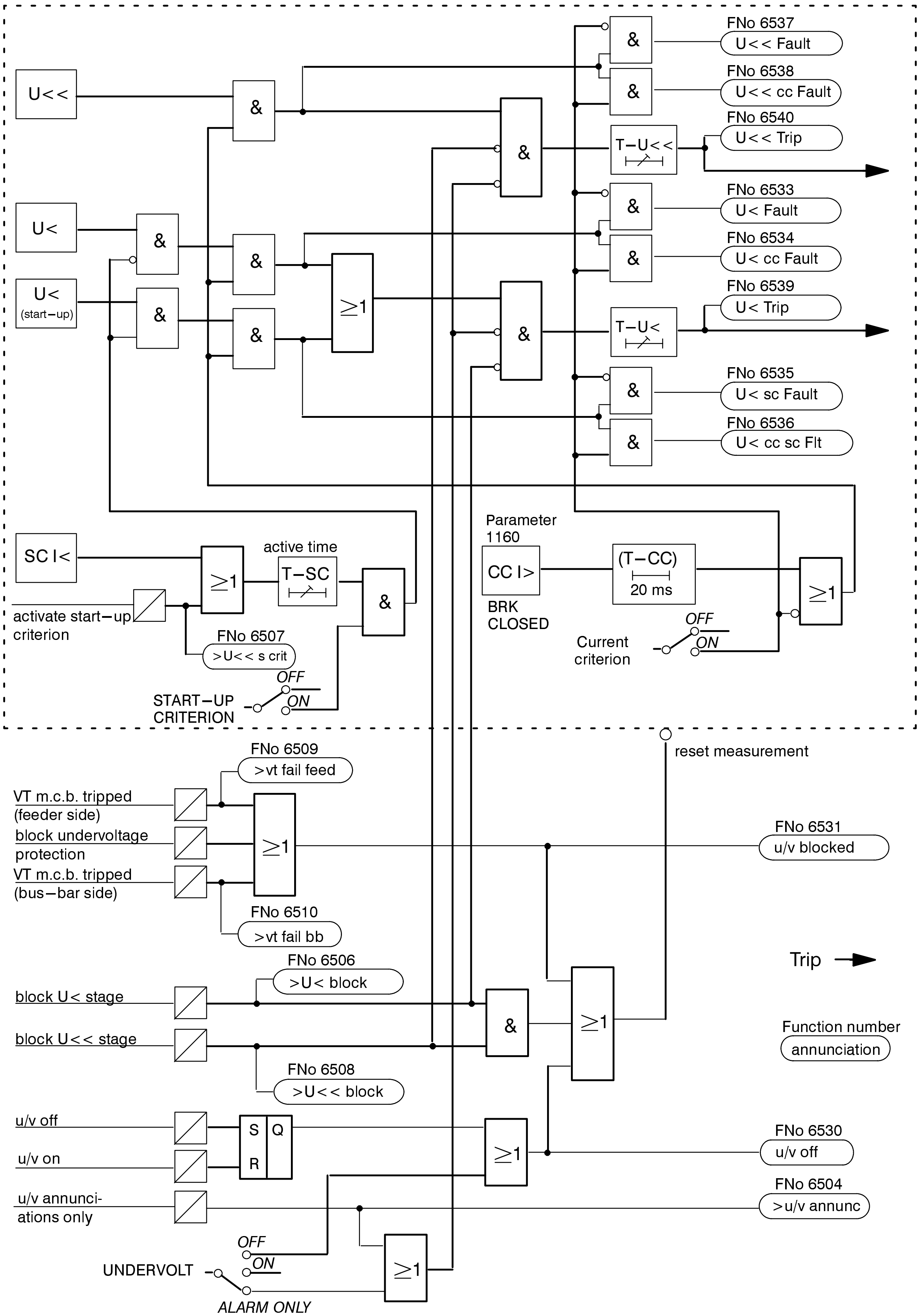


Figure 4.15 Logic diagram of undervoltage protection

4.4.3 Overvoltage protection

The overvoltage protection has to protect electrical equipment from impermissible overvoltages and thus from problems with the insulation.

Overvoltages may occur for example on long EHV transmission lines with low load, in island networks due to failures of the generator voltage regulation or after (full) load shutdown of a generator, in generators disconnected from the network.

When the voltage transformers are connected at the incoming (bus–bar) side, the voltage persists after opening of the circuit breaker or even goes up caused by load drop. In specific cases it may then be reasonable to enforce reset of the overvoltage protection. The criterion is the current, which decreases to zero after the circuit breaker is open, so that the current criterion is no longer fulfilled.

The overvoltage protection is fed by the fundamental wave of the highest of the three measured voltages.

The overvoltage protection has one stage. After exceeding the threshold, which can be parameterized, the protection picks up. When the parameterized time is expired, a trip command is given. This time does not depend of the magnitude of the overvoltage.

Figure 4.16 shows the logic diagram of the overvoltage protection.

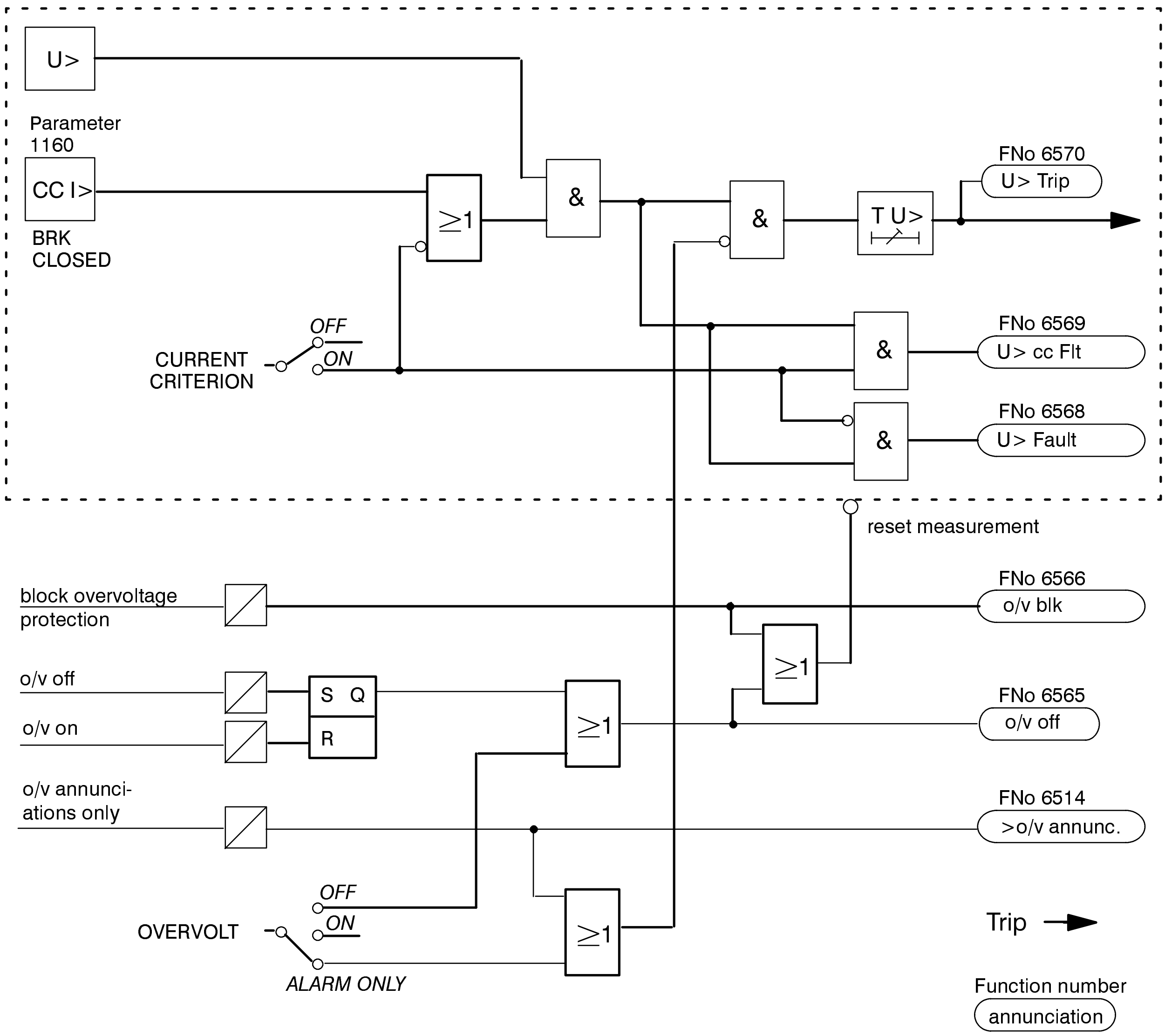


Figure 4.16 Logic diagram of overvoltage protection

4.5 Unbalanced load protection [1])

The unit is equipped with an unbalanced load protection, which is advantageous for protection of motors which are switched by vacuum contactors with associated fuses. When running on single phase the motors develop small and pulsating torques, so that with unchanged torque load the motor will be quickly thermally overloaded. Furthermore, thermal overloading of the motor may arise by unsymmetrical system voltage. Even small unbalanced system voltages may lead to large slip load currents because of the small negative sequence reactances.

The unbalanced load protection detects, additionally, interruptions, short−circuits, and swopped phase connections of the current transformer circuits. Single−phase and two−phase short−circuits can be detected even when the fault current is too small to be detected by the overcurrent time protection.

In the unbalanced load protection of the 7SJ531, the fundamental wave of the phase currents is filtered out and separated into symmetrical components (negative sequence I_2 and positive sequence I_1). The ratio I_2/I_N (I_N = rated relay current) is evaluated for unbalanced load detection.

The unbalanced load protection has two−stage design. If the first adjustable threshold $I_2>$ is reached, timer $T_{I2>}$ is started, the second adjustable threshold $I_2>>$ starts the timer $T_{I2>>}$ (see Figure 4.17). When the associated time has elapsed, trip command is issued.

Filtering of the negative sequence current is possible as long as the highest of the three phase currents is at least 0.1 times rated current of the relay and all phase currents are smaller than 4 times rated current.

Figure 4.18 shows the logic diagram of the unbalanced load protection.

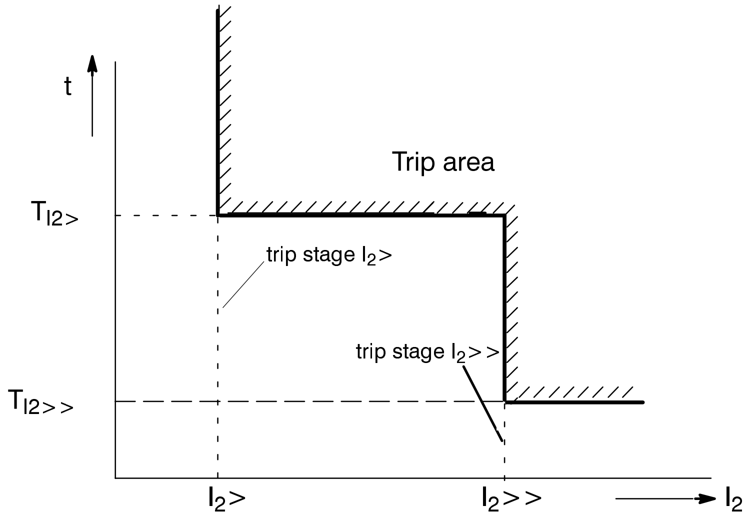


Figure 4.17 Trip time characteristic of the unbalanced load protection

[1]) only for model 7SJ531★−★★★★**2**−★★★★

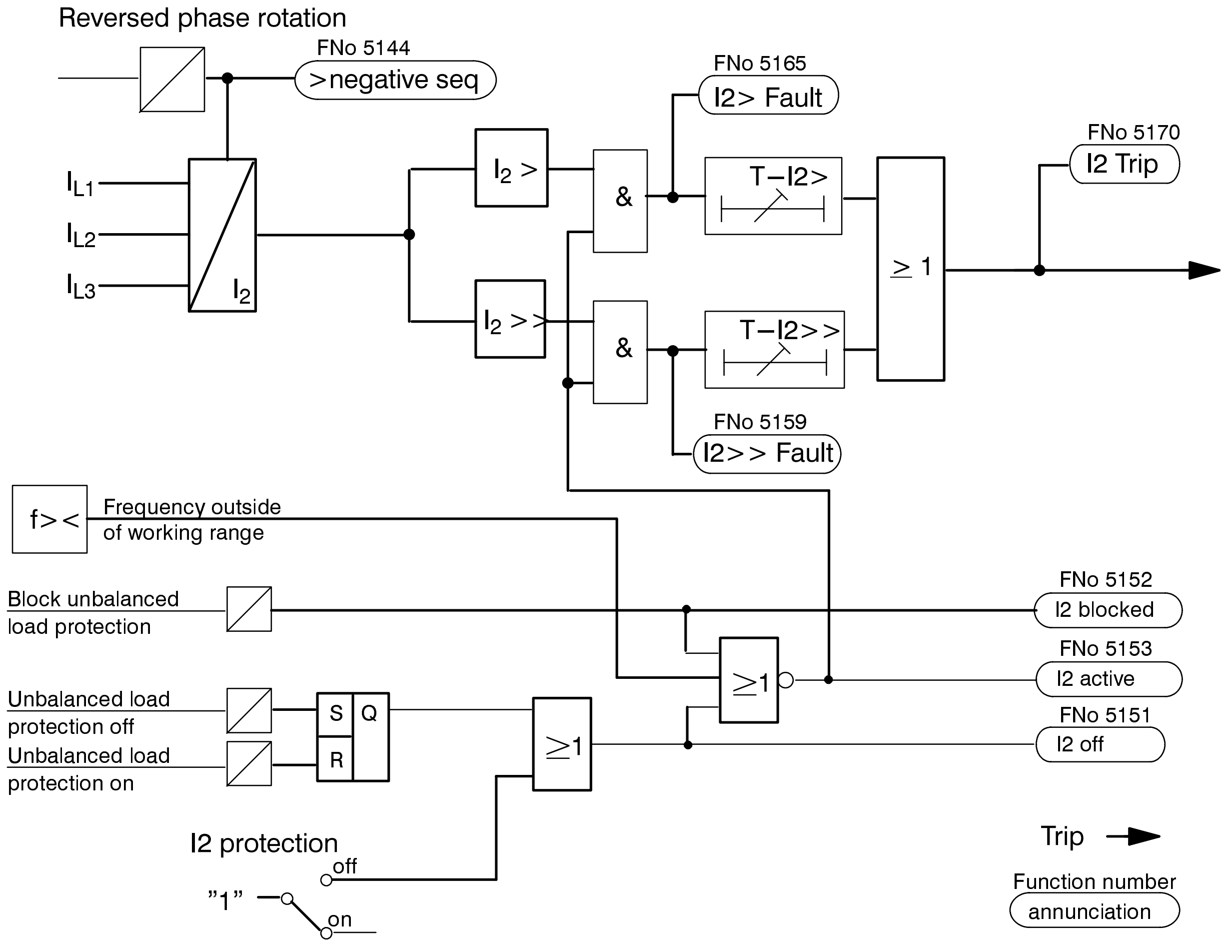


Figure 4.18 Logic diagram of the unbalanced load protection

4.6 Start−up time monitoring for motors [1])

The start−up time monitor prevents the motor from damage caused by excessively long start−up occurrences. These may happen when, for example, the rotor is locked, the driving torque is to high, or impermissible voltage break down occurs. Machines with thermally critical rotor may be stressed up to their thermal limits when they are started several times.

The start−up time monitor provides a definite time stage and a current dependent inverse time stage. The **inverse time** stage operates normally, when the rotor is not locked but the run−up period of the motor is prolonged by reduced voltage and consequently decreased current. The trip time of this stage results from the formula:

$$t = \left(\frac{I_{STRT\,MAX}}{I}\right)^2 \cdot T_{STRT\,MAX} \qquad \text{for } I > I_{STRT-DET}$$

where:

t	−tripping time
I	−actual current (r.m.s.)
$I_{STRT\,MAX}$	−parameterized start−up current
$I_{STRT-DET}$	−parameterized pick−up threshold for start−up detection
$T_{STRT\,MAX}$	−parameterized start−up time

[1]) only for model 7SJ531★−★★★★**2**−★★★★

Start−up criterion is a (settable) current threshold I STRT−DET; when this limit is exceeded the timer according the above formula is released.

The **definite time** stage operates when the rotor is locked. When the start−up period of the motor lasts longer than the maximum permissible locked rotor time, trip is effected provided the locked rotor input of the relay is energized from an external speed monitor. Start−up criterion is again the threshold I STRT−DET.

Figure 4.19 shows the logic diagram of the start−up time monitoring.

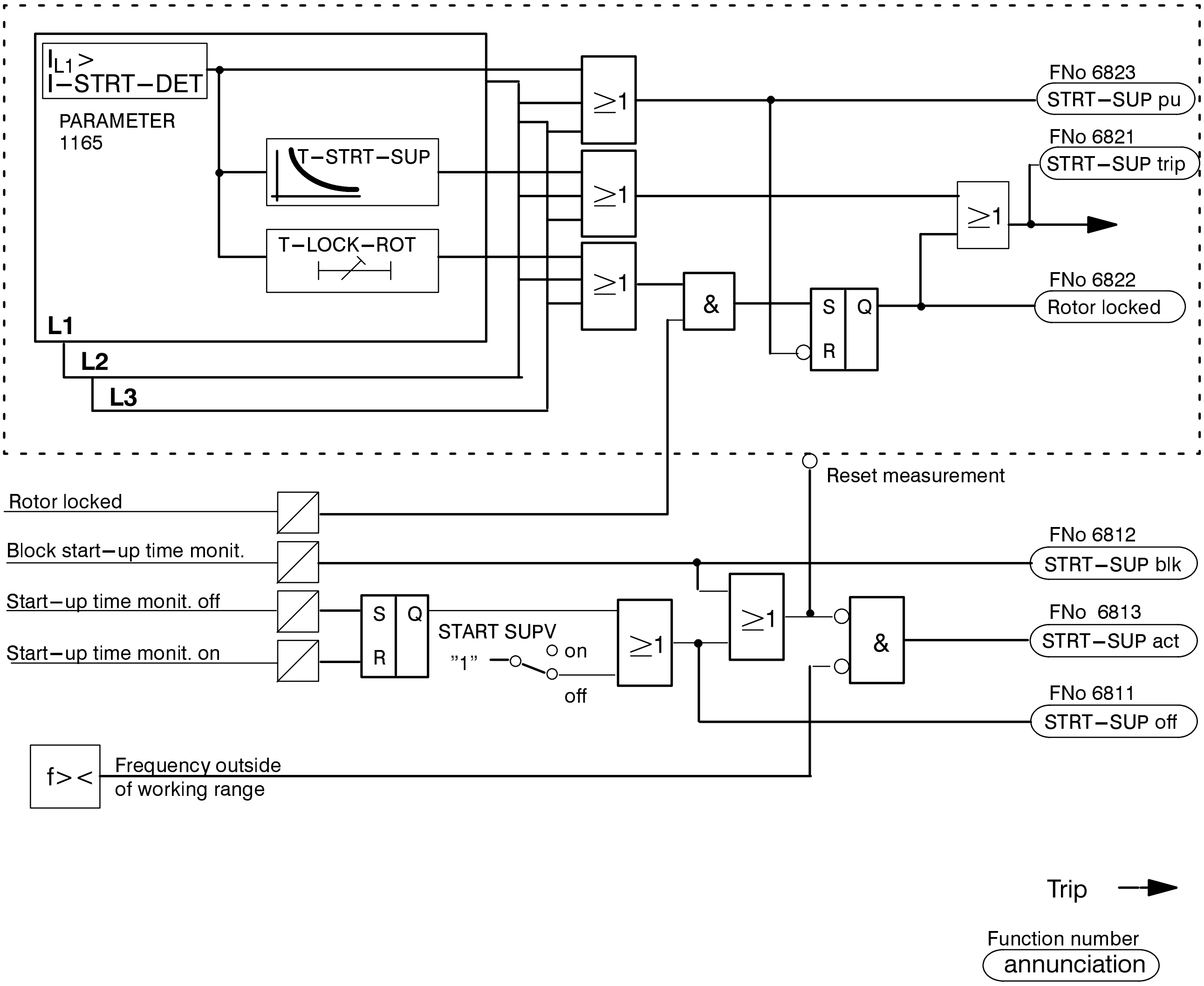


Figure 4.19 Logic diagram of start−up time monitoring

4.7 Thermal overload protection

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

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

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

with Θ – actual temperature rise referred to the final temperature rise for the maximum permissible current of the protected object $k \cdot I_N$

τ – thermal time constant for heating−up of the protected object

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

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 or the average temperature rise should be decisive. A true r.m.s. value measurement is performed in order to include for the effect of harmonic content.

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

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

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

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

The time constant during stand−still of a machine may be much longer than during operation in case of self−ventilated machines because the rotor does not ventilate. That is why the protection uses for the standing machine the cooling−down time constant which can be set as a factor of the heating−up time constant (factor k_τ). In this aspect, the motor is assumed to stand still when the current consumption is less than the settable threshold I BRK−CLOSED. In case of forced−ventilated machines, transformers, or cables is $k_\tau = 1$.

The thermal overload protection is supplemented by the start−up time monitor (see Section 4.6) and the restart lockout function (see Section 4.8) for use on motors. During start−up of the motor, the overload protection does not operate, i.e. change the calculated temperature rise. Start−up criterion is the (settable) current threshold I STRT−DET.

Figure 4.20 shows the logic diagram of the thermal overload protection.

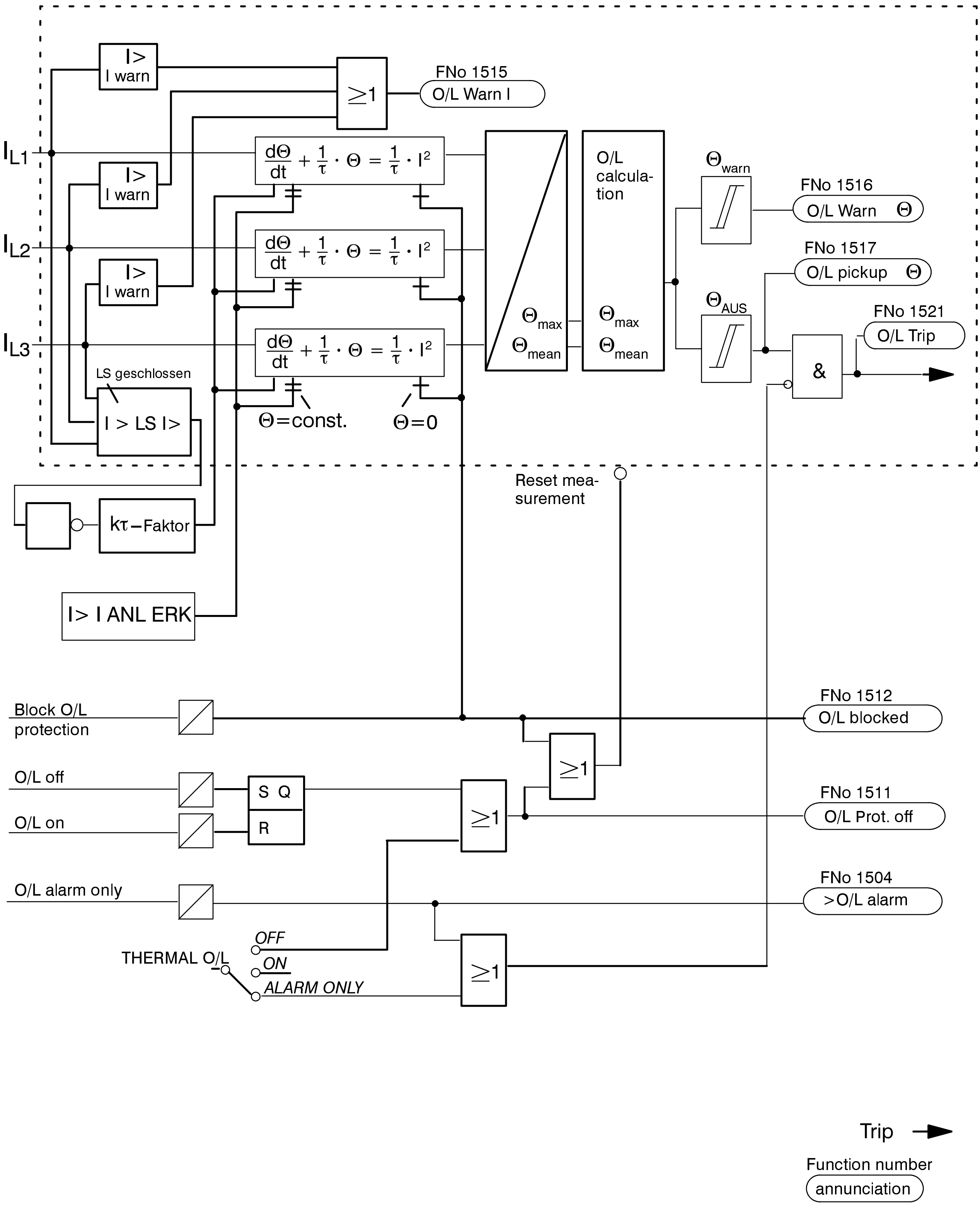


Figure 4.20 Logic diagram of overload protection

4.8 Restart lockout for motors [1])

The rotor temperature of a motor lies far away from the critical temperature limits during normal operation, even with increased load. In contrast, during start−up of the motor, the rotor is thermally endangered rather than the stator because of its smaller time constant in connection with the excessively high start−up currents. When the motor is started repeatedly, it is not desirable that the motor is de−energized during run−up should the limit temperature rise occur during this run−up period. Therefore, it is advisable that the motor start is avoided when overheating of the rotor is <u>expected</u> during run−up.

The rotor current cannot be measured directly. Thus, the restart lockout function of 7SJ531 approximates the rotor temperature rise from the stator currents. It is assumed, that the limit temperature of the rotor is reached, when the motor is energized with the rated start−up current so much time as it is permissible according to the data stated by the manufacturer of the motor. The relay calculates from this data the thermal characteristics which are decisive for thermal replica of the rotor. Restart of the motor is locked as long as the calculated restart limit (see Figure 4.21) is exceeded. Only when this limit is undershot, restart is released.

Switch−on of the motor via the integrated control functions is avoided during restart lockout, so that no measures need be taken: like logical combination or marshalling of the lock−out command. But, if the motor can be started from external control commands, then the lock−out command must be marshalled to an output relay and combined with the external command, so that the latter is locked.

It is of no concern that the heat distribution on the rotor cage bar is much different and produces several hot spots; but it is decisive that the thermal replica of the protection corresponds to the thermal state of the motor after run−up.

Figure 4.21 shows, as an example, the heating−up progress during repeated start−up of a motor and the progress of the calculated thermal replica of the protection.

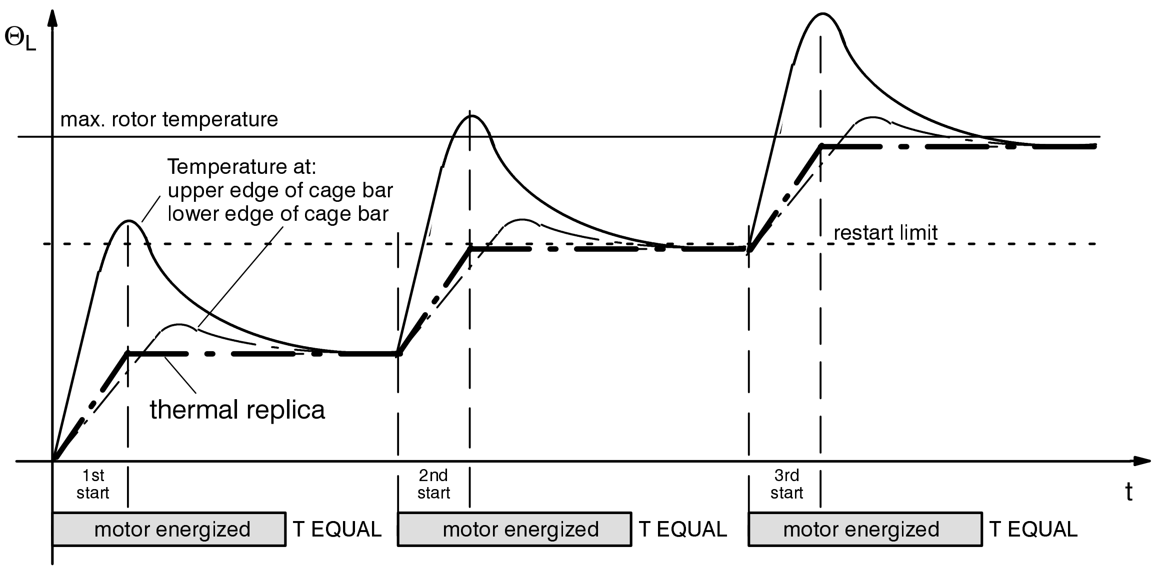


Figure 4.21 Temperature progress in the rotor and the thermal replica during repeated run−up

Besides the restart lockout after a stated number of restarts, an additional lock−out time T EQUAL can be defined. The number of permissible restarts as stated by the motor manufacturer assumes that the motor is not re−energized before it has come to stand−still because of the different heat spots of the rotor. The motor should be restarted only when the rotor temperature has come to a thermal equilibrium after the time T EQUAL has expired.

[1]) only for model 7SJ531⋆−⋆⋆⋆⋆**2**−⋆⋆⋆⋆

The time of thermal equilibrium T EQUAL is started each time the motor is switched off. The thermal replica is not actualized during this time but kept constant in order to simulate temperature equalizing. The total lockout time is composed of the time calculated by the thermal replica plus the time of equilibrium T EQUAL as explained before. T EQUAL can also be set so zero.

The higher cooling−down time constant during stand−still of a self−ventilated machine can be considered by a factor kτ. In this aspect, the motor is assumed to stand still when the current consumption is less than the settable threshold I BRK−CLOSED. In case of forced−ventilated machines is $k_{\tau} = 1$.

If, for operational reasons, it becomes unavoidable that the motor be started regardless of its thermal state (emergency start), the lock−out signal can be blocked via a binary input (">MSP emerg st") of the relay. Thus, restart is permitted. The thermal replica of the protection continues its calculation so that the simulated maximum rotor temperature can be exceeded. The machine breaker is not tripped but the calculated temperature rise can be observed in the operational measured value in order to estimate the risk.

When the restart lockout protection is blocked or switched off, the thermal replica and the timer T EQUAL are reset to zero. A standing lockout command is cancelled.

Figure 4.22 shows the logic diagram of the restart lockout.

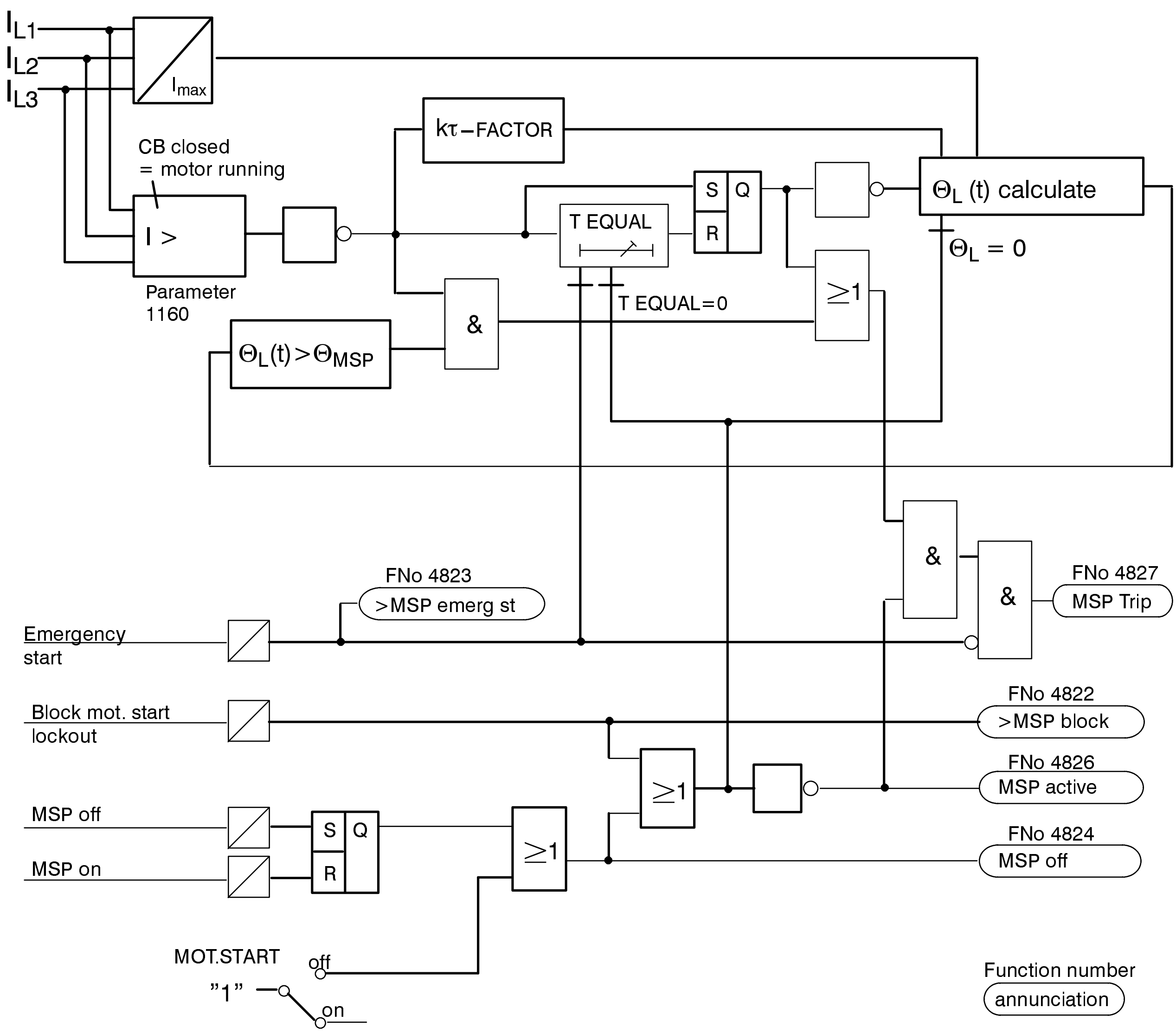


Figure 4.22 Logic diagram of the motor start−up lockout

4.9 Highly sensitive earth fault protection

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

Because of its high sensitivity it is not suited for detection of higher earth fault currents (from 1 A and above at the relay terminals for high−sensitivity earth fault protection). For those applications use the overcurrent time protection for earth currents as described in Sections 4.2 and 4.3.

4.9.1 Voltage stages

The earth fault protection function comprises the earth fault detection by monitoring the displacement voltage $U_E>$ and the recognition of the earth−faulted phase. The displacement voltage may be connected directly to the relay terminals, or may be calculated from the sum of the phase−to−earth voltages. In the latter case the displacement voltage can only be detected when the relay is connected to three phase−earth voltage transformers, the star−point of which is earthed.

If the relay is connected to phase−to−phase voltages, earth fault detection is not possible as the displacement voltage cannot be calculated. The relay is informed about the v.t. connections during configuration.

The displacement voltage U_E initiates earth fault detection and is one condition for release of directional determination according to Section 4.9.3. U_E means the voltage at the input of the device, with open delta VT; if this input is not used, the relay then calculates

$$\underline{U}_E = \sqrt{3} \cdot \underline{U}_0 = (\underline{U}_{L1} + \underline{U}_{L2} + \underline{U}_{L3}) / \sqrt{3}.$$

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

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

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

The logic diagram of the voltage stages of earth fault protection is shown in Figure 4.23.

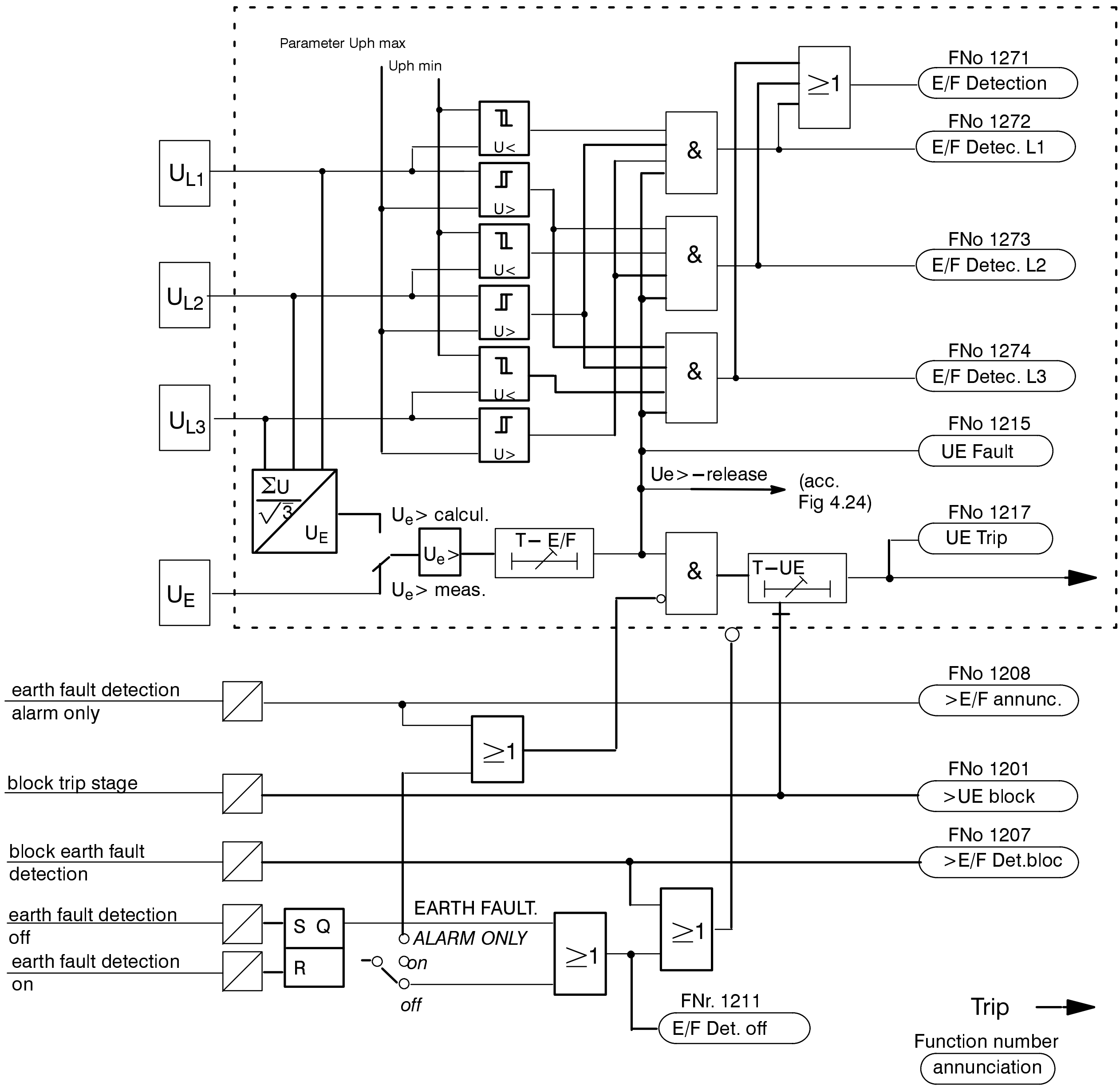


Figure 4.23 Logic diagram of the voltage stages of earth fault protection

4.9.2 Highly sensitive earth current stages [1])

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

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

[1]) only for model 7SJ531★–★★★★**2**–★★★★

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

The low−value stage operates with a definite time lag characteristic. Additionally, a user specified characteristic is possible.

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

The direction determination is performed with the zero sequences quantities: $I_E = -3 \cdot I_0$ and $U_E = \sqrt{3} \cdot U_0$, as described in Section 4.9.3.

The logic diagram of the current stages of earth fault protection is shown in Figure 4.24.

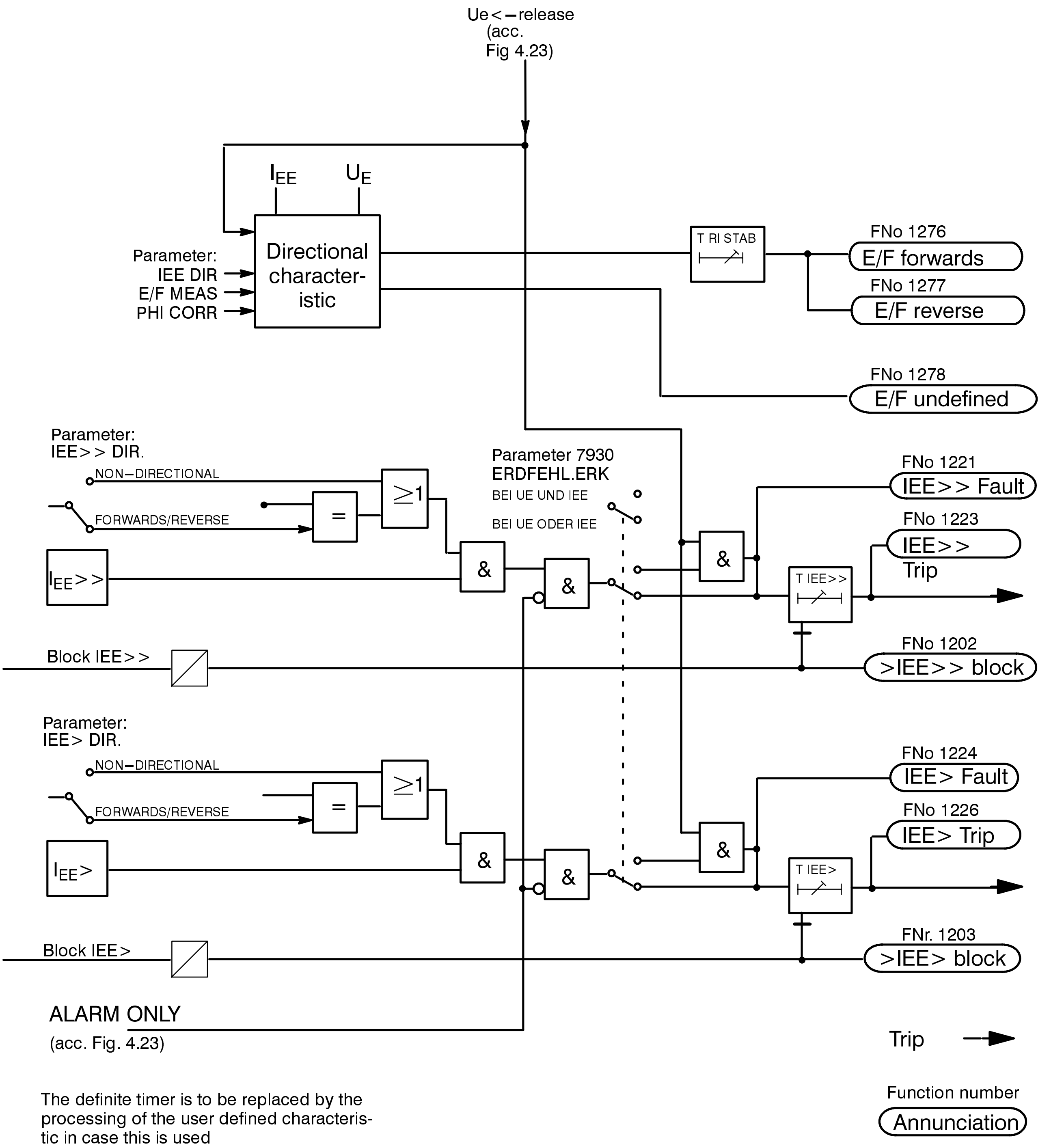


Figure 4.24 Logic diagram of current stages of directional earth fault protection

4.9.3 Highly sensitive direction determination [1])

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

Figure 4.25 shows an example in the complex phasor diagram, in which U_E forms the real axis. In this example, the active component I_{Ea} of the earth current I_E, related to the displacement voltage U_E, is decisive and is compared with the set threshold value $I_{EE\ DIREC}$. Thus, this example is valid for directional earth fault determination in an arc compensated system, where the quantity $I_E \cdot \cos\phi$ is the determining factor. The symmetry axis is identical with the I_{Ea} axis.

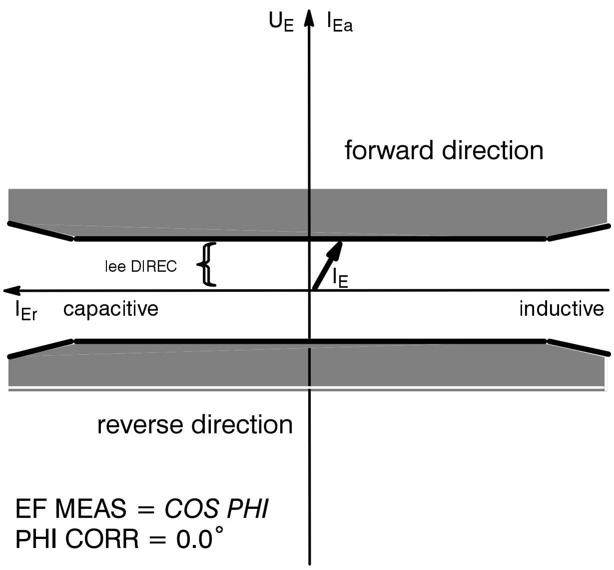


Figure 4.25 Directional characteristic with cos ϕ measurement

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

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

Active power:

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

Reactive power:

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

where T equals period of integration.

The use of an efficient calculation algorithm and simultaneous numerical filtering allows the directional determination to be achieved with high accuracy and sharply defined threshold limits (see Figure 4.26) and insensitivity to harmonic influences − particularly the frequently strong third and fifth harmonics which occur particularly in ohmic earth fault currents. The directional decision results from the signs of active and reactive power.

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

With sin ϕ measurement (for isolated systems):

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

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

With cos ϕ measurement (for compensated systems):

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

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

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

[1]) only for model 7SJ531★−★★★★**2**−★★★★

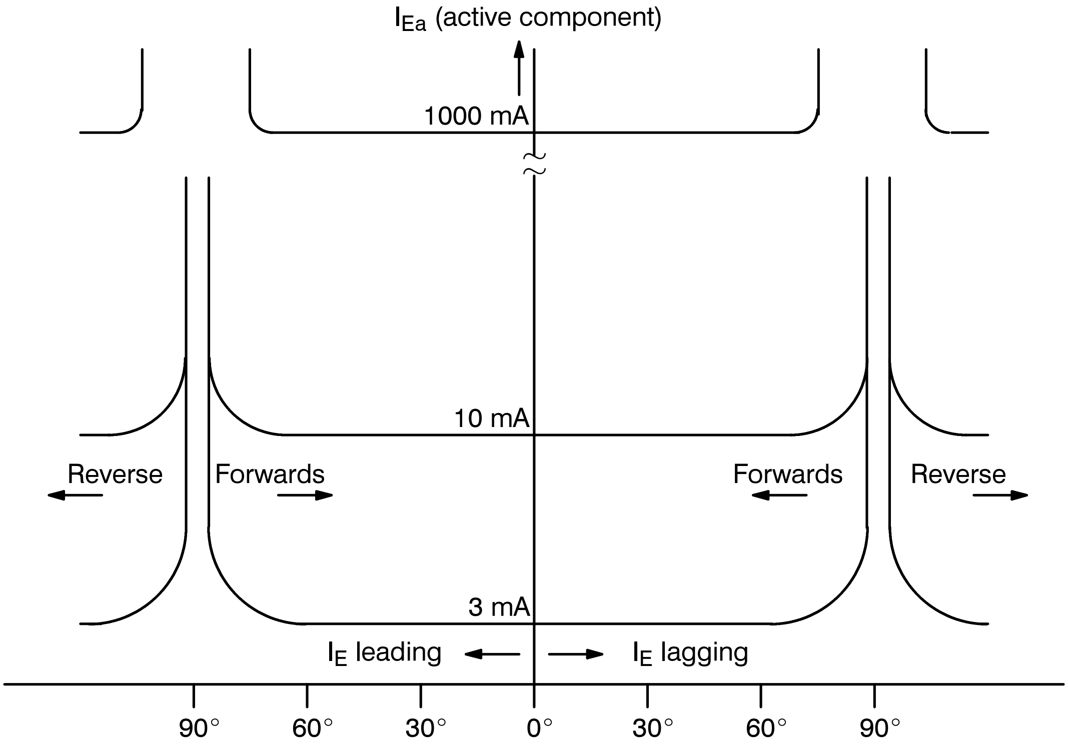


Figure 4.26 Directional earth fault measurement characteristic – example I · cos ϕ

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

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

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

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

Further explanation concerning the characteristic and symmetry axis are given in the setting hints in Section 6.3.15.

4.9.4 Earth fault location

By means of the directional indication of the network, the earth–faulted line can often be located. In radial networks, location of the faulted line is relatively simple. Since all circuits on a busbar (Figure 4.27) carry a capacitive partial current, the measuring point on the faulted line in an isolated network sees almost the entire prospective earth fault current of the network; in compensated networks the wattmetric residual current from the Petersen coil flows through the measuring point. For the faulted line or cable, a definite ”forwards” decision will result, whilst in the remaining circuits a ”reverse” indication will be given unless the earth current is so small that no measurement can be taken. In any case the faulted cable can be clearly determined.

In meshed or ring networks the measuring points at the ends of the faulted cable equally see a maximum of earth fault (capacitive or ohmic) current. Only in this cable will the direction ”forwards” be indicated on both line ends (Figure 4.28). Even the remaining directional indications in the network can aid location of the earth fault. But under certain circumstances one or more indications may not be given due to insufficient earth current. Further advice can be found in the leaflet ”Earth–fault detection in isolated neutral or arc–suppression coil earthed high voltage systems”.

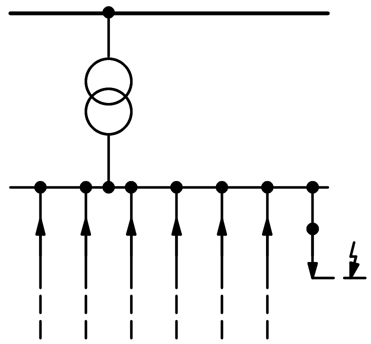


Figure 4.27 Faulted line location in radial network

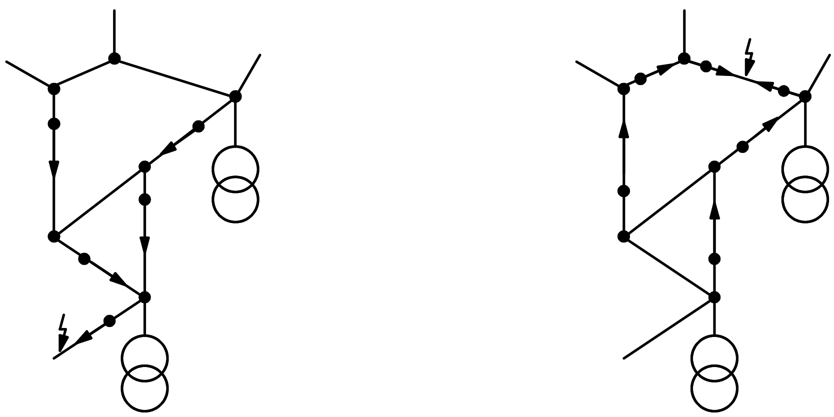


Figure 4.28 Location of earth fault based on the directional indicators in a meshed network

4.10 Automatic reclosure (optional)

4.10.1 General

Experience has shown that approximately 85 % of short circuits are caused by an arc, on **overhead lines**, and self−extinguish after interruption by the protective device. The line can therefore be re−energized. This is carried out by the automatic reclosure (AR) function. In case of generators, motors, transformers, reactors, or cables, auto−reclosure is not reasonable and this function must be de−configured.

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

7SJ531 allows automatic three−pole as well as single− and multi−shot reclosure. If more than one reclose attempt will be carried out, the second and any further auto−reclose cycle are designated in the following with DAR (delayed auto−reclosure) independent on the setting of the dead times of the cycles.

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

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

4.10.2 Protection stages and selectivity during automatic reclosure

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

For each of the protection stages:

− I>> stage for phase currents,

− I> stage (definite time) or I_p stage (inverse time) for phase currents,

− I_E>> stage for earth current,

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

− I>> DIR stage for phase currents,

− I> DIR stage (definite time) or I_p DIR (inverse time for phase currents,

− I_E>> DIR for earth current,

− I_E> DIR stage (definite time) or I_{Ep} stage (inverse time) for earth current,

− I2>>−stage of unbalanced load protection,

− I2>−stage of unbalanced load protection,

can be individually chosen whether the stage shall initiate RAR function or not.

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

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

4.10.3 Action times and reclaim times

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

The AR−functions of 7SJ531 are provided with settable action times, separate for RAR and DAR, which are started by the fault detection signal. If, after expiry of the action time, no tripping signal has been given, reclosure is blocked.

The AR−functions of 7SJ531 are provided with three settable reclaim times, which do not discriminate between RAR and DAR. Generally, the reclaim time is the time period during which no further reclosure attempt is permitted.

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

The lock−out time T−LOCK is the time period during which any further close command by the auto−reclose function is blocked after final disconnection. If this time is set to ∞, closing is locked out until the AR function is reset by energization of the binary input ”>AR Reset”. After the reset signal all functions reset to the quiescent condition.

A special reclaim time T−BLOC MC is provided for manual closing, either via a binary input of the relay or by control operation. During this time after manual close, reclosure is blocked; any trip command will be a final trip.

4.10.4 Three−pole rapid auto−reclosure

When the AR function is ready for operation, the short−circuit protection trips three−pole for all faults within the stage valid for RAR (refer to Section 4.10.2). The AR−function is initiated provided tripping occurs within the action time (refer to Section 4.10.3). With fault clearance due to a trip command after multi−phase faults, the (settable) dead time RAR T−PHAse commences; with fault clearance due to a trip command after a single−phase fault, the (settable) dead time RAR T−EARth commences. After the corresponding dead time, the circuit breaker receives a closing command, the duration of which is settable. Simultaneously, the (settable) reclaim time T−RECLAIM (Section 4.10.3) is started.

If the fault is cleared (successful RAR), the reclaim time T−RECLAIM (Section 4.10.3) expires and all functions reset to the quiescent condition. The network fault is cleared.

If the fault has not been cleared (unsuccessful AR) then the short−circuit protection carries out a final disconnection in the stage that is valid for final trip (refer to Section 4.10.2). Also, every fault during the reclaim time will result in final disconnection.

After unsuccessful AR (final disconnection) the lock−out time T−LOCK (Section 4.10.3) is started. For this time any close command from the AR−function is locked.

The above sequence comes into effect with single−shot RAR. With 7SJ531, multiple AR−attempts (up to 9 DAR−shots, refer Section 4.10.5) are also possible.

4.10.5 Multi−shot delayed auto−reclosure

The internal auto−reclose feature in 7SJ531 will also permit multi−shot reclosure, up to 9 consecutive DAR−cycles. The action time can be independently set for these DAR cycles.

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

The dead times can be individually set for trip after single−phase faults and multi−phase faults.

Each new pick−up restarts the action time DAR T−ACT, within which a tripping command must occur. After fault clearance, the dead time begins. At the end of this, the circuit breaker is given a new closing command. Simultaneously, the reclaim time T−RECLAIM (Section 4.10.3) is started.

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

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

If none of the AR−cycles has been successful then the short−circuit protection carries out a final disconnection after the last permissible cycle in the stage that is valid for final trip. The lock−out time T−LOCK (Section 4.10.3) is started. For this time close command from the AR−function is locked.

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

4.11 Trip circuit supervision [1])

The device includes an trip circuit supervision for one trip circuit. Dependent on the number of binary inputs which are available for this purpose, supervision can be effected with one or two binary inputs. The relay is informed about this during configuration. If the configuration and the marshalled number of binary inputs doe not comply, the alarm ”`SUP MarshFail`” is output. When two binary inputs are used, disturbances in the trip circuit can be detected for every switching condition; when one binary input is used, those disturbances which occur during closed trip contacts cannot be detected.

A precondition for use of the trip circuit supervision is that the control voltage for the circuit breaker is greater than the sum of the voltage drops of the two binary inputs ($U_{cv} > 2 \cdot U_{BI\ min}$) or at one binary input and the replacement resistor R. Since each binary input needs at least 16 V, supervision requires at least 32 V control voltage.

Figure 4.31 shows the logic diagram of the annunciations generated by the trip circuit supervision.

4.11.1 Supervision using two binary inputs

When two binary inputs are used, they are connected according to Figure 4.29: one input in parallel to the trip relay the circuit of which is to be supervised, the other in parallel to the circuit breaker auxiliary contact.

The binary inputs are energized (logical ”H”) or short−circuited (logical ”L”) depending on the status of the trip relay and the circuit breaker.

During normal operation it is not possible that both the binary inputs are de−energized (logical ”L”) at the same time unless for the short time where the trip relay has already closed but the breaker is not yet open.

If both the binary inputs are de−energized continuously, this indicates that either the trip circuit is interrupted, or the trip circuit is short−circuited, or the control voltage for tripping is absent, or the breaker has not properly operated. Thus, this status indicates a fault in the trip circuit.

The status of the two binary inputs is checked approximately every 200 ms. An intentional time delay for alarm is produced by three repeated status checks before an alarm is given. This prevents from faulty alarms due to short transient occurrences.

4.11.2 Supervision using one binary input

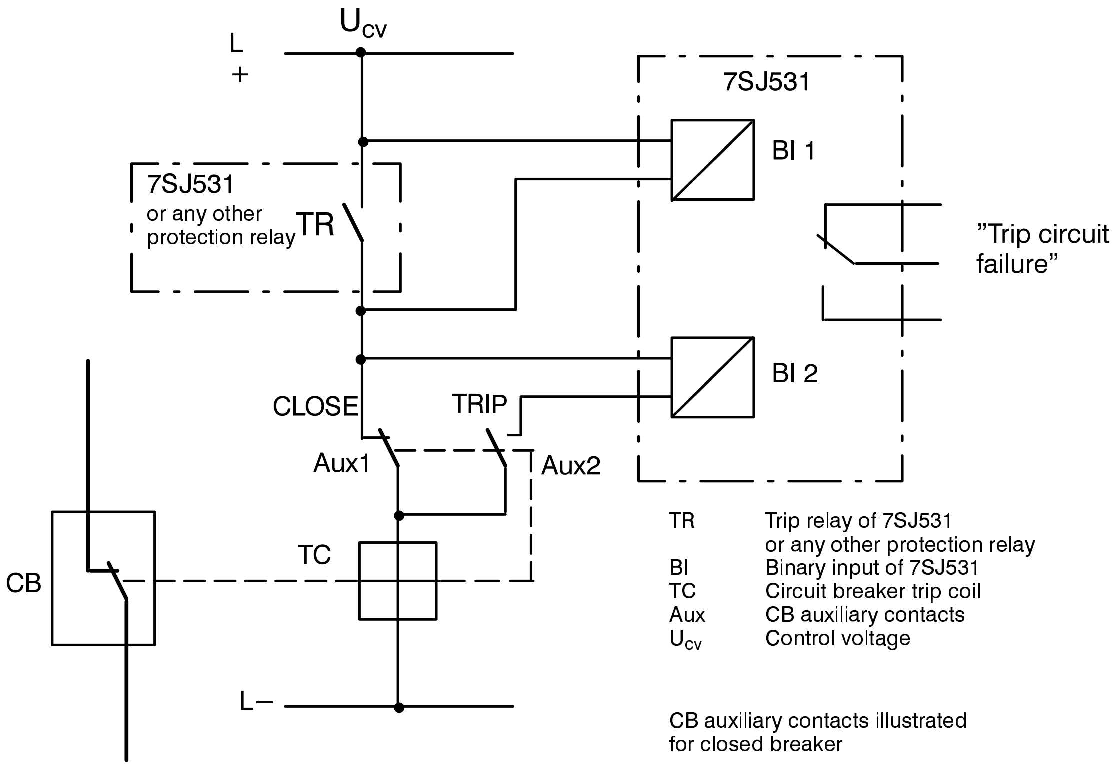
When only one binary input is to be used, this is connected according to Figure 4.30: in parallel to the trip relay the circuit of which is to be supervised.

The binary input is energized (logical ”H”) as long as the trip relay is not energized and the trip circuit is healthy.

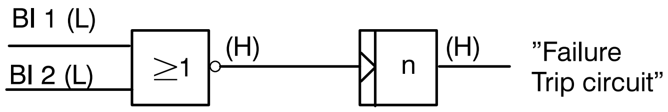
When the binary input is not energized (logical ”L”), this indicates that either the trip contact is closed or the trip circuit is interrupted, or the trip circuit is short−circuited, or the control voltage for tripping is absent. As the trip contacts may be closed during healthy trip circuit condition, alarm must be delayed accordingly. This delay time is adjustable in order to be matched to other trip relays which operate the same breaker. Furthermore, an intentional time delay for alarm is produced by three repeated status checks before an alarm is given. This prevents from faulty alarms during closed trip contacts.

Since the second binary input is not available in this mode, it must be replaced by a resistor R which is connected to the breaker auxiliary contact Aux2 (refer to Figure 4.30, compare with Figure 4.29). This allows to detect disturbance in the trip circuit even when the breaker auxiliary contact Aux1 is open and the trip contact is reset. The resistance of R is dimensioned such that the trip coil TC must not be energized when the circuit breaker is open (auxiliary contact Aux1 open, Aux 2 closed); on the other hand the binary input must be safely energized when the trip contact is open. Information on how to dimension the resistor are contained in Section 5.2.5.3.

[1]) only for model 7SJ531★−★★★★**2**−★★★★



No	Trip relay	CB position	BI 1	BI 2
1	open	CLOSED	H	L
2	open	OPEN	H	H
3	closed	CLOSED	L	L
4	closed	OPEN	L	H



n number of repeated status checks = 3

Figure 4.29 Principle of trip circuit supervision with two binary inputs

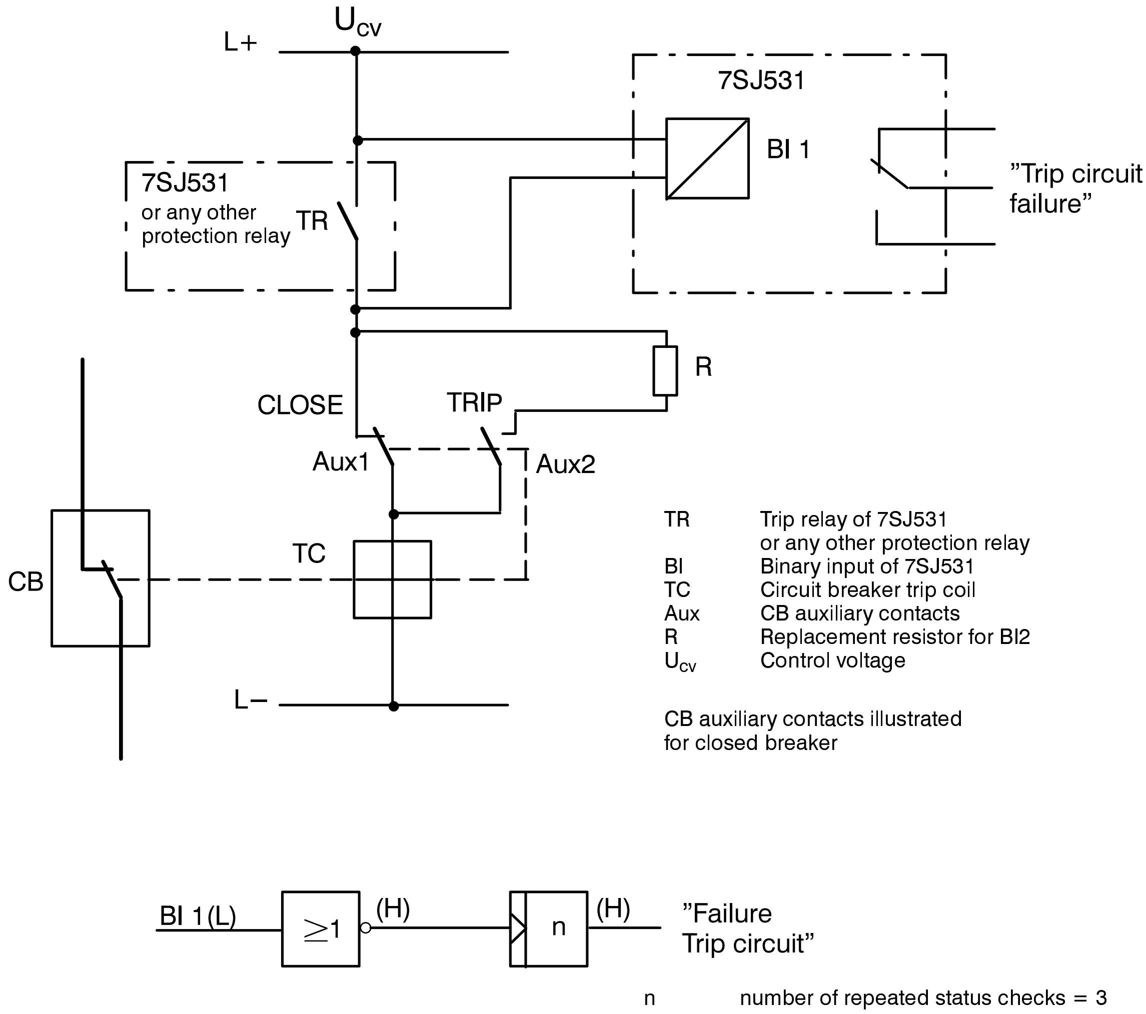


Figure 4.30 Principle of trip circuit supervision with one binary input

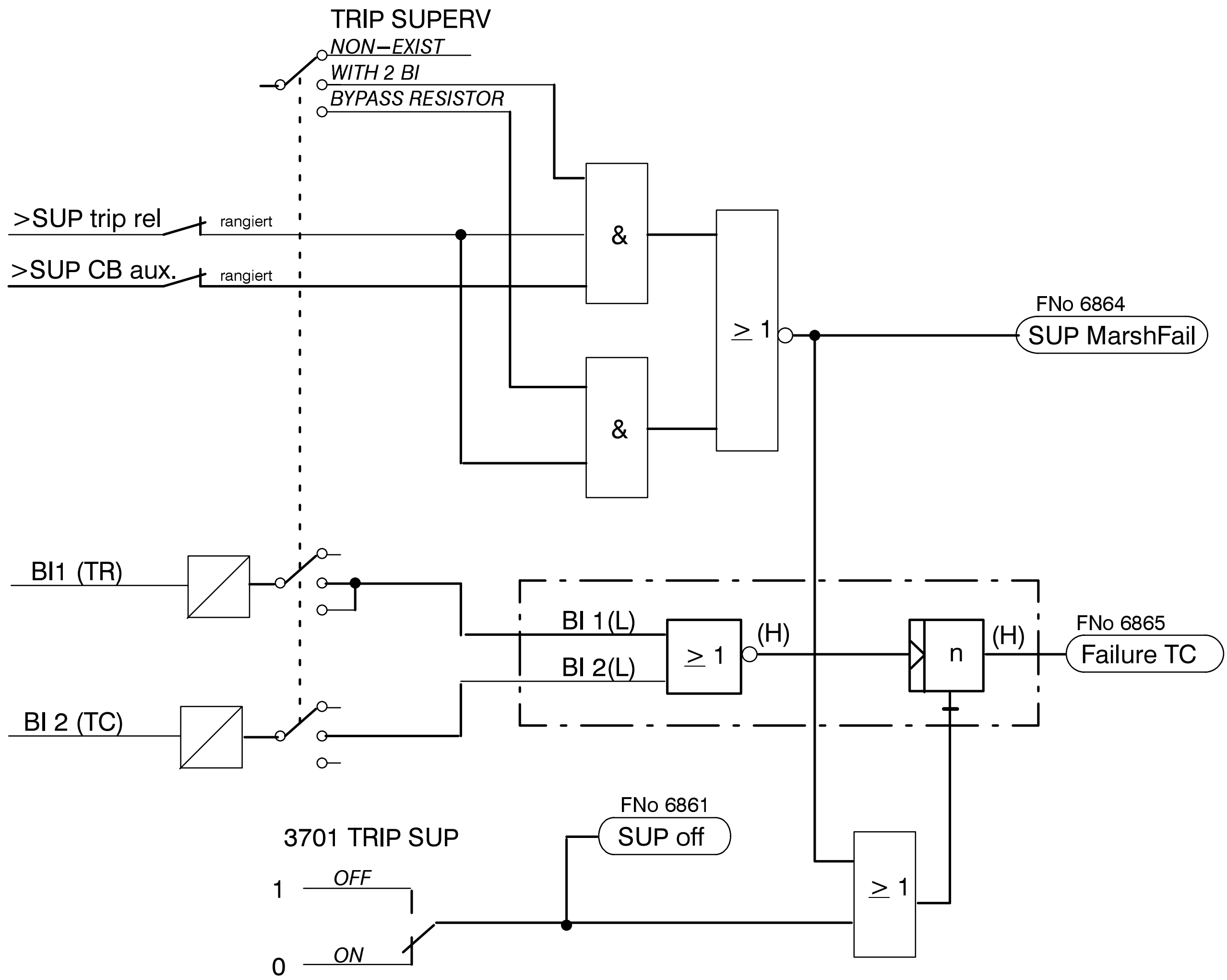


Figure 4.31 Logic diagram of trip circuit supervision

4.12 Distance−to−fault location [1])

Distance−to−fault measurement before clearance of the fault is an important addition to the function of a line protection relay. Availability of the line for energy transmission in the network can be increased by rapid location of point of fault and repair of any resultant damage.

Normally, the fault location function is started by the tripping command from the overcurrent time protection. At first, the fault locator determines the valid measurement loop and the most favourable time interval for measured value storage. Paired values of short circuit current and short circuit voltage, taken at intervals of 1/20 of a cycle and stored in a circulating buffer, are frozen 15 ms later which, even with extremely fast circuit breakers, ensures that the measurements are not distorted by the tripping transients. Filtering of the measured values and quantity of the impedance calculations are automatically matched to the number of incoming value pairs from the time of fault inception to 15 ms after tripping command.

Fault location can also be initiated via a binary input. The overcurrent time protection must have picked up in this case. Thus, calculation is possible when a different protection device effects clearance of a short circuit. Further, fault calculation can be started without receipt of any tripping command, i.e. by pick−up of the overcurrent time protection (selectable).

[1]) only for model 7SJ531★−★★★★**2**−★★★★

Evaluation of the measured values occurs after the fault has been cleared. From the stored and filtered values at least three resultant pairs for R and X are determined. If less than three resultant pairs are available, no fault location is given. From the resultant pairs, average value and standard deviation are calculated. After elimination of ”exceptions”, which are recognized by their excessive difference from the standard deviation, another average is again calculated for X. This average is taken as fault reactance.

As a result of the fault location calculation the following outputs are given:

- the short circuit loop, from which the fault reactance is determined,
- the reactance per phase in Ohms secondary,
- the fault distance in km or miles line length proportional to the reactance, calculated on the basis of the set unit reactance of the line,

Note: Calculation of the distance in km or miles can only be applicable to homogeneous line lengths. But, if the line is made up of sections with differing reactance values, e.g. overhead line – cable combinations, the distance to fault can still be calculated manually from the reactance determined by the fault location, if the line characteristics are known.

4.13 Circuit breaker failure protection

The circuit breaker failure protection monitors the correct opening of the associated circuit breaker. For this purpose two criteria are available:

- check whether the current becomes zero after a trip command is given,
- monitor the circuit breaker's auxiliary contacts.

The criteria which shall cause pick–up are selectable and depend also on the protection function which has given the trip command. When a trip command is given without short–circuit current, e.g. by a voltage protection, then the current is not a reliable criterion for the circuit breaker's reaction. Therefore the pick–up can be made dependent on the auxiliary contact criterion alone. If, however, the current criterion is fulfilled, i.e. the current remains above a settable threshold, then the trip commands are not distinguished as to their originating protection function. In this case a circuit breaker failure is always assumed.

There are three different sources for an initiation of the circuit breaker failure protection:

- internal protection functions in the 7SJ531,
- external starting signals via binary input,
- control command via operating panel or interface.

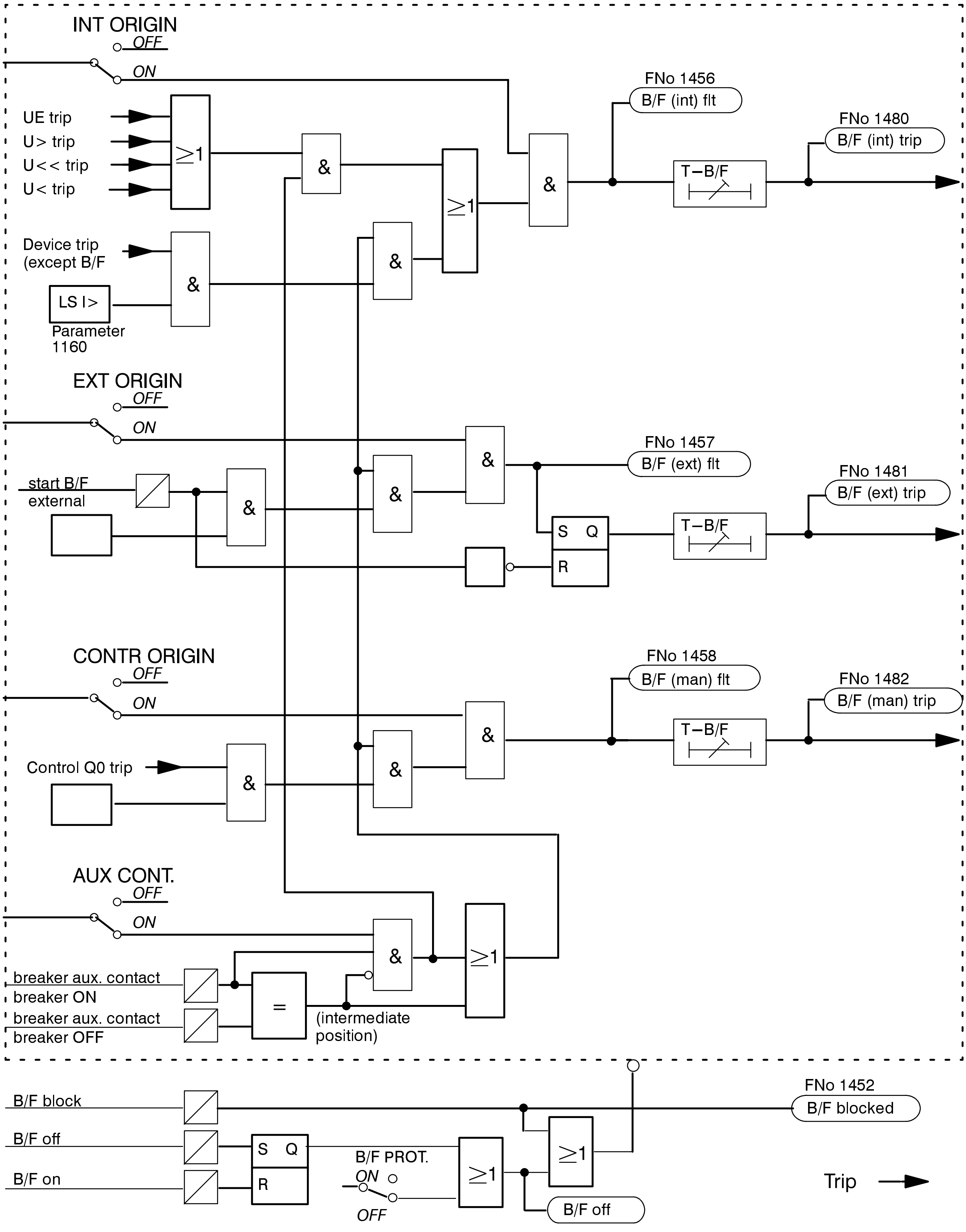
Each of these sources can be switched on or off separately and creates different annunciations.

Upon detection of a circuit breaker failure, the corresponding alarm is given and fault clearing is initiated via the surrounding circuit breakers after a settable time delay. This can be achieved by means of one of the marshallable trip relays; a marshallable alarm relay can be used as well, because in many cases auxiliary relays with high–duty contacts are used for contact multiplication (switching capacity!).

Figure 4.32 shows the logic diagram of the circuit breaker failure protection. The complete circuit breaker failure protection can be switched on or off via parameters and binary inputs, as well as dynamically blocked via binary inputs.

Each of the three sources creates a pick–up annunciation of its own, starts a time delay of its own and forms a trip command of its own. The parameter values for current threshold and time delay are common.

In case that one of the criteria (current value, auxiliary contact), which led to the pick–up, becomes invalid during the running time delay, the pick–up resets and no trip command is created by the circuit breaker failure protection.



INT ORIGIN = internal origin
EXT ORIGIN = external origin
CONTR ORIG = origin local control command
AUX CONT. = processing of circuit breaker auxiliary contact

Figure 4.32 Logic diagram of the circuit breaker failure protection

4.14 Control of switching devices

4.14.1 General

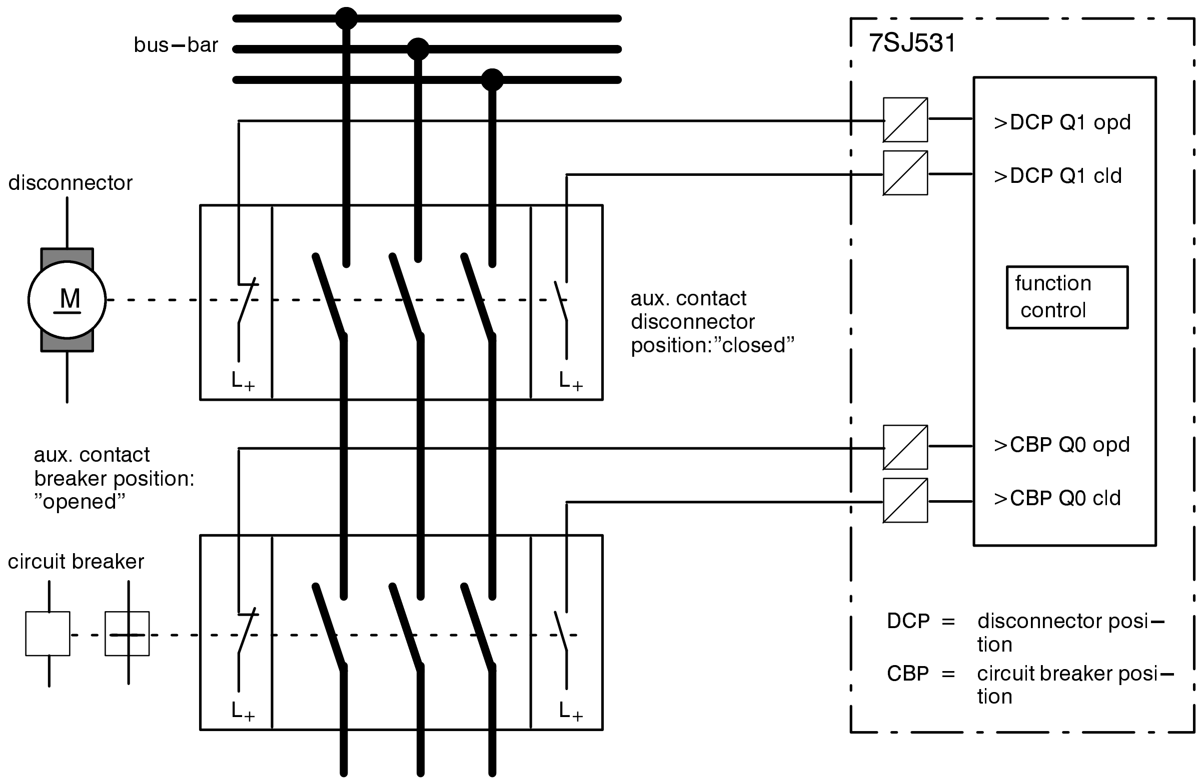
A control function is incorporated in SIPROTEC 7SJ531 which permits the closing and opening of circuit breakers by means of separate control elements in the relay. The momentary switching state of all switching devices is shown in a feeder mimic diagram on the integrated graphical display on the relay's front–plate. Out of a large number of mimic diagrams (see Appendix E) a suitable one can be selected for the switchgear.

A pair of auxiliary contacts (on and off) is required from each switching device which shall be displayed. These feedback signals are assigned to the corresponding binary inputs of the 7SJ531. The assignment of the switch state feedback signals is fixed for each mimic diagram and cannot be marshalled. For breakers, the item designation "Qnn" is used, which is established in DIN 40719.

Figure 4.33 shows a connection example and all relevant breaker designations.

All position feedback signals are monitored for plausibility. If neither the check–back signal ON nor OFF is received from a switching device Qnn, a failure indication "`error pos.`" is sent after a parameterized time. The switch has to be in one of the two positions, except for the instant when switching is performed. In parallel to the individual failure indication a collective alarm "`err:CB/DC pos`" is created with the first indication which is given. This signal disappears when all switching devices have again resumed a defined state.

Pick up of the monitoring of the feedback signal does not create an alarm, as long as the switching command is under execution.



circuit breaker	Q0	feeder earthing disconnector	Q8
load disconnector	Q1 (Q01 in former version)		Q9
1. bus–bar disconnector	Q1	coupling disconnector	Q10
2. bus–bar disconnector	Q2	bus–bar earthing disconnector	Q15
maintenance earthing disconnector	Q5	bus–bar earthing disconnector	Q16
measuring earthing disconnector	Q6		

Figure 4.33 Connection example for feedback alarms in the 7SJ531 to the bay and device designations of possible switching devices

4.14.2 Display and operation

The feeder mimic diagram in the graphical display is presented in the so−called basic diagram 1, see example in Figure 4.34, in which the momentary switching device states are depicted. The relay 7SJ531 disposes of a library with 22 different basic diagrams, from which the suitable one can be selected during configuration (see Appendix E).

From the utilized symbols the type of switching device (disconnector or circuit breaker) and the switching state (closed, open, faulty) can be recognized.

The control of the switching devices can be effected in the 7SJ531 from four command sources:

− local operation via the integrated keypad,

− binary inputs manual close / manual trip,

− remote control via the system interface,

− operation via the PC interface (DIGSI®).

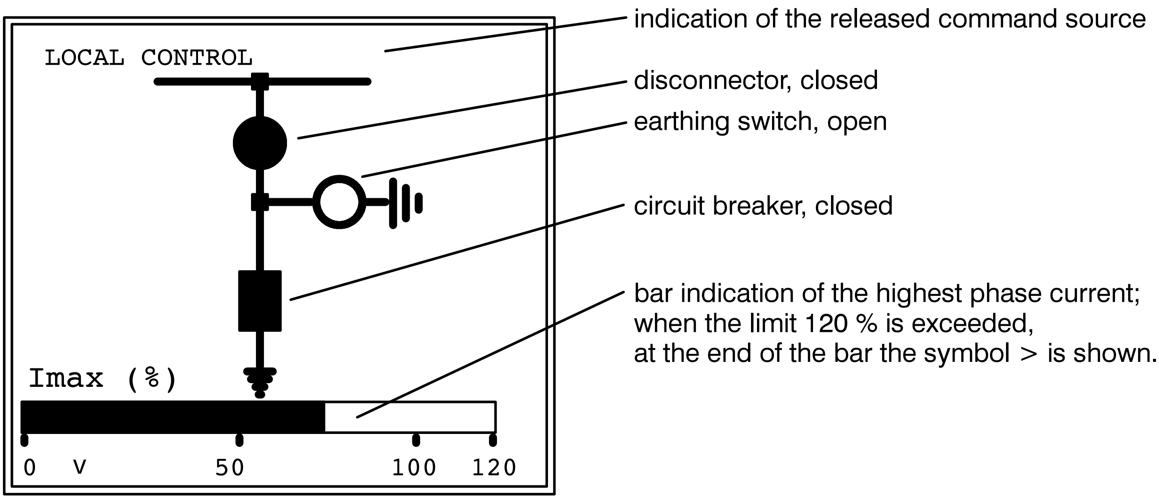
By parameterization it is defined which one of the command sources is activated (switching authority). The released command source is indicated in the headline of basic diagram 1. Change−over of the switching authorization as well as blocking of all command sources is possible by binary inputs.

A circuit breaker may only be controlled, when there is no fault in the network and no test is running. If the protection picks up during the control selection, the operating sequence is interrupted.

4.14.2.1 Switching authority

A control parameter ”switching authority” serves for selection of the switching authorization, which selects the authorized command source. Beside the various changeover options of the local and remote control, any control can be inhibited (FNo 4632) or changeover of the switching authorization via binary input can be provided (FNo 4631). A separate selection feature is integrated which enables quick and direct access to the parameter of switching authority.

Blocking of all control sources is furthermore possible by a binary input.



type of switching device	symbol for the switching device and state closed	open	interm. state	set flashl.	
disconnector switch					selected final state flashing
circuit breaker					

Figure 4.34 Example for a basic diagram 1 and explanation of the symbols for switches

4.14.2.2 Local control

For local control three individual keys of different colour are located at the left side of the keypad. The control keys can only be operated when the feeder mimic diagram is shown in the display. Coming from other operating modes it is necessary to return to basic diagram 1 for control. First the switching direction is defined by operating the ON or OFF key (see Figure 4.35).

The symbol for the circuit breaker starts flashing.

The switching itself is carried out only after pushing the command release key (see Figure 4.35). If no command release is given within a parameterized waiting time T−ENTRY, then the flashing changes into the corresponding original state. The switching procedure can be aborted before the command release or during the selection of the switching device by means of the keys **R** or **MENU**. When a switching direction is selected which corresponds to the switching device's momentary state, the input causes no reaction and no interruption alarm is given.

It can be parameterized that switching device control is released only after input of a codeword.

4.14.2.3 Binary inputs Manual close/Manual trip

Closing and opening of the circuit breaker are also possible via binary inputs, if the corresponding commands are marshalled to the relay's binary inputs and the parameterization was carried out accordingly. The control commands are transferred to the two relevant functions "control" and "protection" in the relay. The binary inputs manual ON and manual OFF must be assigned either to the local or to the remote control with respect to checking the switching authority.

4.14.2.4 Operation via the system interface

Control of the circuit breaker is possible via the serial system interface and connection to the switchgear control system (LSA). This requires that the necessary peripheral features are provided physically in the relay (model 7SJ531*−*****−***C****) as well as in the switchgear. Furthermore specific settings for the serial interface are necessary in the relay (see Section 5.3.4).

4.14.2.5 Operation via personal computer

Control of the circuit breaker is possible via the operation interface with a personal computer and the operation program DIGSI®.

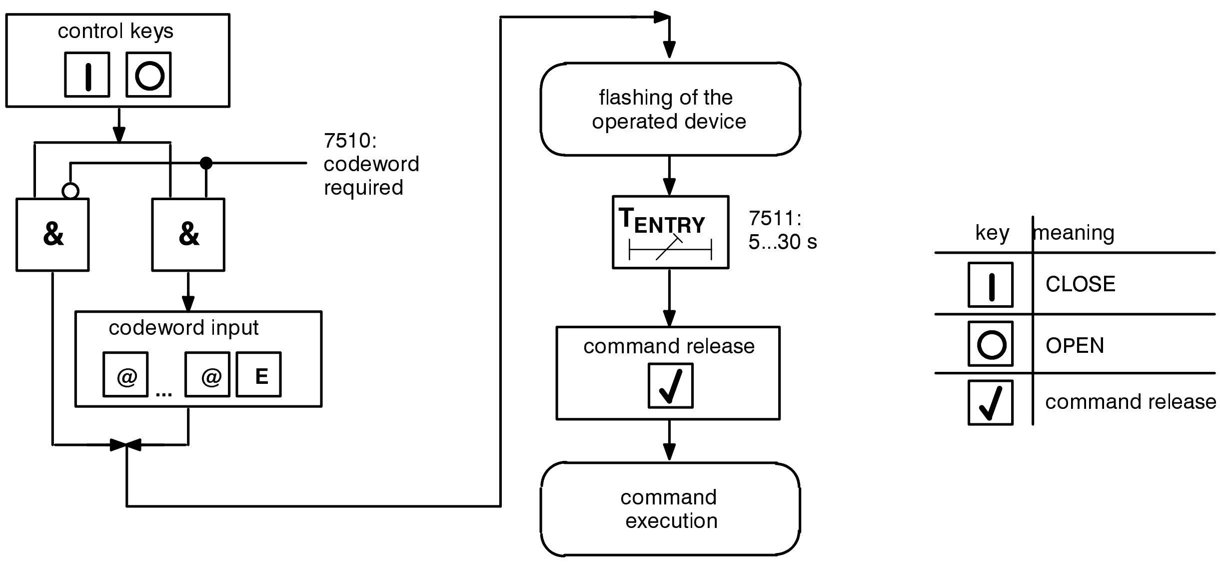


Figure 4.35 Survey of local control

4.14.3 Execution and monitoring of the command

The command execution is initiated by pushing the command release key. Corresponding annunciations are created inside the relay, containing the breaker designation, the control source, the type (command or feedback), the result (positive or negative) and the switching direction.Table 4.2 lists the command annunciations and their meaning. When all conditions are fulfilled and the command relay is marshalled accordingly, the command is given. Figure 4.37 shows an example of the procedure and some annunciations of the command input. The annunciations are shown below the feeder mimic diagram instead of the bar indication of the highest phase current.

Together with the command output a monitoring time is started (command running time monitoring) to check whether the circuit breaker reaches the desired final state within this time (see Figure 4.36). Upon receiving the ”breaker state feedback signal” the command relay drops out and the monitoring time is stopped. In case of a missing feedback, the alarm ”command running time expired (`CR time exp`)” is given.

Any switching command can always be interrupted by a protection trip command.

4.14.3.1 Time−out of the command running time

The relay’s reaction to the alarm ”command running time expired (`CR time exp`)” can be parameterized to make sure that the cancellation of the command does not damage the command relay. It can be selected, whether the running switching command shall drop out after exceeding the monitoring time or whether it shall be maintained and failure of the switching command shall only be indicated by alarm relays or LEDs. In this case the switching command remains active until receiving the corresponding breaker state feedback signal.

When the command running time is expired, the intermediate state monitor for the corresponding switching device is reactivated. If an intermediate state is detected, then the parameterized feedback time delay T−FB CB is disregarded.

4.14.3.2 Command extension time

In order to make sure that the breaker reaches its final position it is in some cases necessary to keep the command relay energized for a defined time after receiving the feedback signal. For this purpose a command extension time $T_{EXT\ CB}$ is provided.

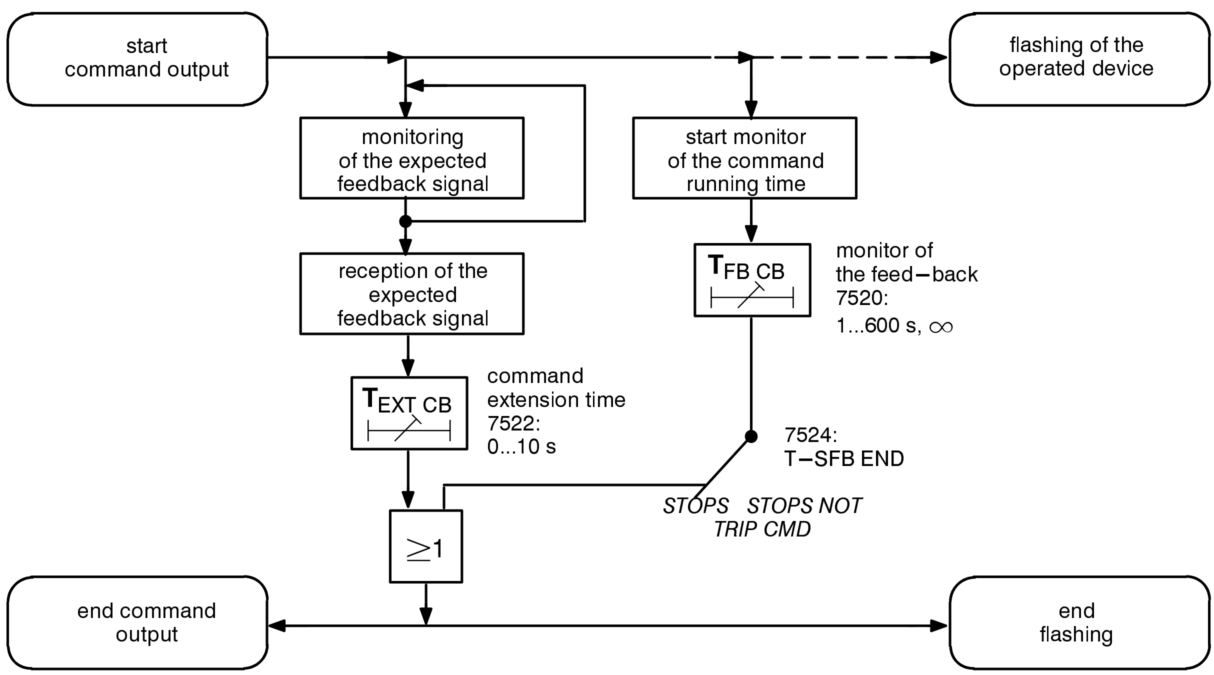


Figure 4.36 General command process

4.14.3.3 Closing of the circuit breaker

When the circuit breaker is closed onto a faulty line, undelayed tripping is normally required. For this purpose the "manual close" parameters are foreseen during CLOSE control for the reaction of the relay. It can be selected for the overcurrent time protection and for the directional overcurrent time protection, whether the I>> stages or the I>(definite time) or I_p (inverse time) stages shall operate in this case instantaneously or with the parameterized time delay.

If it is required that in parallel to the circuit breaker control by the relay 7SJ531, operation shall also be possible by means of a control–discrepancy switch, the latter has to be connected with the binary input for MANUAL–CLOSING together with the corresponding marshalling of the binary input. The integrated manual–close–logic in the 7SJ531 distinguishes for a closing command between an external control command, an internal control command and an automatic reclosing by the internal AR function.

The binary input MANUAL–CLOSING can thus be connected directly to the closing coil's control circuit. If, however, external closing commands are possible which shall not activate the manual–close function (e.g. an external AR relay), then the binary input MANUAL–CLOSING has to be energized by a separate auxiliary contact of the control–discrepancy switch.

4.14.3.4 Tripping of the circuit breaker

Tripping of the circuit breaker is always possible when the required switching authorization, eventually by codeword input, is given. The internal AR function is not activated. If there is an external AR relay, it would be started and would result in direct reclosing of the circuit breaker. In order to avoid this, any external auto–reclosing must be blocked via an input. For this purpose, this blocking input has to be connected with an accordingly parameterized alarm relay of the 7SJ531.

The following abbreviations are possible for the annunciation texts, e.g. "CB–Q0 RB OP–CLOSE":

Designation	Selection	Description
Type of switching element (part 1 process object)	CB DC	**c**ircuit **b**reaker **d**is**c**onnector
Designation of switching el. (part 2 process object)	–Q0 –Q1 to –Qnn	acc. DIN 40719 (refer also to Figure 4.33)
Switching source	LB LD LK RB RD RK	**l**ocal **b**inary input **l**ocal personal computer (via **D**IGSI®) **l**ocal integrated operation panel **r**emote **b**inary input **r**emote via **D**IGSI® **r**emote via LSA
Mode (part 1 cause)	OP FB	**op**eration (control) command state **f**eed**b**ack signal
Result (part 2 cause)	+ –	positive, expected negative, noht expected
Switching direction (value)	CLS TRP	switch on (**cl**o**s**e switching device) switch off (**trip** switching device)

Table 4.2 Annunciations during switching and their meaning

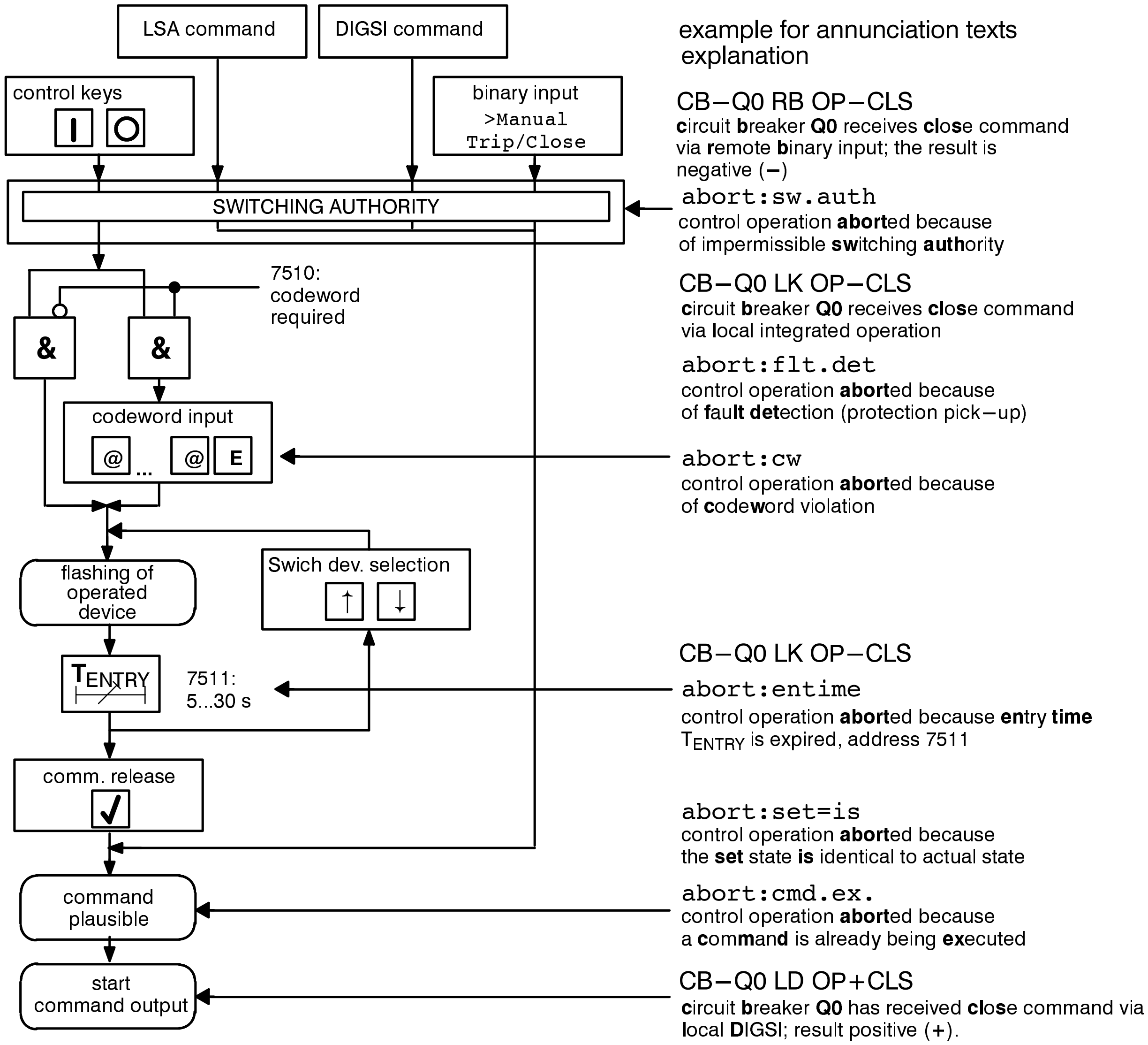


Figure 4.37 Overview generation of alarm with command input of the control (example)

FNr.	Meldungstext	Bedeutung der Abbruchmeldungen
4670	`abort:sw.auth`	Abortion of the control operation due to impermissible switching authority
4671	`abort:flt.det`	Abortion of the control operation due to protection pick−up
4672	`abort:cw`	Abortion of the control operation due to codeword violation
4673	`abort:entime`	Abortion of the control operation due to expired entry time
4674	`abort: set=is`	Abortion of the control operation due to set state already being equal to actual state
4675	`abort:cmd ex.`	Abortion of the control operation due to an already running command
4676	`abort:BI dbl`	Abortion of the control operation due to double selection of binary inputs
4677	`abort:test`	Abortion of the control operation due to running of a test sequence

Note: After an `abort` annunciation the relay cannot be operated before the alarm be acknowledged by pressing the key **E**

Table 4.3 Abort annunciations and their meaning

4.15 Switch−over of the phase rotation [1])

The relay provides the facility to change the phase rotation via energization of a binary input (`>negative seq,` FNo 5144). This allows to use all protection functions in case the phase rotation is counter−clockwise without interchanging of phases.

When the phase rotation is reversed the relay must be informed about this via the binary input. On energization of this input, the phase quantities of the phases L2 and L3 are swapped. But this is relevant only for the internal calculation of the symmetrical components; the phase dedicated annunciations, fault recordings, and measured values are not affected.

4.16 Processing of user defined annunciations

Four annunciations are available, which can be defined by the user himself. Signals and messages of other devices which have no interfaces (PC or LSA interface) can be included in the annunciation processing of the device. Like the internal annunciations, they can be 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 relays without serial interfaces.

4.17 Circuit breaker trip test

Numerical protection, control, and supervision device 7SJ531 allows checking of the tripping circuits and the circuit breaker by a simple method. By means of the incorporated auto−reclose feature, a TRIP−CLOSE test sequence is possible.

A precondition for any test sequence is that no protection function has picked up. If the circuit breaker auxiliary contacts advise the relay, through a binary input, of the circuit breaker position, the test cycle can only be started when the circuit breaker is closed.

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

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

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

The 7SJ531 also allows direct control of the circuit breaker by means of specific keys dedicated to the control. In correspondence to the blocking of the automatic reclosing for manual closing, there is also a blocking facility provided for a closing command carried out by the control, be it via parameter or via binary input. After an opening command by the control the internal automatic reclosing will not be started under any condition.

[1]) only for model 7SJ531★−★★★★**2**−★★★★

4.18 Ancillary functions

The ancillary functions of the numerical protection, control, and supervision device 7SJ531 include:

– Processing of annunciations,

– Storage of short circuit data for fault recording,

– Operational measurements and testing routines,

– Monitoring functions.

4.18.1 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.

4.18.1.1 Indicators and binary outputs (signal relays)

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

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

The memories of the LEDs can be safe against supply voltage failure. They can be reset:

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

– remotely by energization of the remote reset input,

– remotely via the serial interfaces,

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

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

A green LED indicates readiness for operation. This LED 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.

4.18.1.2 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 (feeder mimic diagram and an operational measured value). 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 4.18.1.1.

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

After a fault, for example, important information concerning its history, such as pick–up and tripping, can be called up on the display of the device. The fault inception is indicated with the absolute time of the operating system. The sequence of the events is tagged with the relative time referred to the moment at which the fault detector has picked up. Thus, the elapsed time until tripping is initiated and until the trip signal is reset can be read out. The resolution is 1 ms at 50 Hz.

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

The protection device stores the data of the last eight network faults; if a ninth fault occurs the oldest fault is overwritten in the fault memory.

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

4.18.1.3 Information to a central unit (optional)

In addition, all stored information can be transmitted via an optical fibre connector or the isolated second interface to a control centre, for example, the SIEMENS Localized Substation Automation System LSA 678. Transmission uses a standardized transmission protocol according to VDEW/ZVEI and IEC 870−5−103.

4.18.2 Data storage and transmission for fault recording

The instantaneous values of the measured values

i_{L1}, i_{L2}, i_{L3}, i_E, i_{EE}, u_{L1}, u_{L2}, u_{L3}, $3 \cdot u_0$

(voltages as connected) are sampled at 1.25 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. A fault record can also be initiated via a binary input or by operator request or via the serial interface.

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

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 and voltages are referred to their maximum values, normalized to their rated values and prepared for graphic visualization. In addition, signals can be marked as binary traces, e.g. ”Pick−up” and ”Trip”.

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

− the relay signals the availability of fault record data,

− the data are ready until the store is overwritten by newer data,

− a transmission in progress can be aborted by the central unit.

4.18.3 Operating measurements and conversion

For local recall or transmission of data, the true r.m.s. values of the currents and voltages as well as further data are always available.

The following is valid:

− I_{L1}, I_{L2}, I_{L3}, I_E	phase and earth currents in amps primary and in % of rated current,
− U_{L1-E}, U_{L2-E}, U_{L3-E}	voltages (phase−earth) in kilovolts primary provided the phase−earth voltages are connected,
− U_E	$(U_{L1-E}+U_{L2-E}+U_{L3-E})/\sqrt{3}$ = displacement voltage calculated from the phase−earth voltages provided these are connected, in kilovolts primary,

– U_{L1-L2}, U_{L2-L3}, U_{L3-L1}	voltages (phase–phase) in kilovolts primary,
– P, Q	active and reactive power in kW or MW or GW resp. in kVAR or MVAR or GVAR primary,
– cos φ	power factor,
– f	frequency in Hz,
– Wp , Wq	active and reactive energy in kWh or MWh or GWh resp. in kVARh or MVARh or GVARh primary, separate for each direction,
– Setting date	the date when the metering store have been set the last time,
– Θ/Θ_{tripL1}, Θ/Θ_{tripL2}, Θ/Θ_{tripL3} Θ/Θ_{trip} Θ_L/Θ_{Ltrip}	temperature rises calculated by the thermal overload protection and the restart lockout, referred to the trip temperature rise,
– I_{EEa}	active component of the earth fault current in A primary and mA secondary,
– I_{EEr}	reactive component of the earth fault current in A primary and mA secondary.

– Operation hour meter (operation statistics).

4.18.4 Monitoring functions

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

4.18.4.1 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 or five input converters (dependent on model); the digitized sum of the outputs of the four currents must always be zero. A fault in the current path is recognized when

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

and (model 7SJ531★–★★★★**2**)

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

An adjustable factor k_I (parameter Ie/Iph or Iee/Iph WD) can be set to correct the different ratios of phase and earth current transformers (e.g. summation transformer or window type current transformer). If the residual earth current is derived from the current transformer starpoint, $k_I = 1$. SUM.Ithres and SUM.Fact.I are setting parameters. The component SUM.Fact.I x I_{max} takes into account permissible current proportional transformation errors in the input converters which may particularly occur under conditions of high short circuit currents (Figure 4.38).

Note: Current sum monitoring can operate properly only when the residual current of the protected line is fed to the I_E and i_{EE} inputs of the relay.

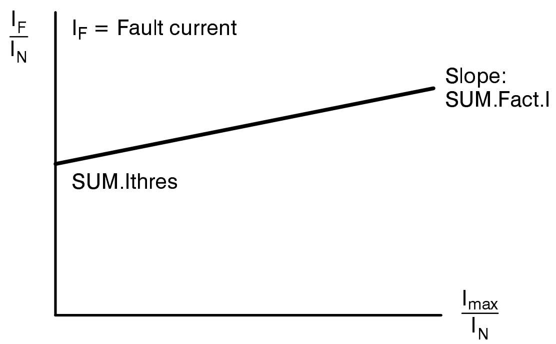


Figure 4.38 Current sum monitoring (current plausibility check)

In the **voltage path**, there are three input converters. The sum of the phase–to–phase voltages is always monitored since these are not affected by earth faults. If the phase–to–earth voltages are connected, the phase–to–phase voltages are calculated in the relay from those. A fault in the voltage circuits will be recognized when

$$|u_{L1-L2} + u_{L2-L3} + u_{L3-L1}| > 20 \text{ V.}$$

– Command output channels:

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

– Memory modules:

The memory modules are periodically checked for fault by:

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

4.18.4.2 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 system.

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.

4.18.4.3 Monitoring of external measuring transformer circuits

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

– Current symmetry

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

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

I_{max} is always the largest of the three phase currents and I_{min} always the smallest. The symmetry factor SYM.Fact.I represents the magnitude of asymmetry of the phase currents, and the threshold SYM.Ithres is the lower limit of the processing area of this monitoring function (see Figure 4.39). Both parameters can be set (see Section 6.3.14).

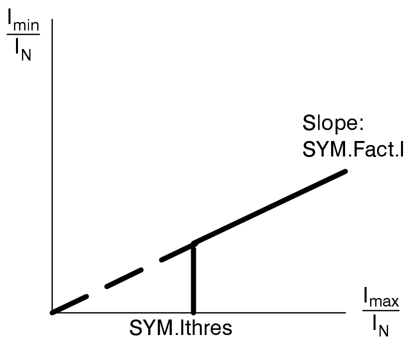


Figure 4.39 Current symmetry monitoring

– Voltage symmetry

In healthy operation it can be expected that the voltages will be approximately symmetrical. Therefore, the device checks the three phase–to–phase voltages for symmetry. Monitoring of the sum of the phase–to–phase voltages is not influenced by earth faults, which can be a lasting operating condition in non–earthed networks. If the phase–to–earth voltages are connected, the relay calculates the phase–to–phase voltages from these.

The following applies:

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

whereby U_{max} is the largest of the three voltages and U_{min} the smallest. The symmetry factor SYM.Fact.U represents the magnitude of the asymmetry of the voltages. The threshold SYM.Uthres is the lower limit of the processing area of this monitoring function (see Figure 4.40). Both parameters can be set (see Section 6.3.14).

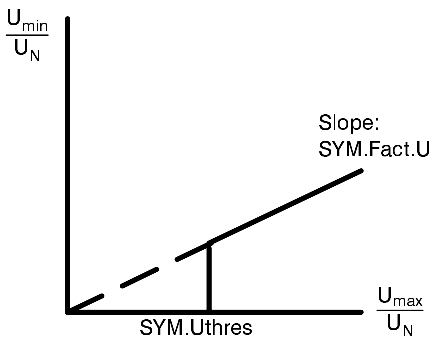


Figure 4.40 Voltage symmetry monitoring

– Phase rotation

The phase sequence is checked in cyclical time periods in order to detect wrong connections. The phase–to–phase voltages as well as the phase currents are used. If the phase–to–earth voltages are connected, the relay calculates the phase–to–phase voltages from these:

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

The voltage check is carried out as long as the measured voltages have a minimum value of

$|U_{L1}|, |U_{L2}|, |U_{L3}| > 40V$

The current check is carried out as long as the measured currents have a minimum value of

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

Counter–clockwise rotation will cause an alarm.

In those cases where counter–clockwise phase rotation can occur during operation, the relay must be informed about the reversal of the phase sequence via a appropriately assigned binary input. When this input is energized, the phases L2 and L3 are internally swapped in order to ensure correct symmetrical component calculation (see also Section 4.15). The phase dedicated annunciations, fault recordings, and measured values are not affected.

– Limit values

In order to detect extraordinary operating conditions on the protected feeder, limit stages can be set for the currents I_{L1}, I_{L2}, I_{L3}, and the residual current I_E, the power factor cos ϕ, the active and the reactive power. When the set limit stages are exceeded (the power factor fallen below), an annunciation is generated. This can be assigned to an output relay or LED. These stages are independent of the protection functions and operate in background with steady state measured values. They do, therefore, not operate as long as a network fault is detected. So they are not supplementary stages e.g. of overcurrent protection but pure operational monitoring functions.

Table 4.4 gives a survey of all the functions of the measured value monitoring system.

Monitoring	Failure covered, reaction
1. Plausibility check of currents $\lvert i_{L1} + i_{L2} + i_{L3} +$ **Ie(e)/Iph** $\times i_{E(E)} \rvert >$ **SUM.Ithres** $\times I_N +$ **SUM.Fact.I** $\times I_{max}$	Relay failures in the signal acquisition circuits i_{L1}, i_{L2}, i_{L3}, i_E, i_{EE} delayed alarm ”`Failure ΣI`”
2. Plausibility check of voltages phase−phase $\lvert u_{L1-L2} + u_{L2-L3} + u_{L3-L1} \rvert > 20$ V	Relay failures in the signal acquisition circuits u_{L1}, u_{L2}, u_{L3} delayed alarm ”`Failure ΣUp-p`”
3. Current unbalance $\frac{\lvert I_{min} \rvert}{\lvert I_{max} \rvert} <$ **SYM.Fact.I** and $\lvert I_{max} \rvert >$ **SYM.Ithres**	Single, or phase−to−phase short circuits or broken conductors in the c.t. circuits i_{L1}, i_{L2}, i_{L3} or Unbalanced load delayed alarm ”`Failure Isymm`”
4. Voltage unbalance (phase−phase) $\frac{\lvert U_{min} \rvert}{\lvert U_{max} \rvert} <$ **SYM.Fact.U** and $\lvert U_{max} \rvert >$ **SYM.Uthres**	Short−circuit or interruption (1−phase, 2−phase) in v.t. secondary circuits or unbalanced voltage on the system delayed alarm ”`Failure Usymm`”
5. Voltage phase sequence U_{L1-L2} before U_{L2-L3} before U_{L3-L1}, as long as $\lvert U_{L1-L2} \rvert, \lvert U_{L2-L3} \rvert, \lvert U_{L3-L1} \rvert > 40$ V	Swopped voltage connections or reverse rotation sequence delayed alarm ”`Fail.PhSeq U`”
6. Current phase sequence I_{L1} before I_{L2} before I_{L3}, as long as $\lvert I_{L1} \rvert, \lvert I_{L2} \rvert, \lvert I_{L3} \rvert > 0.5\, I_N$	Swopped voltage connections or reverse rotation sequence delayed alarm ”`Fail.PhSeq I`”
7. Current limit monitor $I_{L1} >$ **LIMIT IL1**	Operational current higher than expected delayed alarm ”`IL1 exceeded`”
8. Current limit monitor $I_{L2} >$ **LIMIT IL2**	Operational current higher than expected delayed alarm ”`IL2 exceeded`”
9. Current limit monitor $I_{L3} >$ **LIMIT IL3**	Operational current higher than expected delayed alarm ”`IL3 exceeded`”
10. Current limit monitor $I_E >$ **LIMIT IE**	Operational current higher than expected delayed alarm ”`IE exceeded`”
11. Current limit monitor $I_L <$ **LIMIT IL<**	Operational current lower than expected delayed alarm ”`IL< alarm`” (annunciation rests when current reverts to 0)
12. Power factor limit monitor $\cos \phi <$ **LIMIT cos φ<**	Operational power factor lower than expected delayed alarm ”`cosφ alarm`”
13. Active power limit monitor $P >$ **LIMIT P**	Operational active power higher than expected delayed alarm ”`P exceeded`”
14. Reactive power limit monitor $Q >$ **LIMIT Q**	Operational reactive power higher than expected delayed alarm ”`Q exceeded`”

Bolted figures are setting values.

Table 4.4 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 255−21, which specifies the impact resistance of packaging.

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

The transport packing can be re−used for further transport when applied in the same way. 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 255−21−1 class 2 and IEC 255−21−2 class 1.

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

5.2 Preparations

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

Caution!

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

In installed conditions, the modules are in no danger.

5.2.1 Mounting and connections

5.2.1.1 Model 7SJ531⋆−⋆B⋆⋆⋆ for panel surface mounting

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

– Connect earthing terminal (Terminal 16) of the unit to the protective earth of the panel.

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

– Make connections via screwed terminals.

5.2.1.2 Model 7SJ531⋆−⋆E⋆⋆⋆ for panel flush mounting or for cubicle installation

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

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

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

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

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

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

5.2.2 Checking the rated data and the modules

5.2.2.1 Rated data of the unit

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.

5.2.2.2 Allocation of the modules

A reduced and simplified front view of the device is shown in Figure 5.1 when the front door is opened. The modules are designated with numbers 1 to 3. These numbers are used for identification of the individual modules in the following sections.

5.2.2.3 Control d.c. voltage of binary inputs

When delivered from the factory, the binary inputs are designed to operate in the total control voltage range from 19 V to 288 V. If the rated control voltage for the binary inputs is 110 V or higher, it is advisable to fit a higher pick−up threshold to these inputs to increase stability against stray voltages in the d.c. circuits.

For rated control voltages of 110 Vdc or higher the pick−up threshold can be increased to approximately 80 V; for rated control voltages of 220 V or higher to approximately 160 V. In order to fit a higher pick−up threshold solder bridges must be removed. Figure 5.2 shows the location of these solder bridges and their assignment for the basic p.c.b. 3, Figure 5.3 for the additional p.c.b. 1.

– Open housing cover.

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.

– Loosen the captive screws of the housing and remove the front plate.

– Remove both multi–pin plugs that connect the graphic display and the membrane keyboard to the module 3.

– Carefully loosen the ribbon cables that link the modules with each other so that the desired module can be drawn out.

– Loosen the locking aids at the top and bottom of the modules 1 and 3, i.e. compress them in the direction of the impressed arrows and turn them out.

– Pull out the modules and place them on a surface which is suited to electrostatically endangered components (EEC).

– Check the plugs according to Figures 5.2 and 5.3.

The ribbon cables need not be re–connected now if the back–up battery is to be inserted (refer to Section 5.2.3) or if the interface to LSA shall be matched (refer to Section 5.2.4). Otherwise continue with the next steps:

– Re–insert the modules into the housing; ensure that the locking aids are turned out of the front.

– Compress the locking aids in the direction of the impressed arrows.

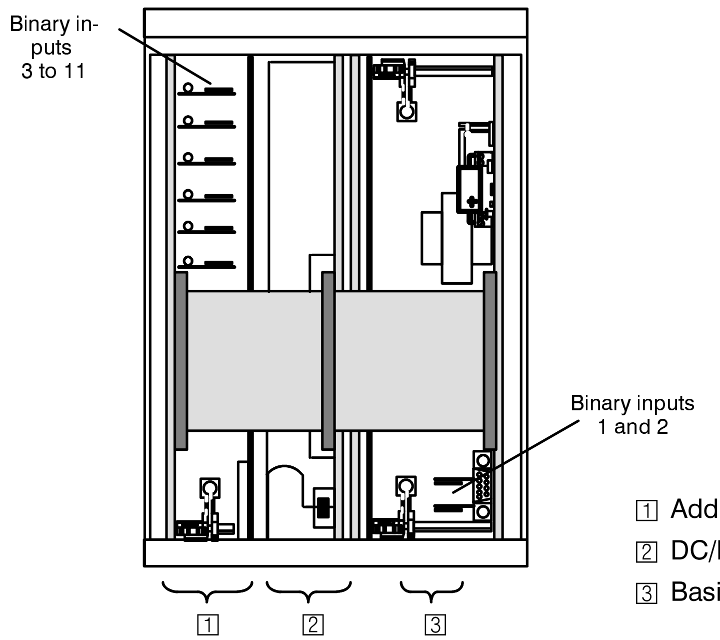
– Push the locking aid while the module is being inserted; press the module in until the locking aid clicks into place.

– Re–connect the multi–pin plugs that connect the graphic display and the membrane keyboard to the module 3.

– Re–connect the ribbon cables to all concerned modules; observe the mark (top!). Ensure that the connection pins do not bend! Do not use force!

– Fix the front plate with the four fixing screws.

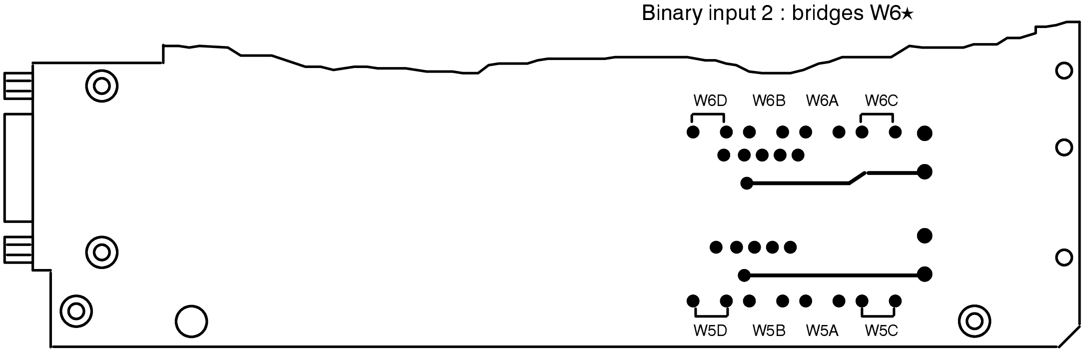
– Close housing cover.



1 Additional module EAZ3
2 DC/DC converter SV
3 Basic module EPS3

Figure 5.1 Front view 7SJ531 after removal of the front plate (reduced and simplified)

Binary input 2 : bridges W6★



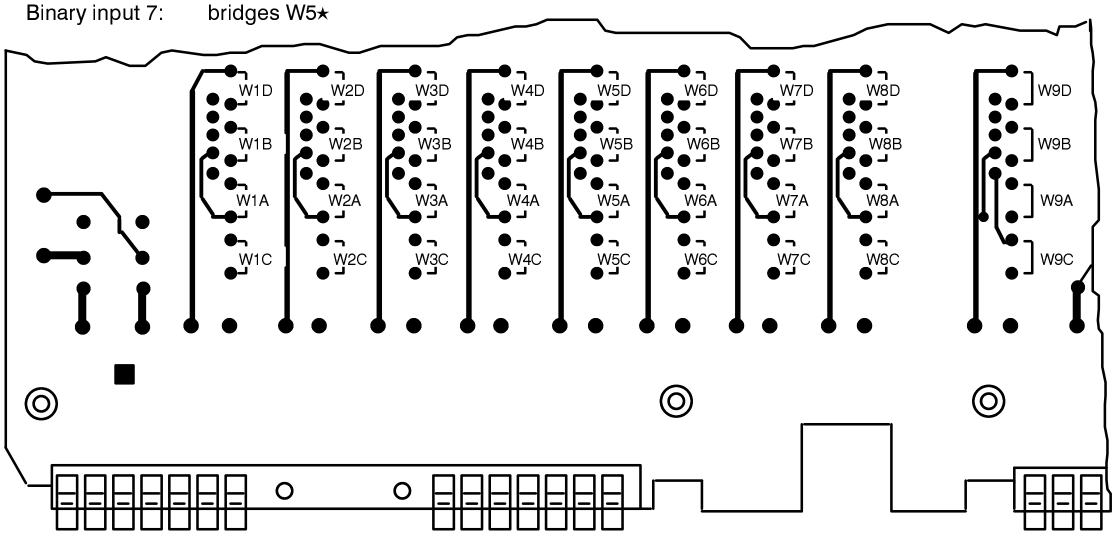
Binary input 1 : bridges W5★

for rated voltages <110 Vdc: Bridges W★C and W★D must be inserted! (as delivered)
for rated voltages ≥110 Vdc: Bridges W★C must be inserted. Bridges W★D may be removed
for rated voltages ≥220 Vdc: Bridges W★C and W★D may be removed

Bridges W★A and W★B cannot be used in the actual version; they are not fitted.

Figure 5.2 Checking for control voltages for binary inputs 1 and 2 on the p.c.b. 3 (refer to Figure 5.1)

Binary input 3:	bridges W1★
Binary input 4:	bridges W2★
Binary input 5:	bridges W3★
Binary input 6:	bridges W4★
Binary input 7:	bridges W5★
Binary input 8:	bridges W6★
Binary input 9:	bridges W7★
Binary input 10:	bridges W8★
Binary input 11:	bridges W9★



for rated voltages <110 Vdc: Bridges W★C and W★D must be inserted! (as delivered)
for rated voltages ≥110 Vdc: Bridges W★C must be inserted. Bridges W★D may be removed
for rated voltages ≥220 Vdc: Bridges W★C and W★D may be removed

Bridges W★A and W★B cannot be used in the actual version; they are not fitted.

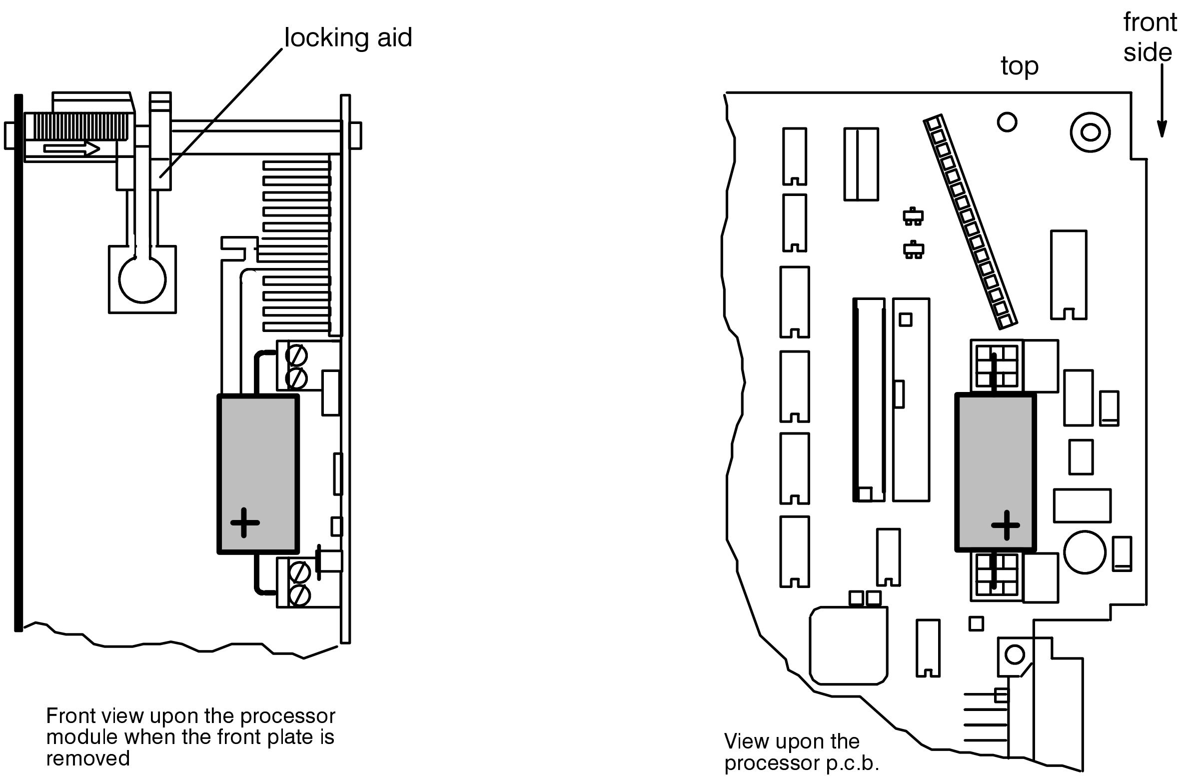
Figure 5.3 Checking for control voltages for binary inputs 3 to 11 on the p.c.b. 1 (refer to Figure 5.1)

5.2.3 Inserting the back−up battery

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

The battery is supplied separately with the device. This prevents it from discharging before the unit is used.

The battery is located at the front edge of the processor board of the basic p.c.b. ($\boxed{3}$ in Figure 5.1), refer to Figure 5.4. The front plate must be removed when the battery is to be inserted.



Front view upon the processor module when the front plate is removed

View upon the processor p.c.b.

Figure 5.4 Position of the back−up battery on the processor p.c.b. $\boxed{3}$

The procedure for inserting the battery into a new unit is described below. **Proceed according to Section 7.2 when replacing an existing battery or when inserting the battery into a unit which has already been connected to the power supply.**

− Prepare area of work: provide a surface that is suited for electrically endangered components (EEC).

− Open housing cover.

− Loosen the captive screws of the housing and remove the front plate.

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.

− Carefully loosen the ribbon cables that link the modules with each other so that the p.c.b. at the right side ($\boxed{3}$ in Figure 5.1) can be drawn out. If necessary, loosen the cable from the adjacent modules, too.

– Loosen the locking aids at the top and bottom of the processor p.c.b. 3, i.e. compress them in the direction of the impressed arrows and turn them out.

– Remove processor p.c.b. and place it on the EEC surface.

– Prepare the battery as in Figure 5.5:

Caution!

Do not short–circuit the battery poles! Do not place the battery on the conductive surface!

– Shorten the legs to 15 mm (6/10 inch) each and bend over at a length of 40 mm (16/10 inch); ensure that the polarity signs are visible.

– Insert the prepared battery into the terminals as in Figure 5.5 and tighten the screws; the location of the battery is illustrated in Figure 5.4.

The following steps are necessary only in case that the normal signal position for the LSA interface need not be altered (refer to Section 5.2.4):

– Re–insert the processor p.c.b. into the housing; ensure that the locking aids are turned out of the front.

– Compress the locking aids in the direction of the impressed arrows.

– Push the locking aid while the module is being inserted; press the module in until the locking aid clicks into place.

– Re–connect the multi–pin plugs that connect the graphic display and the membrane keyboard to the module 3.

– Re–connect the ribbon cables to all concerned modules; observe the mark (top!). Ensure that the connection pins do not bend! Do not use force!

– Fix the front plate with the four fixing screws.

– Close housing cover.

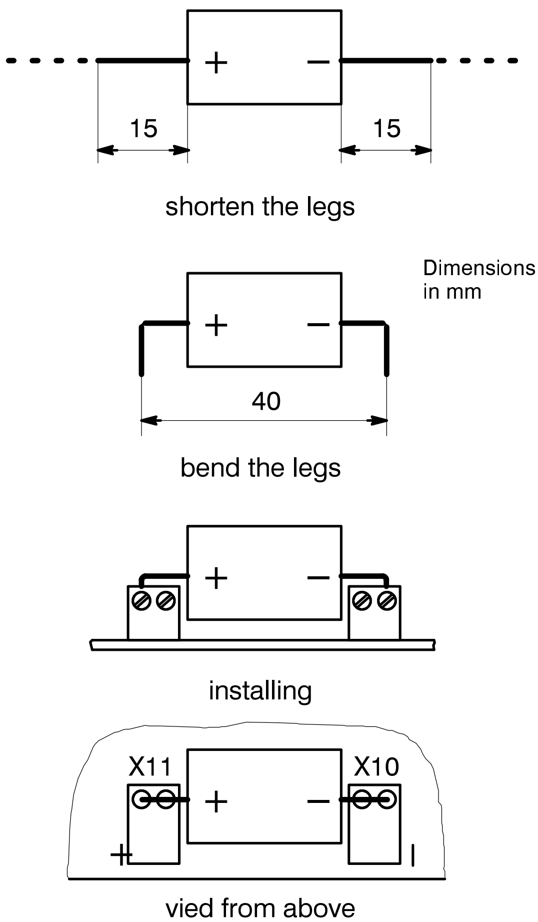


Figure 5.5 Inserting the back–up battery

5.2.4 Checking 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.

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

The normal signal position for the data transmission is factory preset as ”light off”. This can be changed by means of a plug jumper X91 which is accessible when the processor p.c.b. $\boxed{3}$ is removed from the case. The jumper is situated in the rear area of the processor module (Figure 5.6).

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

– Open housing cover.

– Loosen the captive screws of the housing and remove the front plate.

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.

– Remove both multi–pin plugs that connect the graphic display and the membrane keyboard to the module $\boxed{3}$.

– Carefully loosen the ribbon cables that link the modules with each other so that the processor p.c.b. can be drawn out. If necessary, loosen the cable from the adjacent modules, too.

– Loosen the locking aids at the top and bottom of the processor p.c.b. $\boxed{3}$, i.e. compress them in the direction of the impressed arrows and turn them out.

– Remove processor p.c.b. and place it on the EEC surface.

– Check the plug according to Figure 5.6 and change when necessary.

– Re–insert the processor p.c.b. into the housing; ensure that the locking aids are turned out of the front.

– Compress the locking aids in the direction of the impressed arrows.

– Push the locking aid while the module is being inserted; press the module in until the locking aid clicks into place.

– Re–connect the multi–pin plugs that connect the graphic display and the membrane keyboard to the module $\boxed{3}$.

– Re–connect the ribbon cables to all concerned modules; observe the mark (top!). Ensure that the connection pins do not bend! Do not use force!

– Fix the front plate with the four fixing screws.

– Close housing cover.

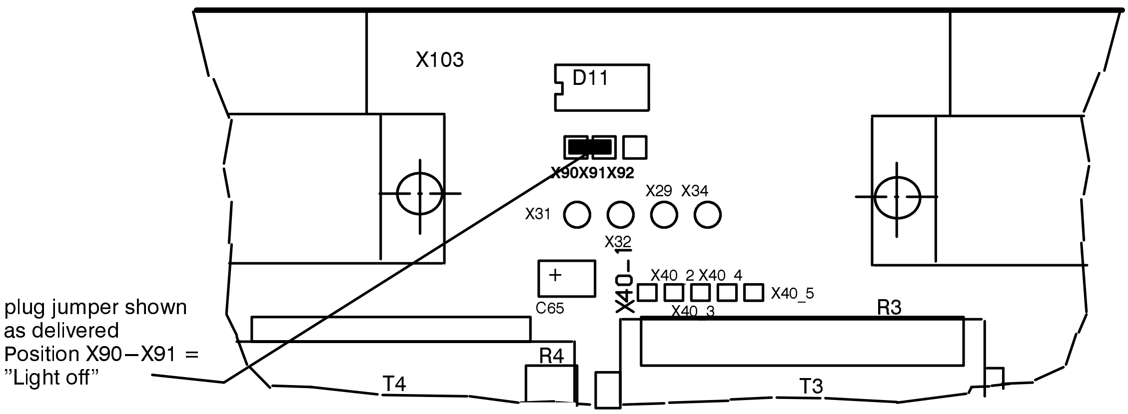


Figure 5.6 Position of the jumper X91, on processor p.c.b. EPS3 ($\boxed{3}$ in Figure 5.1)

5.2.5 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.

5.2.5.1 Connections for circuit breaker auxiliary contacts

The integrated switching device control processes the state of the switching devices in the switchgear. Furthermore the circuit breaker check feature can monitor the circuit breaker's movement during the operation.

Various binary inputs are provided for the position indication of the switches to the display in the feeder mimic diagram. They can be connected with auxiliary contacts of the switching devices. The assignment (see Appendix E) is fixed by the selected feeder mimic diagram, marshalling of these binary inputs is neither necessary nor possible.

5.2.5.2 Connections for switch−over of parameter sets

Switch−over of different parameter can be performed via one binary input. Using normally open control mode, parameter set A is effective as long as the assigned binary input is not energized, otherwise parameter set B. Further information on selectable parameter sets is given in the Sections 6.3.1.2 and 6.5.5.3.

5.2.5.3 Connections for trip circuit supervision

If the trip circuit supervision is used, decision must be made whether two binary inputs or only one is available for this purpose. The function is explained in detail in Section 4.11, where also the principle connections are illustrated.

Note: It must be considered that two binary inputs (or one input and a replacement resistor) are connected in series. Therefore, the pick−up threshold of the binary input(s) (Section 5.2.2.3) must be clearly smaller than half the control voltage. This supervision is, therefore, not suitable for a rated d.c. voltage of 24 V.

If one single binary input is available (Figure 5.7), an external resistor R must be connected in the circuit of the breaker auxiliary contact (Aux2), which replaces the missing second binary input (refer also to Section 4.11.2). It may be possible in this case that a smaller control voltage is sufficient than twice the minimum voltage of the binary input. A fault is also detected when the NO auxiliary contact is open and the trip relay contact has reset. This resistor must be dimensioned such that the trip coil (TC) of the breaker cannot operate when the breaker is open (Aux1 open and Aux2 closed), but that the binary input (BI1) can operate when the trip contact of the device has opened, at the same time (Figure 5.7).

This results in an upper limit R_{max} and a lower limit R_{min} of the resistance, from which the arithmetical mean value is taken:

$$R = \frac{R_{max} + R_{min}}{2}$$

The maximum resistance R_{max} is derived from the minimum control voltage of the binary input:

$$R_{max} = \left(\frac{U_{CV} - U_{BI\ min}}{I_{BI\ (High)}} \right) - R_{TC}$$

The minimum resistance R_{min} is derived from the maximum control voltage which does not operate the circuit breaker trip coil:

$$R_{min} = R_{TC} \cdot \left(\frac{U_{CV} - U_{TC\ (LOW)}}{U_{TC\ (LOW)}} \right)$$

$I_{BI\ (High)}$	constant current which operates the binary input (1.7 mA)
$U_{BI\ min}$	minimum control voltage for the binary input (16 V at delivery, 80 V with increased pick−up)
U_{CV}	Control voltage of the trip circuit
R_{TC}	ohmic resistance of the trip coil
$U_{TC(LOW)}$	maximum voltage which does not operate the trip coil

If the result of the calculation shows that $R_{max} < R_{min}$, the calculation must be repeated with the next lower input voltage of the binary input. Refer to Section 5.2.2.3 for realization of the control voltages of binary inputs.

The power capability of the resistor is as follows:

$$P_R = I^2 \cdot R = \left(\frac{U_{St}}{R + R_{LSS}}\right)^2 \cdot R$$

<u>Example:</u>

$I_{BI\ (High)}$	1.7 mA (protection relay data)
$U_{BI\ min}$	16 V (protection relay data)
U_{CV}	110 V (switchgear control voltage)
R_{TC}	500 Ω (circuit breaker data)
$U_{TC\ (LOW)}$	2 V (circuit breaker data)

$$R_{max} = \left(\frac{110\,V - 16\,V}{1.7\,mA}\right) - 500\,\Omega$$

$$R_{max} = 54.8\,k\Omega$$

$$R_{min} = 500\,\Omega \cdot \left(\frac{110\,V - 2\,V}{2\,V}\right)$$

$$R_{min} = 27\,k\Omega$$

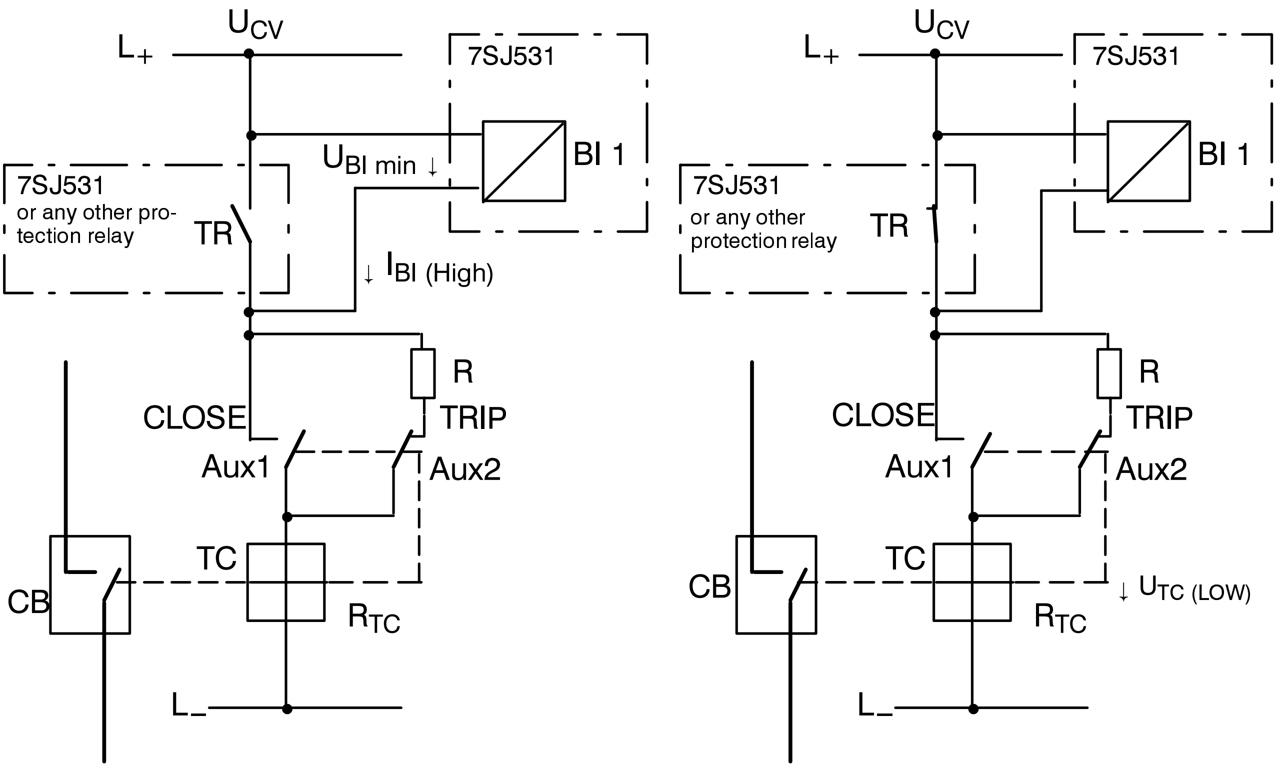
$$R = \frac{R_{max} + R_{min}}{2} = 40.9\,k\Omega$$

The nearest standard value is selected: 39 kΩ

The minimum power capability is:

$$P_R = \left(\frac{110\,V}{(39 + 0,5)\,k\Omega}\right)^2$$

$$P_R \geqq 0,3\,W$$



trip contact open

trip contact closed

Figure 5.7 Dimensioning the external resistor R when one single binary input is used

5.2.6 Checking the connections

Warning

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

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

– Switch off the circuit breakers for the dc supply and the voltage transformer circuits!

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

- Are the current transformers correctly earthed?
- Are the polarities of the current transformer connections consistent?
- Is the phase relationship of the current transformers correct?
- Are the voltage transformers correctly earthed?
- Are the polarities of the voltage transformer circuits correct?
- Is the phase relationship of the voltage transformers correct?
- Is the polarity of the earth current transformer(s) 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.

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

– Fit a d.c. ammeter in the auxiliary power circuit; range approx. 1.5 A to 3 A.

– Close the battery supply circuit breaker; check polarity and magnitude of voltage at the terminals of the unit or at the connector module.

– The measured current consumption should correspond to approximately 6 W. Transient movement of the ammeter pointer only indicates the charging current of the storage capacitors.

– Put the miniature slide switch of the front plate in the ”ON” position ⊙ . The unit starts up and, on completion of the run−up period, the green LED on the front comes on, the red LED gets off after at most 5 sec.

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

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

– Close the voltage transformer m.c.b. (secondary circuit).

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

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

– Check through the tripping circuits to the circuit breaker.

– Check through the control wiring to and from other devices and to the switching devices of the switchgear.

– Check the signal circuits.

– Reclose the protective m.c.b.s.

5.3 Configuration of operation and memory functions

5.3.1 Operational preconditions and general

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

– configuration parameters for configuration of the operation language, the interfaces and the device functions,

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

– setting of functional parameters (thresholds, functions),

– initiation of test procedures,

– initiation of control operations.

Code words are not required for the read–out of annunciations, operating data or fault data, or for the read–out of setting parameters.

The 7SJ531 disposes of four different code levels, i.e. different authorization levels. **Code level 1** releases the functions control/switching, setting of the clock, creating of a measuring record and switch–over of the active parameter set. That means with a code word the operator can carry out specific settings, which are typical for normal operation conditions.

For operations of special importance, like the parameterization of functions and pick–up values, the start of test routines, the setting of files etc. **code level 2** is required. The code word for this level comprises the menu items from code level 1, too.

For the configuration, i.e. the marshalling and configuration of the relay, **code level 3** is applicable.

The code words pre–set upon delivery of the relay can be substituted by self–selected code words. Changing of the code words is done under addresses 7151 to 7154. These addresses are visible only when **code level 4** is fulfilled. The procedure is described in Section 5.3.3.

That means the code word has to be entered as a proof for the operation authorization. When the key CW is operated in menu levels which require a code word, the last three lines on the bottom of the display are extinguished and the text ”ENTER CODEWORD:” is shown. The code word can now be entered (see Figure 5.8).

```
8200
     RESET
8201■RESET
     LED ?
8202 RESET
     OPERAT.ANNUNC. ?
8203 RESET
     FAULT ANNUNC. ?
8204 Trip No =

8206 RESET

ENTER CODEWORD:

@@@@@@

CW ACCEPTED

CODEWORD WRONG
```

Figure 5.8 Example of code word entry

The code ”word” is a number of up to 6 digits. All numerical keys plus the enter–key E for terminating the entry are released for the entry. Upon delivery of the relay the number ”0” is pre–set for all code levels.

The entered numbers do not appear in the display. Instead only @ is shown. After confirming the entry with **E**, CW ACCEPTED is shown in the display, if the code word is correct. Continue with **E**. The original information of the three extinguished lines is reestablished and the cursor starts flashing. Now the required operations can be carried out.

If the code is not correct, CODEWORD WRONG is displayed. After operating the key **CW** a new code word entry may be performed or by operating the key **E** the code word entry may be interrupted. In the latter case the original content of the three extinguished lines is reestablished, too.

The operating interface is built up by a hierarchically structured menu tree. A complete overview can be found in Appendix D. Figure 5.9 shows which steps are necessary for the execution of configuration.

When the relay is ready for operation, first the key **MENU** is pushed: the first page of the OPERATION−MENU is shown. As the whole number of menu options can not be shown on one page, the double arrow key ⩔ leads to the second page of the OPERATION−MENU, back again with key ⩓. The display shows the paging possibilities by the double arrows at the left top and/or bottom edge. Within one page, the required menu option can directly be selected by entry of the corresponding number, what opens the sub−menu (Figure 5.9 below). In the end a series of operating addresses is shown, marked by the four−digit address number (e.g. 7100) and the head line of the operating block (e.g. INTEGRATED OPERATION).

Returning to the previous menu level is achieved by operating the return key R. When operating the return key in the highest menu level, the basic diagram returns to the display.

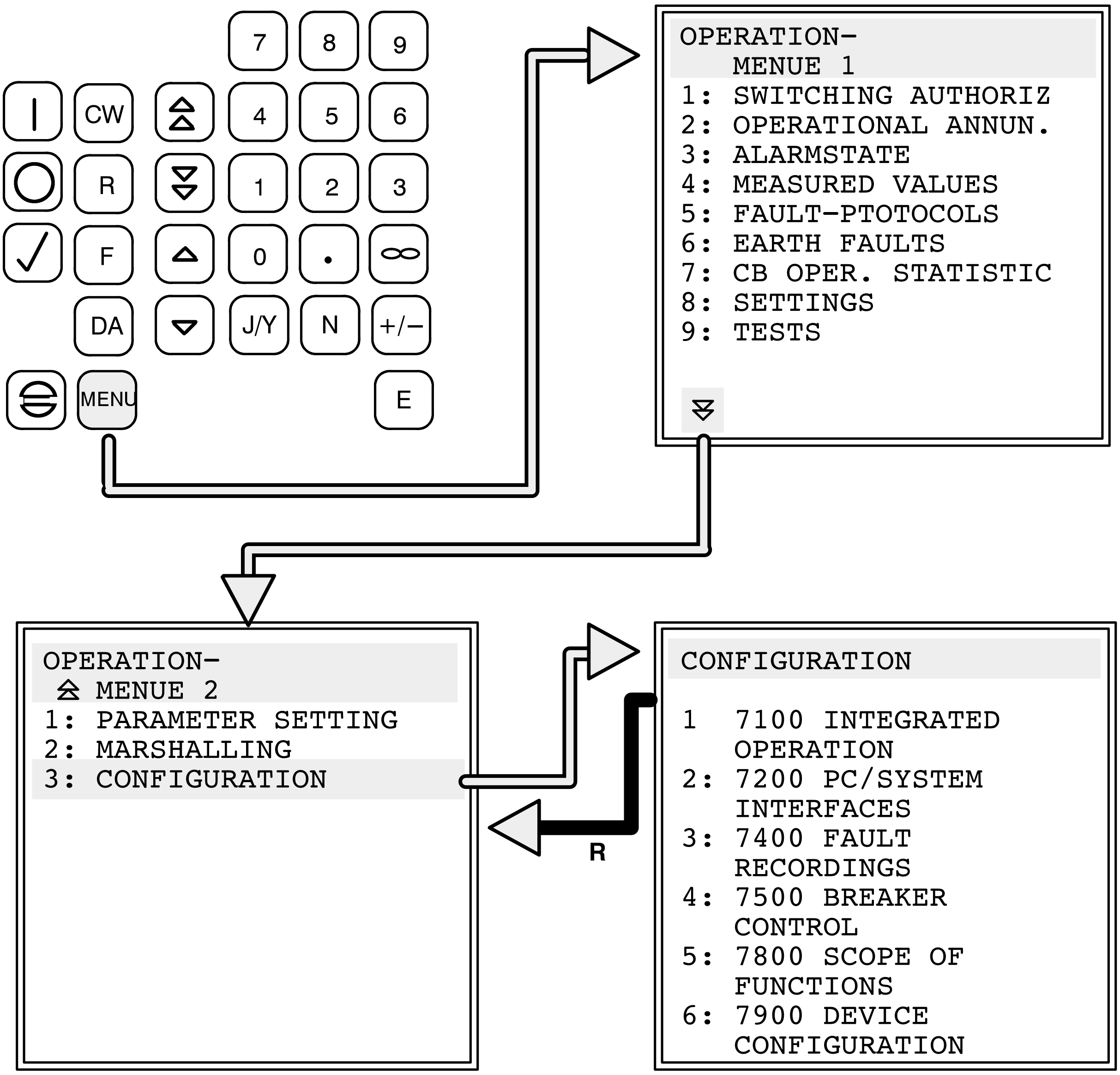


Figure 5.9 Menu selection for configuration

Through the required menu number (e.g. **1**) the individual addresses associated with this operation block are accessible. The display shows the four−digit address numbers, i.e. address block and sequence number. Then follows the meaning of the shown parameters (see Figure 5.10). In the directly following display line, the text for the parameter is written. The cursor can be moved to the required address by means of the keys △ and ▽. When the total number of all addresses of one operation block cannot be shown on one page, the next page can be displayed again with the key ▽▽.

After entering the code word, the possible alternatives can be scrolled through the display by means of the "No"−key **N**. The alternative which shall be selected, **is confirmed with the enter key E**. If in addresses which require numerical entry the value is to be changed, this is done by the numerical keys. **Finally the entry has to be confirmed with the entry key E!** The relay displays the adopted value.

The setting procedure can be ended at any time by the key combination **F E**, i.e. depressing the function key **F** followed by the entry key **E**. The display shows the question "SAVE NEW SETTINGS ?". Confirm with the "Yes"−key **J/Y** that the new settings shall become valid now. If you press the "No"−key **N** instead, code word operation will be aborted, i.e. all alterations which have been changed since the last code word 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), e.g. by trying to select a different menu, 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 EE−PROMs 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.

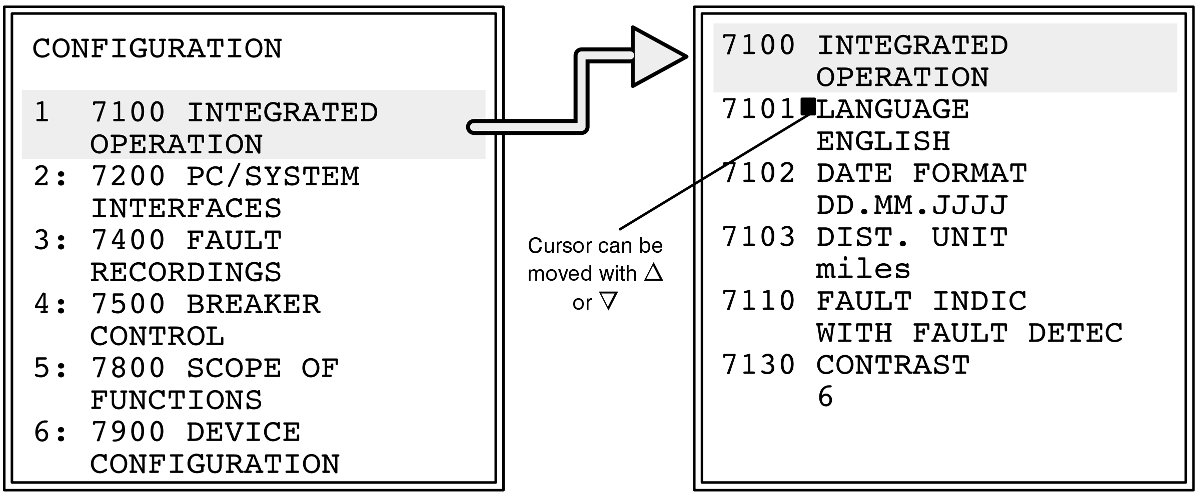


Figure 5.10 Addresses of an address block

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 the code words to be changed and the date format to be selected. Messages on the front display can be selected here for the quiescent state of the unit or after a fault event. To change any of these parameters, code word entry of code level 3 is necessary.

The address block is reached by pressing the **MENU**–key → double arrow key ⩔ → option 1: 7100 INTEGRATED OPERATION, as described in Section 5.3.1.

When delivered from factory, the device is programmed to give function names and outputs in the German language, the date is shown in the European format. This can be changed under addresses 7101 and 7102. The operator languages available at present are shown below.

```
R  7100 INTEGRATED
        OPERATION
```

Beginning of the block ”Integrated operation”

```
▽  7101 ■LANGUAGE
        DEUTSCH

N       ENGLISH
```

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

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

```
△  7102 ■DATE FORMAT
▽       DD.MM.YYYY

N       MM/DD/YYYY
```

When delivered from factory, the date is shown in 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).

```
△  7103 ■DIST. UNIT
▽       km

N       miles
```

Unity for display of the distance to fault; may be

kilometers: the per unit reactance of the line must then be entered in Ω/km (address 1123), the distance is displayed in km

miles: the per unit reactance of the line must then be entered in Ω/mile (address 1122), the distance is displayed in miles

```
△  7110 ■FAULT INDIC
▽       WITH FAULT DETEC

N       WITH TRIP COMM.
```

Stored LED indications and the fault event messages in the display can be displayed either with each fault detection or only after trip command is given. This mode can be changed by depressing the ”No”–key **N** and confirmed with the enter–key **E**.

```
↑↓ || 7130 CONTRAST       ||
   ||      6              ||
```

Setting of the LC–display contrast. Higher value means more contrast to ease read–out
Smallest setting value: **3**
Largest setting value: **9**

Note: When the contrast is to low, there is a risk that the display cannot be read any more, **so that operation becomes impossible**. Therefore the pre–set value **should be kept or changed by one step only**.

5.3.3 Changing the code words – address block 71

The code words can be changed in addresses 7151 to 7154 for all four available code levels. This allows a downgrading of the operating authorization.

These four addresses are visible and changeable only when code word level 4 (highest authorization stage) is fulfilled. This requires entry of the level 4 code word.

It applies for all code levels that the higher level always includes the operation facilities of the lower code levels.

Code words can be abbreviated to less than six digits. Then they have to be entered with exactly the same number of digits for each code word entry.

If the user does not change the code words, then the pre–set code words remain valid. They are ”0” for all four code levels. Entry of the previously used pre–set code word ”000000” is accepted, too.

```
△  || 7151 CW-LEVEL 1     ||
⇊  ||      0              ||
```

Code level 1: this authorization level allows operations for the normal operating procedures control/switch, start fault recording, set the clock, select the active parameter set.

Smallest setting value: **0**
Largest setting value: **999999**

Addresses 7152 to 7154 are on page 2 of the level INTEGRATED OPERATION. They can be reached by operation of the key ⇊. Switching between the two pages with ⇊ resp. ⇈.

```
⇈  || 7152 CW-LEVEL 2     ||
▽  ||      0              ||
```

Code level 2: this authorization level allows operations of specific importance: functional parameters (address blocks 11 to 39), test routines (address blocks 41 to 49), setting and resetting of buffers and counters (address block 82) and process parameter sets (address block 85).

Smallest setting value: **0**
Largest setting value: **999999**

△ ▽ 7153 CW−LEVEL 3
0

Code level 3: this authorization level allows the configuration: marshalling (address blocks 61 to 64), interfaces (address blocks 71 to 72), fault recording (address block 74), scope of functions (address block 78), configuration of the relay (address block 79)

Smallest setting value: **0**
Largest setting value: **999999**

△ 7154 CW−LEVEL 4
0

Code level 4: this is the highest authorization level for the user and allows alteration of the code words (addresses 7151 to 7154)

Smallest setting value: **0**
Largest setting value: **999999**

5.3.4 Configuration of the serial interfaces − address block 72

The device provides one or two serial interfaces: one operation 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. Code word input of code level 3 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 F.

R 7200 PC/SYSTEM
INTERFACES

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

▽ 7201■DEVICE ADD.
1

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

△ ▽ 7202■FEEDER ADD.
1

Number of the feeder within the substation; valid for both the interfaces (operating and system interface)
Smallest permissible number: **1**
Largest permissible number: **254**

```
△ ║7203■SUBST. ADD.  ║
▽ ║     1            ║
```

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

```
△ ║7208■FUNCT. TYPE ║
▽ ║     160          ║
```

Function type in accordance with VDEW/ZVEI and IEC 870−5−103; for overcurrent protection no. 160.
This address is mainly for information, it should not be changed.

```
△ ║7209■DEVICE TYPE ║
▽ ║     23           ║
```

Device type for identification of the device in Siemens LSA 678 and program *DIGSI*®. For 7SJ531 V3 no. 23
This address is only for information, it cannot be changed.

Addresses 7214 to 7216 are valid for the operating (PC) interface on the front of the relay.

The setting of the PC GAPS (address 7214 for the operating interface) or the SYS GAPS (address 7224 for the system interface) is relevant only when the relay is intended to communicate via a modem. The settings are the maximum time period which is tolerated by the relay when gaps occur during transmission of a telegram. Gaps may occur, when modems are used, by compression of data, error correction, and differences of the Baud−rate. With good transmission quality, 1.0 s is adequate. The value should be increased when transmission quality is not so good. It must be noted that GAPS must be smaller than the setting of "reaction time protection relay" in the protection software DIGSI® V3. Recommended value:

$$\text{GAPS} \approx \frac{\text{''reaction time protection relay''}}{2}$$

Higher values for "reaction time protection relay" reduce the transmission speed in case of transmission errors. If the relay interface is connected directly to a personal computer, then GAPS may be set to 0.0 s.

```
△ ║7214■PC GAPS ║
⩡ ║     0.0 s   ║
```

Maximum time period of data gaps within telegrams which may occur during data transmission via modem on the operating (PC) interface
Smallest setting value: **0.0** s
Largest setting value: **5.0** s

Addresses 7215 to 7225 are on page 2 of the level PC/SYSTEM INTERFACES. Scrolling between the two pages with ⩡ resp. ⩠.

```
⩠ ║7215■PC-BAUDRATE ║
▽ ║     9600 BAUD   ║

N │    19200 BAUD   │

  │     1200 BAUD   │

  │     2400 BAUD   │

  │     4800 BAUD   │
```

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**.

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

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

△ ▽	7221 ■SYS INTERF. VDEW COMPATIBLE	Format of annunciations and fault records for the system (LSA) interface: only data in accordance with *VDEW*/ZVEI and IEC 870−5−103
N	VDEW EXTENDED	data in accordance with *VDEW*/ZVEI and IEC 870−5−103, extended by Siemens specified data
	DIGSI V3	format for Siemens protection data processing program *DIGSI*® Version *V3*

△ ▽	7222 ■SYS MEASUR. VDEW COMPATIBLE	Format of measured values for the system (LSA) interface: only data in accordance with *VDEW*/ZVEI and IEC 870−5−103
N	VDEW EXTENDED	data in accordance with *VDEW*/ZVEI and IEC 870−5−103, extended by Siemens specified data

△ ▽	7224 ■SYS GAPS 0.0 s	Maximum time period of data gaps within telegrams which may occur during data transmission via modem on the system (LSA) interface Smallest setting value: **0.0** s Largest setting value: **5.0** s

△ ▽	7225 ■SYS BAUDR. 9600 BAUD	The transmission Baud−rate for communication via the system interface can be adapted to the system interface, e.g. LSA, if necessary. The available possibilities can be displayed by repeatedly depression of the ”No”−key **N**. Confirm the desired Baud−rate with the entry key **E**.
N	19200 BAUD	
	1200 BAUD	
	2400 BAUD	
	4800 BAUD	

Addresses 7226 to 7235 are on page 3 of the level PC/SYSTEM INTERFACES. Scrolling between the two pages with ⩔ resp. ⩓.

△ ▽	7226 ■SYS PARITY VDEW/DIGSIV3/LSA	Parity and stop−bits for the system (LSA) interface: format for *VDEW*−protocol (IEC 870−5−103) or Siemens protection data processing program *DIGSI*® *V*ersion *3* and former *LSA*
N	NO 2 STOP	transmission with *NO* parity and *2 STOP*−bits
	NO 1 STOP	transmission with *NO* parity and *1 STOP*−bit, e.g. modem

It is possible to switch the VDEW−protocol (acc. IEC 870−5−103) over to the transmission protocol according to the operation software DIGSI® during operation. A precondition is that a transmission format is selected for the system interface which is compatible to the VDEW−protocol (acc. IEC 870−5−103), i.e. address 7221 SYS INTERF is switched to *VDEW COMPATIBLE* or *VDEW EXTENDED*. If this facility is to be used, address 7227 SYS SWITCH must be set to *YES*. This configuration address does only permit to switch over from VDEW−protocol (acc. IEC 870−5−103) to DIGSI®−protocol and vice versa at the system interface. The actual switch−over is arranged by a special telegram which is sent by DIGSI® to the system interface when to PC−operator initiates the corresponding command. When address 7235 (see below) is equally set to *YES*, then remote parameterizing is possible via the system interface by means of DIGSI®−procedures.

	7227 ■SYS SWITCH NO	Switch−over between VDEW transmission protocol (acc. IEC 870−5−103) and DIGSI®−protocol via the system interface *NO* – is not permitted
N	YES	*YES* – is permitted

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

△	7235 ■SYS PARAMET NO	**Only in case the interface is connected with a hardware that operates with protection data processing program DIGSI® V3:** Remote parameterizing via the system interface *NO* – is not permitted
N	YES	*YES* – is permitted

5.3.5 Settings for fault recording − address block 74

The device 7SJ531 is equipped with a fault data store (see Section 4.16.2). Distinction must be made between the reference instant and the storage criterion (address 7402). Normally, the general fault detection signal of the protection is the reference instant. The storage criterion can be the general fault detection, too (*STORAGE BY FD*), or the trip command (*STORAGE BY TRIP*). Alternatively, the trip command can be selected as reference instant (*START WITH TRIP*), in this case, the trip command is the storage criterion, too.

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

The actual recording time starts with the pre−trigger time T−PRE (address 7411) before the reference instant and ends with the post−fault time T−POST (address 7412) after the recording criterion has disappeared. The permissible recording time for each record is set under address 7410. Altogether 5 s are available for fault recording. In this time range up to 7 fault records can be stored. When the back−up battery is installed, the fault records are saved against supply outage.

Note: The set times are referred to 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 or system interface. The storage is triggered dynamically, in these cases. The length of a record is determined by the settings in addresses 7431 and 7432. Pre−trigger time and post−fault time are additive to the set values. If the storage time for start via binary input is set to ∞, then the storage goes on as long as the binary input is activated (statically), but not longer than T−MAX (address 7410).

```
R   7400 FAULT
         RECORDINGS
```

Beginning of block ”Fault recordings”

```
▽   7402■INITIATION
         STORAGE BY FD.

N        STORAGE BY TRIP

N        START WITH TRIP
```

Data storage is initiated:

− fault detection is reference instant
  fault detection is storage criterion

− fault detection is reference instant
  trip command is storage criterion

− trip command is reference instant
  trip command is storage criterion

```
△   7403■SCOPE
▽        FAULT EVENT

N        FAULT IN POW.SYS
```

Scope of a fault record:

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

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

```
△   7410■T-MAX
▽        1.00 s
```

Maximum time period of a fault record

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

```
△ ║ 7411■T-PRE
▽ ║       0.10 s
```

Pre−trigger time before the reference instant
Smallest setting value: **0.05** s
Largest setting value: **0.40** s

```
△ ║ 7412■T-POST
▽ ║       0.10 s
```

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

```
△ ║ 7431■T-BINARY IN
⩔ ║       0.50 s
```

Storage time when fault recording is initiated via a binary input, 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)

The address 7432 is on page 2 of the level FAULT RECORDING. Scrolling between the two pages with ⩔ resp. ⩓.

```
⩓ ║ 7432■T-KEYBOARD
  ║       0.50 s
```

Storage time when fault recording is initiated via the membrane keyboard, pre−trigger and post−fault times are additive
Smallest setting value: **0.10** s
Largest setting value: **5.00** s

5.4 Configuration of the protective functions

5.4.1 Introduction

The **device** 7SJ531 is capable of providing a series of **protection** and additional functions. The scope of the hard− and firm−ware is matched to these functions. Additionally, the **control** functions can be matched to the on−site conditions. Furthermore, individual functions can be set (configured) to be effective or non−effective or the interaction of the functions can be modified by configuration parameters. Additionally, the relay can be adapted to the system frequency.

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

2nd example for the interaction of the functions:
The high−current stage **I**>> of the overcurrent time protection should operate before automatic reclosure, the remaining stages should not. The device will be "informed" of this condition during configuration.

3rd example for matching of the control functions to the switchgear:
By selection of the feeder mimic diagram, the position feedback signals are assigned to the required binary input.

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 the 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 code word with level 3 (see Section 5.3.1). Without code word, the setting can be read out but not altered.

For the purpose of configuration, address blocks 78 and 79 are provided. One can access the beginning of the configuration blocks from the **MENU** → double arrow key ⩔ → option **3** CONFIGURATION → option **5**: 7800 SCOPE OF FUNCTIONS, as described in Section 5.3.1 (refer also to Figures 5.9 and 5.10).

Within the block 78 one can move the cursor with ▽ or △, and, thus reach the individual addresses for configuration parameters. In the following sections, each address is shown in a box and explained. In the first line of each address, behind the address number, 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 to 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 further alternatives which can then be displayed by repeated depression of the "No"−key **N**. The required alternative **must be confirmed with the key E!**

With the backspace key **R** one goes back to the higher menu level CONFIGURATION; the menu option **6** will lead to address block 79 with further addresses, the setting of which may be altered or not.

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, code word operation will be aborted, i.e. all alterations which have been changed since the last code word 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) by trying to return to the main menu, the display shows the question "END OF CODEWORD OPERATION ?". Press the "No"−key **N** to continue configuration. If you press the "Yes"−key **J/Y** instead, another question appears: "SAVE NEW SETTINGS ?". Now you can confirm with **J/Y** or abort with **N**, as described above.

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

5.4.2 Programming the scope of functions – address block 78

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

Functions which are **configured** as *NON EXIST* will not be processed in 7SJ531: 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.

```
R  7800 SCOPE OF
        FUNCTIONS
```

Beginning of the block "Scope of functions"

Characteristic of phase overcurrent time protection:

```
▽  7812 ■CHARAC. PH
         DEFINITE TIME
N        INV. TIME IEC
N        INV. TIME ANSI
N        USER CHARACTER.
```

Characteristic of directional phase overcurrent time protection:

```
▽  7814 ■O/C DIR.PH
         DEFINITE
N        INV. TIME IEC
N        INV. TIME ANSI
N        USER CHARACTER.
N        NON-EXIST
```

Characteristic of earth overcurrent time protection:

```
△
▽  7813 ■CHARAC. E
         DEFINITE TIME
N        INV. TIME IEC
N        INV. TIME ANSI
N        USER CHARACTER.
```

Characteristic of directional earth overcurrent time protection:

```
△
▽  7815 ■0/C DIR. E
         DEFINITE TIME
N        INV. TIME IEC
N        INV. TIME ANSI
N        USER CHARACTER.
N        NON-EXIST
```

Voltage protection:

```
△ 7816 ■VOLT. PROT.
▽       NON-EXIST
N       EXIST
```

Unbalanced load protection:

```
△ 7818 ■NEG. SEQ.
▽       NON-EXIST
N       EXIST
```

Motor start–up time monitoring:

```
△ 7821 ■START SUPV
▽       NON-EXIST
N       EXIST
```

Thermal overload protection:

```
△ 7827 ■THERMAL OL
▽       NON-EXIST
N       EXIST
```

Motor restart lockout:

```
△ 7828 ■MOTOR START
▽       NON-EXIST
N       EXIST
```

Earth fault detection:

```
△ 7830 ■EARTH FAULT
▽       NON-EXIST
N       DEFINITE TIME
N       USER CHARACTER.
```

Automatic reclosure:

```
△ 7834 ■INTERNAL AR
▽       NON-EXIST
N       EXIST
```

Trip circuit supervision:

```
△ 7837 ■TRIP SUPERV
▽       NON-EXIST
N       WITH 2 BI
N       BYPASS RESISTOR
```

Distance–to–fault location:

```
△ 7838 ■FAULT LOCAT
▽       NON-EXIST
N       EXIST
```

Circuit breaker failure protection:

```
△ 7839 ■BREAK. FAIL
▽       NON-EXIST
N       EXIST
```

Note: Configuration of the feeder mimic diagram (addresses 7875 to 7879) is explained in Section 5.4.3.

Switch–over of parameter sets:

```
△ 7885 ■PARAM. C/O
        NON-EXIST
N       EXIST
```

5.4.3 Configuration of the feeder mimic diagram – address block 78

Out of a total of 22 available feeder mimic diagrams in the relay (see Appendix E) the suitable one for the protected switchgear is selected and configured under following addresses.

Under address 7875 a general pre–selection (circuit breaker, disconnector or sectionalizer feeder or no mimic diagram) is carried out and thus defined which of the three following addresses (7876 to 7879) applies. The fine selection is then possible under the applicable address. The mimic diagrams in annex E are structured in the same sequence.

Note: Configuration of the type of feeder (addresses 7875 to 7879) cancels all previous marshallings of binary inputs – even those which are fixed for other signals than breaker position feedback. This means all binary inputs are automatically pre–set "`not allocated`". The only exception is binary input 11, which is pre–set for blocking of the undervoltage protection; this pre–setting is preserved.

If *NON–EXIST* is configured for address 7875, then no binary input except no.11 is activated.

△ ▽	7875 ■BAY TYPE	**General selection of the type of feeder:**
	CB BAY	circuit breaker feeder
	DISCON. BAY	disconnector feeder
N	SECTIONALIZER	sectionalizer
	DOUBLE-BB	Double bus–bar
	NON-EXIST	not existing

△ ▽	7876 ■CB BAY	**Selection of the circuit breaker feeder:**
	CB BAY 1	circuit breaker feeder
	CB BAY 2	circuit breaker feeder with bus–bar earthing
	CB BAY 3	circuit breaker feeder with bus–bar voltage transformer
	CB BAY 4	circuit breaker feeder, drawer
N	CB BAY 5	circuit breaker feeder, drawer with bus–bar earthing
	CB BAY 6	circuit breaker feeder, earthing drawer
	CB BAY 7	circuit breaker feeder, earthing drawer, bus–bar earth.
	CB BAY 8	circuit breaker feeder with load disconnector
	CB BAY 9	circuit breaker feeder with load disconnector with bus–bar earthing
	CB BAY 10	circuit breaker feeder with bus–bar earth and feeder earth

	Selection of the disconnector feeder:
△ ▽ 7877 ■DIS BAY DISCON. BAY 1	disconnector feeder
N DISCON. BAY 2	disconnector feeder with bus−bar earthing
DISCON. BAY 3	disconnector feeder with bus−bar voltage transformer

	Selection of the coupling feeder:
△ ▽ 7878 ■SECT BAY SECTIONALIZER 1	sectionalizer with earthing
SECTIONALIZER 2	sectionalizer type 1, riser T2
N SECTIONALIZER 3	sectionalizer type 2, riser T2
SECTIONALIZER 4	sectionalizer type 1, riser T1
SECTIONALIZER 5	sectionalizer type 2, riser T1
SECTIONALIZER 6	bus−bar sectionalizer
SECTIONALIZER 7	sectionalizer with bus−bar earthing and voltage transformer, type 1
SECTIONALIZER 8	sectionalizer with bus−bar earthing and voltage transformer, type 2

	Selection of the circuit breaker feeder: Double bus−bar (not for 7SJ531★−★★★★0−)
△ ▽ 7879 ■DOUBLE−BB CB BAY 1	circuit breaker bay 1
N CB BAY 2	circuit breaker bay 2
CB BAY 3	circuit breaker bay 3
CB BAY 4	circuit breaker bay 4
CB BAY 5	circuit breaker bay 5
SECTIONALIZER 1	sectionalizer 1

5.4.4 Setting the rated system frequency − address block 78

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

△ 7899 ■FREQUENCY fN 50 Hz	Rated system frequency *50 Hz* or *60 Hz*
N fN 60 Hz	

5.4.5 Configuration of the switching device control − address block 75

Settings for the integrated switching device control can be carried out only when the corresponding feeder mimic diagram has been selected during configuration, see Section 5.4.3, addresses 7875 to 7879. The configuration work assigns the binary inputs of the relay to the feedback signals from the switchgear. Address block 75 is addressed via OPERATION MENU (page 2) → option **3** CONFIGURATION → option **4** BREAKER CONTROL, as described in Section 5.3.1 (Figure 5.9).

Under address 7501 it is defined which of the alternatives shall be available for the operators for handling the switching authority (see Section 6.5.6). These alternatives are laid down under addresses 7598 or 7599. Depending of this pre−selection, either the option as per address 7598 or the option as per address 7599 are available for the switching authority. These addresses are shown at the end of this section.

R	`7500 BREAKER` `     CONTROL`	Beginning of the block ”Breaker control”, from menu level CONFIGURATION with option **4**
▽	`7501■SW AUTH REM` `     REMOTE ONLY`	This address determines the mode of switching authority *REMOTE ONLY* the options according address 5799 are available
N	`     INCL. LOCAL`	*INCL. LOCAL* the options according address 7598 are available

---

Address 7502 determines whether the binary inputs ”`>Manual Close`” and ”`>Manual Trip`” shall be assigned to the local control (integrated keypad) or the remote control (LSA interface).

In the same way address 7503 determines whether the control via the operation interface with the PC program DIGSI® shall be assigned to the local control or the remote control.

Under addresses 7510 and 7512 it is determined whether the command release of a control process or the switch−over of the switching authority requires entry of the code word (code level 1).

Under further addresses the parameters of the control monitoring, which were already described in Section 4.14, are set. T−ENTRY (address 7511) determines the maximum permissible time between two key entries for switching device control.

In order to ensure that the circuit breaker final state is safely reached, it is sometimes necessary to keep the command relay energized for a defined time even after receiving the feedback signal. This is done with the command extension time (address 7522).

When a command relay is energized, but the breaker position feedback signal does not indicate the required final state of the circuit breaker within the permissible command running time T−FB CB, which is set under address 7520, then this exceeded running time is indicated. Under address 7524 it can be determined whether the running control command shall be cancelled or not. Interruption of the control command should be allowed only when the destruction of the command relays can be excluded.

The time T−DWI (address 7525) monitors the intermediate state while switching devices are operated. If the intermediate state lasts longer than this time, alarm is given.

△ ▽ 7502■SW AUTH BI LOCAL	Parameter to determine which control mode the binary inputs for manual close and manual trip control shall be assigned to.
N REMOTE	
LOCKED	For setting *LOCKED* the binary inputs ”`>Manual Close`” and ”`>Manual Trip`” will not create a switching command

△ ▽ 7503■SW AUTH DIG LOCAL	Parameter to determine which control mode the control via the interface with DIGSI shall be assigned to.
N REMOTE	
LOCKED	For setting *LOCKED* no breaker control via DIGSI is possible

△ ▽ 7510■CONTROL W/O CODEWD	Command release is possible *W/O* without entry of a *CODEW*ORD or only *WITH C*ODE*W*ORD
N WITH CW	

△ ▽ 7511■T-ENTRY 10 s	Maximum permissible time between two key inputs for switching device control after beginning of the flashing Smallest setting: **5** s Largest setting value: **30** s

△ ▽ 7512■LOC/REM SEL W/O CODEWD	Parameter to determine whether code word entry is necessary or not for switch−over local/remote
N WITH CW	

△ ▽ 7520■T-FB CB 1 s	Time to monitor the command running time of command relay up to reception of breaker feedback signal for circuit breakers Smallest setting value: **1** s Largest setting value: **600** s and ∞

△ ▽ 7522■T-EXT CB 0.0 s	Time extension for energization of the command relay after reception of the feedback signal following a control command Smallest setting value: **0,0** s Largest setting value: **10,0** s

```
△ ║7524▪T-SFB END        ║
▽ ║     STOPS TRIP CMD   ║

N │     STOPS NOT TRIP C │
```

Parameter describing the reaction of the command relay after exceeding the monitored command running time

```
△ ║7525▪T-DWI            ║
▽ ║     10 s             ║
```

Monitoring time for the intermediate position of the breaker state feedback signals (disappearance of the feedback up to giving the corresponding alarm)

Smallest setting value: **0** s

Largest setting value: **60** s

and ∞

Addresses 7598 and 7599 prepare the operational control facilities. Depending on the setting of parameter 7501 either the options as per address 7598 or as per address 7599 are offered during operation when selecting the menu option SWITCH AUTHority out of the OPERATION−MENU. Further details are given in Section 6.5.6.1.

5.4.6 Setting the device configuration − address block 79

The configuration affects the interaction of the protective and additional functions, above all, for 7SJ531, the interaction of the auto−reclosing system with the protection functions, the connection mode of the voltage transformers and the selection of the voltages. Address block 79 is addressed via OPERATION MENU (page 2) → option **3** CONFIGURATION → option **6** DEVICE CONFIGURATION, as described in Section 5.3.1 (Figure 5.9).

```
R ║7900 DEVICE           ║
  ║     CONFIGURATION    ║
```

Beginning of the block ”Device configuration”

```
▽ ║7901▪I>>              ║
  ║     START AR         ║

  │     NO AR            │
```

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

```
△ ║7902▪I>/Ip            ║
▽ ║     START AR         ║

  │     NO AR            │
```

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

Display	Description
7903 I>/Ip DIR. [1] [4] START AR NO AR	I> stage (definite time) or I_p stage (inverse time) of directional phase overcurrent time protection initiates auto−reclosure or not [1] [4]
7904 IE>> [1] [4] START AR NO AR	I_E>> stage of earth overcurrent time protection initiates auto−reclosure or not [1] [4]
7905 IE>/IEp [1] [4] START AR NO AR	I_E> stage (definite time) or I_{Ep} stage (inverse time) of earth overcurrent time protection initiates auto−reclosure or not [1] [4]
7906 IE>/IEp DIR [1] [4] START AR NO AR	I_E> stage (definite time) or I_{Ep} stage (inverse time) of directional earth overcurrent time protection initiates auto−reclosure or not [1] [4]
7907 I>> DIR. [1] [4] START AR NO AR	I>> stage of directional phase overcurrent time protection initiates auto−reclosure or not [1] [4]
7908 IE>> DIR. [1] [4] START AR NO AR	I_E>> stage of directional earth overcurrent time protection initiates auto−reclosure or not [1] [4]
7909 NEG. SEQ. [1] START AR NO AR	Unbalanced load protection initiates auto−reclosure or not [1]
7910 CB TEST BI THREE-POLE TRIP TRIP-CLOSE 3POLE	Circuit breaker test via binary input is carried out: *THREE−POLE TRIP* will be initiated (without reclose) *TRIP−CLOSE 3POLE*, that is three−pole AR cycle

[1]) only model 7SJ531★−★★★★2−★★★★

[4]) only model 7SJ531★−★★★★★−★★★1

	Connection and processing of the voltage transformer values:
△▽ 7911 ■VT CONNECT PH−E CALC PH−E	*PH−E CALC PH−E*, i.e. the three phase−to−earth voltages are connected and the phase−to−earth voltages are processed (e.g. see connection diagram B.1 or B.2 in Appendix B);
P−E, UE, PROT P−E	*P−E, UE, PROT P−E*, i.e. two phase−to−earth voltages and the displacement voltage U_{EN} are connected, the phase−to earth voltages are processed (e.g. see connection diagram B.10 in Appendix B);
N P−E, UE, PROT P−P	*P−E, UE, PROT P−P*, i.e. two phase−to−earth voltages and the displacement voltage U_{EN} are connected, the phase−to phase voltages are processed (e.g. see connection diagram B.10 in Appendix B);
PH−E CALC PH−PH	*PH−E CALC PH−PH*, i.e. the phase−to−earth voltages are connected and the phase−to−phase voltages are processed, (e.g. see connection diagram B.1 or B.2 in Appendix B);
PH−PH CALC PH−PH	*PH−PH CALC PH−PH*, i.e. the phase−to−phase voltages are connected and the phase−to−phase voltages are processed

△ 7930 ■E FLT DET [1] [2] WITH UE OR IEE	Conditions for earth fault detection [1] [2]: *WITH UE OR IEE,* i.e. an earth fault is detected when either displacement voltage threshold U_E *OR* residual current threshold I_{EE} is exceeded;
WITH UE AND IEE	*WITH UE AND IEE*, i.e. an earth fault is only detected when the displacement voltage threshold U_E *AND* the residual current threshold I_{EE} are both exceeded;

[1] only model 7SJ531⋆−⋆⋆⋆⋆2−⋆⋆⋆⋆

[2] only models 7SJ531⋆−⋆⋆⋆⋆⋆−0⋆⋆⋆ and −1⋆⋆⋆

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 outputs and a part of the inputs of the internal functions can be rearranged and thus adapted to the on−site conditions. Dependent of the selected feeder mimic diagram, a part of the binary inputs is fixedly assigned to the auxiliary contacts of the switching elements; these cannot be altered. Appendix E shows the available feeder mimic diagrams and the assigned binary inputs.

When the 7SJ531 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: Fault detection is registered from the overcurrent protection. This event is generated in 7SJ531 as an "annunciation" (logical function) and should be available at certain terminals of the unit as a N.O. contact. Since specific unit terminals are hard−wired to a specific (physical) signal relay, e.g. to the signal relay 1, the processor must be advised that the logical signal "`Device FltDet`" should be transmitted to the signal relay 1. Thus, when marshalling is performed two statements of the operator are important: **Which** (logical) annunciation generated in the protection unit program should trigger **which** (physical) signal relay? Up to 20 logical annunciations can trigger one (physical) signal relay.

A similar situation applies to binary inputs, which can be freely assigned, i.e. which are not assigned to the auxiliary contacts of switching elements. In this case external information (e.g. blocking of stage I>>) is connected to the unit via a (physical) input module and should initiate a (logical) function, namely blocking. The corresponding question to the operator is then: **Which** signal from a (physical) input relay should initiate **which** reaction in the device? One physical input signal can initiate up to 10 logical functions.

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

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

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

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

Marshalling of the inputs, outputs and LEDs is performed by means of the integrated operator panel or via the operating interface in the front. Marshalling begins at the parameter address 6000.

The input of the code word of code level 3 is required for marshalling (refer Section 5.3.1). Without code word entry, parameters can be read out but not be changed. During code word operation, i.e. from code word entry until the termination of the marshalling procedure, the solid bar in the display flashes.

The beginning of the marshalling parameter blocks is reached by depressing the **MENU**−key: the OPERATION MENU 1 appears. Since the total menu takes more than one display page, the double−arrow key ⇟ is used to page to OPERATION MENU 2; use the key ⇞ to page back. Within the menu, a menu option is selected by entering the assigned digit, refer to Figure 5.11. Finally, the sub−menu with the configuration address blocks is displayed. The addresses are defined by the four−digit address number (e.g. 6100) and the heading of the address block (e.g. MARSHALLING BINARY INPUTS).

The previous menu can be reached with the backspace key **R**. If the **R**−key is pressed on the level of the main menu, the basic display will appear. If the **MENU**−key is pressed, the first main menu appears.

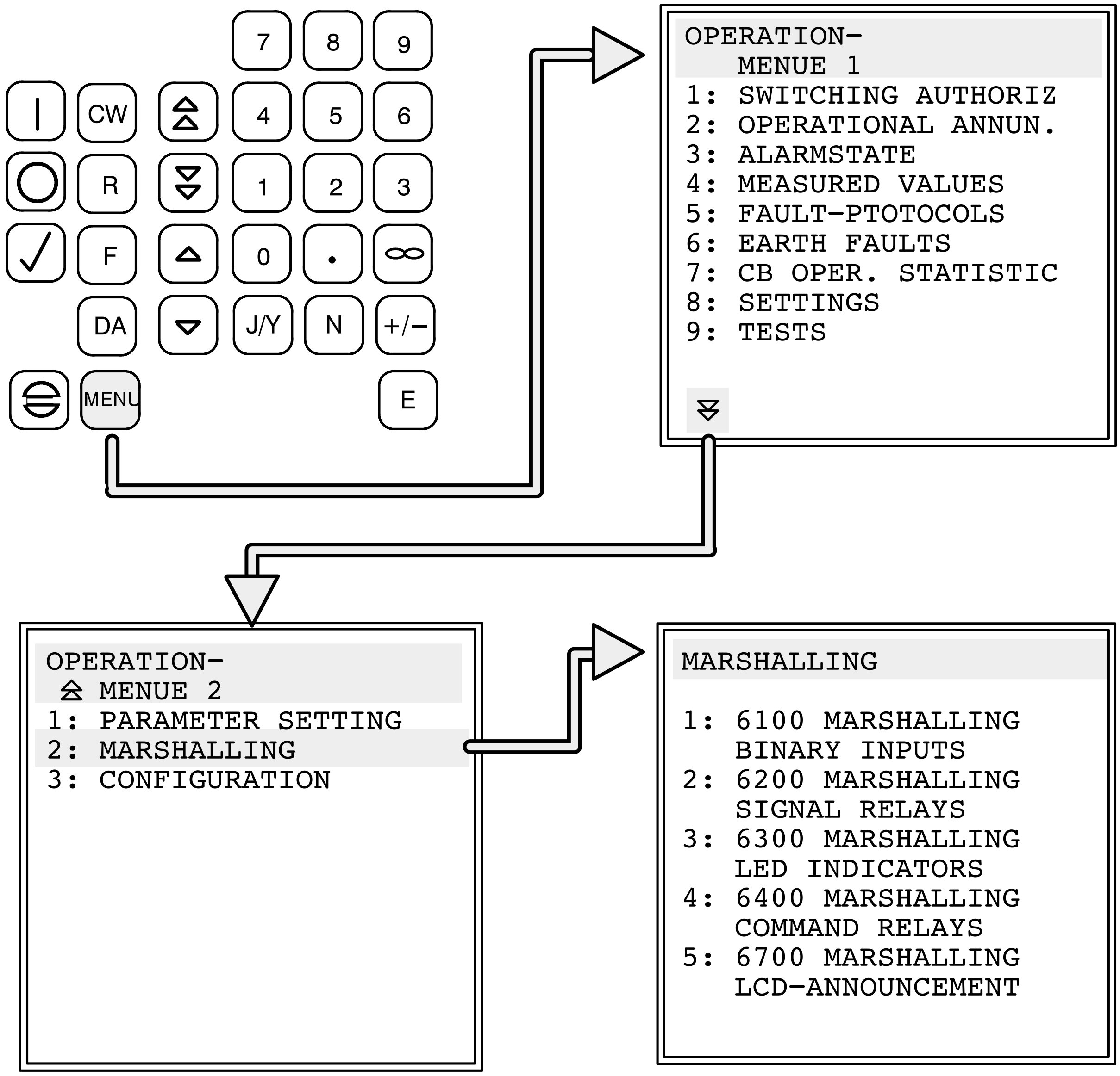


Figure 5.11 Operation menu for marshalling

With the selected menu option (e.g. 1 for MARSHALLING BINARY INPUTS) access is gained to the individual addresses of this operation block. The display shows the four−digit address numbers, i.e. address block number and sequence number, followed by the name of the input or output unit (see Figure 5.12). By means of the keys △ or ▽ the cursor can be moved to the selected address. When not all addresses of an operation block can be shown in the display on one page, then the next page can be selected again with the key ⩔ (Figure 5.12).

When the cursor is located beside the name of the selected input or output unit, then the combination of the keys **F**△ (i.e. functional key **F** followed by the arrow key △) leads to the selection level for the corresponding function. The address number is now replaced by a three−digit counting−index (001 to 010) and the physical input/output unit in short form. The following line indicates the logical function which is momentarily assigned to this physical input/output unit.

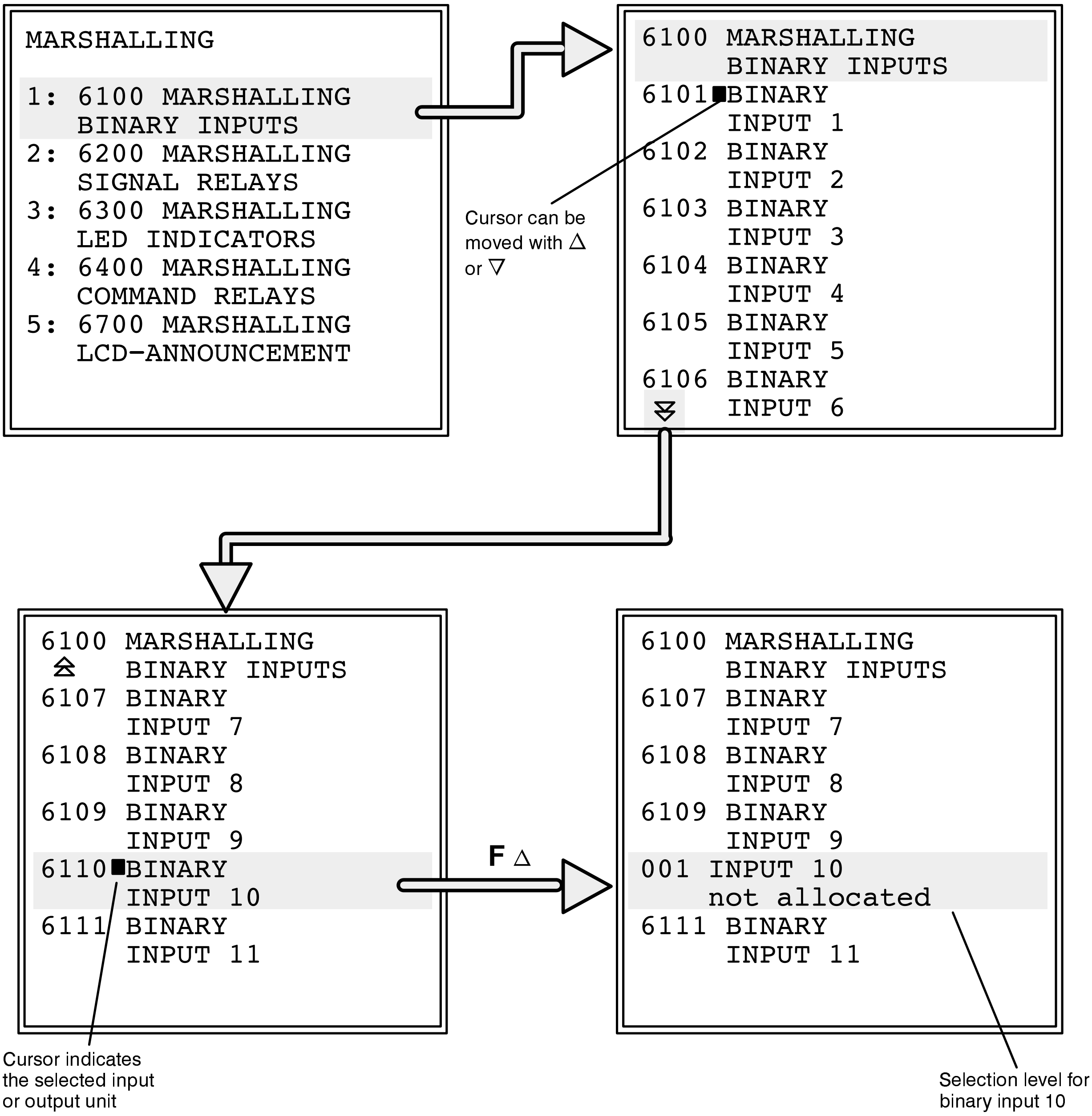


Figure 5.12 Marshalling example

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 keys △ or ▽. **Each selection must be confirmed by pressing the key E!** If a selection place shall not be assigned to a function, selection is made with the function "not allocated".

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

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

The backspace key **R** is used to change back to the menu MARSHALLING. A new selection can be made in order to allocate different input/output units.

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, code word operation will be aborted, i.e. all alterations which have been changed since the last code word 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) by jumping back to the main menu (OPERATION MENU) by pressing the backspace key **R** or the **MENU**−key, 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.

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

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

5.5.2 Marshalling of the binary inputs − address block 61

The relay disposes of 11 binary inputs, designated as BINARY INPUT 1 to BINARY INPUT 11. The major part of these inputs is used for registration of the momentary position of the switchgear's switching devices. Each switch controls with its auxiliary contacts two binary inputs. By selection of a specific feeder mimic diagram, the assignment of the switch position feedback signals to the binary inputs is automatically fixed.

Note: Changing the configuration of the type of feeder re−configures all binary inputs, which are not used for breaker state feedback signalling (except binary input 11), as ”`not allocated`”. This means that previously entered marshallings of binary inputs are lost. Therefore the suitable feeder mimic diagram should be selected at first and configured with the addresses 7875 to 7878 (see Section 5.4.3).

The remaining binary inputs, which depend on the selected type of feeder, can freely be marshalled in address block 61. This block is addressed by the **MENU**−key through OPERATION MENU (page 2) → 1: MARSHALLING →1: MARSHALLING BINARY INPUTS, as described under Section 5.5.1.

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

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

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

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

Table 5.1 shows a complete list of all the binary input functions with their associated function number **FNo**. Input functions naturally have no effect if the corresponding protection function is not fitted in the relay or has been programmed out (”de−configured”, refer Section 5.4.2).

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

.0 means ”normally open” mode, corresponds to ”`NO`” as above.

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

Each input must be confirmed with the enter key **E**.

If the extension with .0 or .1 is omitted the display first indicates the function designation in ”normally open” mode `NO`. By pressing the ”No”−key **N** the mode is changed to `NC`. After direct input other functions can be selected by paging through the functions forwards with the ”No”−key **N** or backwards with the backspace key **R**. The changed function then must be re−confirmed by the entry key **E**.

Note: One logical function should not be marshalled to two binary inputs, because an OR−logic of both signals can not be guaranteed!

In the following boxes an example is given for binary input 11. This is the only freely marshallable binary input, which is already pre−set upon delivery ex works and which is not lost during the configuration of the type of feeder.

Table 5.2 shows all binary inputs as preset from the factory.

```
6111■BINARY-
     INPUT 11
```

F△ — Allocations for binary input 11

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

△	001 INPUT 11 >u/v block NO	Blocking of undervoltage protection, FNo 6503; ”normally open” operation: Undervoltage protection is blocked when control voltage present; this blocking is necessary when the relay is switched on and no measured voltage is present
△ ▽	002 not allocated 003 not allocated	No further functions are initiated by binary input 11

Note: The pre−setting of binary input 11 has a special meaning. When the undervoltage protection is switched on (address 1601 = *ON*), unlike the setting upon delivery, and is activated and no voltage is measured, then the undervoltage criterion is immediately fulfilled and the protection picks up. As operation of the relay is not possible during pick−up conditions, a voltage above the reset threshold of the undervoltage protection would have to be applied to allow operation of the relay. If this is not possible or too complicated from the switchgear side, the undervoltage protection can be blocked and thus the pick−up reset by energizing binary input 11.

Leave the selection level with key combination **F** △. You can go then to the next binary input with the arrow key △ or go back to the marshalling level with the **R**−key.

△ ▽	6111■BINARY- INPUT 11	Allocations for binary input 11

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
11	>Annunc. 1	User definable annunciation 1
12	>Annunc. 2	User definable annunciation 2
13	>Annunc. 3	User definable annunciation 3
14	>Annunc. 4	User definable annunciation 4
15	>Sys-Test	System interface messages/values are marked with ”Test operation”
16	>Sys-MM-block	System interface messages and measured values are blocked
356	>Manual Close	Circuit breaker is 3−pole closed (from CB auxiliary contact)
358	>Manual Trip	Circuit breaker is manually closed (from discrepancy switch)
383	>RAR Release	Release RAR stages from external (e.g. external AR device)
391	>Buchh. Warn	Warning stage from Buchholz protection
392	>Buchh. Trip	Tripping stage from Buchholz protection
1106	>Start FltLoc	Start fault locator from external command via binary input
1156	>CB Test	Trigger circuit breaker test
1201	>UE block	Block U_E−stage of earth fault detection
1202	>IEE>> block	Block I_{EE}>> stage of high−sensitivity E/F protection
1203	>IEE> block	Block I_{EE}> stage (definite time) of high−sensitivity E/F protection
1204	>IEEp block	Block I_{EE}> stage (inverse time) of high−sensitivity E/F protection

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

FNo	Abbreviation	Description
1205	>E/F Det. on	Switch on earth fault detection for non−earthed system
1206	>E/F Det. off	Switch off earth fault detection for non−earthed system
1207	>E/F Det.bloc	Block earth fault detection for non−earthed system
1208	>E/F annunc.	Earth fault detection only annunciations, no trip
1401	>B/F on	Switch on breaker failure function
1402	>B/F off	Switch off breaker failure function
1403	>B/F block	Block breaker failure function
1431	>B/F Start	Start breaker failure protection
1501	>O/L on	Switch on overload protection
1502	>O/L off	Switch off overload protection
1503	>O/L block	Block overload protection
1504	>O/L alarm	Overload protection: alarm only, no trip
1701	>O/C Ph on	Switch on overcurrent protection phase
1702	>O/C Ph off	Switch off overcurrent protection phase
1704	>O/C Ph block	Block overcurrent protection phase
1711	>O/C E on	Switch on overcurrent protection earth
1712	>O/C E off	Switch off overcurrent protection earth
1714	>O/C E block	Block overcurrent protection earth
1721	>I>> block	Block I>> stage of overcurrent protection
1722	>I> block	Block I> stage of overcurrent protection (definite time)
1723	>Ip block	Block I_p stage of overcurrent protection (inverse time)
1724	>IE>> block	Block I_E>> stage of overcurrent protection
1725	>IE> block	Block I_E> stage of overcurrent protection (definite time)
1726	>IEp block	Block I_{Ep} stage of overcurrent protection (inverse time)
2601	>dirO/C P on	Switch on directional overcurrent protection phase
2602	>dirO/C P off	Switch off directional overcurrent protection phase
2604	>dirO/C P blk	Block directional overcurrent protection phase
2611	>dirO/C E on	Switch on directional overcurrent protection earth
2612	>dirO/C E off	Switch off directional overcurrent protection earth
2614	>dirO/C E blk	Block directional overcurrent protection earth
2615	>I>>Block dir	Block I>> stage of directional overcurrent protection
2616	>IE>>Bloc dir	Block I_E>> stage of directional overcurrent protection
2621	>I> Block dir	Block I> stage of directional overcurrent protection (definite time)
2622	>Ip Block dir	Block I_p stage of directional overcurrent protection (inverse time)
2623	>IE>Block dir	Block I_E> stage of directional overcurrent protection (definite time)
2624	>IEpBlock dir	Block I_{Ep} stage of directional overcurrent protection (inverse time)
2625	>Blk fw fail.	Blocking signal for forward direction disturbed
2626	>Blk rw fail.	Blocking signal for reverse direction disturbed
2701	>AR on	Switch on internal auto−reclose function
2702	>AR off	Switch off internal auto−reclose function
2703	>AR block	Block internal auto−reclose function statically
2704	>AR reset	Reset internal auto−reclose function
2709	>DAR block	Block complete DAR
2711	>Start AR	Start signal from external protection for internal AR
2715	>Trip E Fail.	Trip signal earth fault from external protection for internal AR
2716	>Trip Ph Fail	Trip signal phase fault from external protection for internal AR
2730	>CB ready	Circuit breaker ready for AR cycle
4601	>CBP Q0 cld	Position feedback signal circuit breaker: Q0 closed
4602	>CBP Q0 opd	Position feedback signal circuit breaker: Q0 opened
4603	>DCP Q1 cld	Position feedback signal bus−bar disconnector: Q1 closed
4604	>DCP Q1 opd	Position feedback signal bus−bar disconnector: Q1 opened
4605	>DCP Q01 cld	Position feedback signal load disconnector: Q01 closed
4606	>DCP Q01 opd	Position feedback signal load disconnector: Q01 opened

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

FNo	Abbreviation	Description
4607	>DCP Q5 cld	Position feedback signal operation earthing switch: Q5 closed
4608	>DCP Q5 opd	Position feedback signal operation earthing switch: Q5 opened
4609	>DCP Q6 cld	Position feedback signal measuring earthing switch: Q6 closed
4610	>DCP Q6 opd	Position feedback signal measuring earthing switch: Q6 opened
4611	>DCP Q8 cld	Position feedback signal feeder earthing switch: Q8 closed
4612	>DCP Q8 opd	Position feedback signal feeder earthing switch: Q8 opened
4613	>DCP Q10 cld	Position feedback signal coupling disconnector: Q10 closed
4614	>DCP Q10 opd	Position feedback signal coupling disconnector: Q10 opened
4615	>DCP Q15 cld	Position feedback signal bus-bar earthing switch: Q15 closed
4616	>DCP Q15 opd	Position feedback signal bus-bar earthing switch: Q15 opened
4617	>DCP Q16 cld	Position feedback signal bus-bar earthing switch: Q16 closed
4618	>DCP Q16 opd	Position feedback signal bus-bar earthing switch: Q16 opened
4619	>DCP Q2 cld	Position feedback signal bus-bar disconnector: Q2 closed
4620	>DCP Q2 opd	Position feedback signal bus-bar disconnector: Q2 opened
4631	>SW.auth.rem	Switching authorization: remote
4632	>SW.auth.bloc.	Switching authorization: blocked
4801	>MCB trip	Miniature circuit breaker trip
4802	>SF6 pres fd	SF6 pressure alarm (feeder)
4803	>SF6 pres bb	SF6 pressure alarm (bus-bar)
4804	>HV fuse bl	HV fuse blown
4805	>LV plug rem	LV plug removed
4807	>tempalarm	Temperature alarm
4808	>temptrip	Temperature trip
4820	>MSP on	Switch on motor restart lockout
4821	MSP off	Switch off motor restart lockout
4822	>MSP block	Block motor restart lockout
4823	>MSP emerg st	Override motor restart lockout for emergency start
5140	>I2 on	Switch on unbalanced load protection
5141	>I2 off	Switch off unbalanced load protection
5143	>I2 block	Block unbalanced load protection
5144	>negative seq	Activate negative phase sequence (counter-clockwise phase rotation)
6501	>u/v on	Switch on undervoltage protection
6502	>u/v off	Switch off undervoltage protection
6503	>u/v block	Block undervoltage protection completely
6504	>u/v annunc	Undervoltage protection: annunciations only
6506	>U< block	Block undervoltage protection stage U<
6507	>U<< s crit	Undervoltage protection start-up criterion
6508	>U<< block	Block undervoltage protection stage U<<
6509	>vt fail feed	vt failure feeder
6510	>vt fail bb	vt failure bus-bar
6511	>o/v on	Switch on overvoltage protection
6512	>o/v off	Switch off overvoltage protection
6513	>o/v block	Block overvoltage protection
6514	>o/v annunc.	Overvoltage protection: annunciations only
6801	>STRT-SUP blk	Block motor start-up time supervision
6803	>STRT-SUP on	Switch on motor start-up time supervision
6804	>STRT-SUP off	Switch off motor start-up time supervision
6805	>Rotor locked	Rotor is locked (from motor speed monitor)
6852	>SUP trip rel	Trip circuit supervision: input in parallel to trip relay contact
6853	>SUP CB aux.	Trip circuit supervision: input in parallel to CB auxiliary contact

Table 5.1 Marshalling possibilities for binary inputs

Addr	1st display line	2nd display line	FNo	Remarks
6100	MARSHALLING	BINARY INPUTS		Heading of the address block
				Breaker position feedback signals (matched with the pre−selected feeder mimic diagram CB feeder 1 in the diagrams E1 in the annex):
6101	BINARY INPUT 1	INPUT 1 >CBP Q0 opd NO	4602	for circuit breaker Q0 in OFF−position
6102	BINARY INPUT 2	INPUT 2 >CBP Q0 cld NO	4601	for circuit breaker Q0 in ON−position
6103	BINARY INPUT 3	INPUT 3 >DCP Q1 opd NO	4604	for bus−bar disconnector Q1 in OFF−position
6104	BINARY INPUT 4	INPUT 4 >DCP Q1 cld NO	4603	for bus−bar disconnector Q1 in ON−position
6105	BINARY INPUT 5	INPUT 5 >DCP Q8 opd NO	4612	for feeder earthing switch Q8 in OFF−position
6106	BINARY INPUT 6	INPUT 6 >DCP Q8 cld NO	4611	for feeder earthing switch Q8 in ON−position
6107	BINARY INPUT 7	INPUT 7 not allocated	1	no pre−selection is configured for binary inputs 7 to 10
6108	BINARY INPUT 8	INPUT 8 not allocated	1	
6109	BINARY INPUT 9	INPUT 9 not allocated	1	
6110	BINARY INPUT 10	INPUT 10 not allocated	1	
6111	Binary INPUT 11	INPUT 11 >u/v block NO	6503	block both stages of the undervoltage protection

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 in address block 62. The signal relays are designated SIGNAL RELAY 1 to SIGNAL RELAY 4. The block is reached with the **MENU**–key → OPERATION MENU 1 → paging with ⩔ to OPERATION MENU 2 → 1: MARSHALLING → 2: MARSHALLING SIGNAL RELAYS, as described in Section 5.5.1.

Multiple annunciations are possible, i.e. one logical annunciation function can be routed to several physical signal relays (see also Section 5.5.1).

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

The assignment of the output signal relays as delivered from factory is shown in the general diagrams in Appendix A. The following boxes show examples for marshalling. In the example for signal relay 4 the group annunciation for several annunciation functions on one signal relay is shown. Table 5.4 shows all signal relays as preset from the factory.

Note as to Table 5.3: Annunciations which are indicated by a leading ">" sign, represent the direct confirmation of the binary inputs and are available as long as the corresponding binary input is energized.

Further information about annunciations see Section 6.4.

R	`6200 MARSHALLING` `     SIGNAL RELAYS`	Beginning of the block "Marshalling of the output signal relays"

Within the address block, the cursor can be moved with the keys △ and ▽ in order to access to a certain signal relay, e.g. signal relay 1:

R **F**△	`6201■SIGNAL` `     RELAY 1`	Allocations for signal relay 1

After code word entry (code level 3), change over to the selection level with **F** △:

▽	`001■RELAY 1` `Device FltDet`	Signal relay 1 has been preset for: General fault detection of device, FNo `501`;
△ ▽	`002 RELAY 1` `not allocated`	no further functions are preset for signal relay 1

Leave the selection level with key combination **F** △. You can go then to the next signal output relay with the arrow key ▽. Signal relay 4 represents – as preset from the factory – an example for a group annunciation, i.e several logical annunciation functions are given to one output signal relay.

R **F**△	`6204 SIGNAL` `     RELAY 4`	Allocations for signal relay 4, Meaning: "Failure in measured quantities"

△	001 RELAY 4 Failure ΣI	Signal relay 4 has been preset for: 1st: Failure detected by measured current sum monitor, FNo 162:
△ ▽	002 RELAY 4 Failure ΣUp-p	Signal relay 4 has been preset for: 2nd: Failure detected by measured voltage sum monitor phase−to−phase, FNo 166;
△ ▽	003 RELAY 4 Failure Isymm	Signal relay 4 has been preset for: 3rd: Failure detected by measured current symmetry monitor, FNo 163;
△ ▽	004 RELAY 4 Failure Usymm	Signal relay 4 has been preset for: 4th: Failure detected by measured voltage symmetry monitor phase−to−phase, FNo 167;
△ ▽	005 RELAY 4 Fail.PhSeq I	Signal relay 4 has been preset for: 5th: Failure detected by phase sequence supervision current, FNo 175;
△ ▽	006 RELAY 4 Fail.PhSeq V	Signal relay 4 has been preset for: 6th: Failure detected by phase sequence supervision voltage, FNo 176;
△ ▽	007 RELAY 4 Fail.Battery	Signal relay 4 has been preset for: 7th: Failure of internal back−up battery, FNo 177;
△ ▽	008 RELAY 4 err:CB/DC pos	Signal relay 4 has been preset for: 8th: Error in check−back indication, general, FNo 4689;
△ ▽	009 RELAY 4 not allocated	no further functions are preset for signal relay 4

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

R ▽	6204 SIGNAL RELAY 4	Allocations for signal relay 4, Meaning: ”Failure in measured quantities or check−back indications”

FNo	Abbreviation	Description
1	not allocated	Binary output is not allocated to any annunciation function
3	>Time Synchro	Synchronize internal real time clock
4	>Start FltRec	Start fault recording from external command via binary input
5	>LED reset	Reset LED indicators
7	>ParamSelec.1	Parameter set selection 1
11	>Annunc. 1	User definable annunciation 1
12	>Annunc. 2	User definable annunciation 2
13	>Annunc. 3	User definable annunciation 3
14	>Annunc. 4	User definable annunciation 4
15	>Sys-Test	System interface messages/values are marked with ”Test operation”
16	>Sys-MM-block	System interface messages and measured values are blocked
51	Dev.Operative	Device is operative
52	Prot.active	At least one protection function is active
60	LED reset	Stored annunciations are reset
95	Param.running	Parameters are being set
96	Param. Set A	Parameter Set A is activated
97	Param. Set B	Parameter Set B is activated
141	Failure 24V	Failure 24 V internal dc supply
143	Failure 15V	Failure 15 V internal dc supply
145	Failure 0V	Failure 0 V A/D converter
151	Failure I/O 1	Failure in first input/output module
161	I supervision	General failure detected by current supervision
162	Failure ΣI	Failure supervision ΣI (measured currents)
163	Failure Isymm	Failure supervision symmetry I
164	U supervision	General failure detected by voltage supervision
166	Failure ΣUp-p	Failure supervision ΣU phase–phase
167	Failure Usymm	Failure supervision symmetry U
171	Fail.PhaseSeq	Failure supervision phase sequence, general
173	Fail.ΣI (IEE)	Failure superv. ΣI (phase currents with sensitive earth current input)
175	Fail.PhSeq I	Failure supervision phase sequence of currents
176	Fail.PhSeq V	Failure supervision phase sequence of voltages
177	Fail.Battery	Failure internal back–up battery
280	IL1 exceeded	Limit value I_{L1} exceeded
281	IL2 exceeded	Limit value I_{L2} exceeded
282	IL3 exceeded	Limit value I_{L3} exceeded
283	IE exceeded	Limit value I_E exceeded
284	IL< alarm	Phase current smaller than operational limit
285	cosϕ alarm	Power factor smaller than operational limit
287	Pr exceeded	Limit value reactive power P_r exceeded
288	Pa exceeded	Limit value active power P_a exceeded
356	>Manual Close	Circuit breaker is 3–pole closed (from CB auxiliary contact)
358	>Manual Trip	Circuit breaker is manually closed (from discrepancy switch)
383	>RAR Release	Release RAR stages from external (e.g. external AR device)
391	>Buchh. Warn	Warning stage from Buchholz protection
392	>Buchh. Trip	Tripping stage from Buchholz protection
501	Device FltDet	General fault detection of the device
510	Device Close	General close command of the device
511	Device Trip	General trip command of the device
519	Protect. Trip	Trip of any protection function
561	Manual Close	Manual close indication of circuit breaker
563	CB Alarm Supp	Circuit breaker operation alarm suppressed
1106	>Start FltLoc	Start fault locator by external command via binary input
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
1201	>UE block	Block U_E–stage of earth fault detection
1202	>IEE>> block	Block I_{EE}>> stage of high–sensitivity E/F protection

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

FNo	Abbreviation	Description
1203	>IEE> block	Block I_{EE}> stage of high−sensitivity E/F protection
1204	>IEEp block	Block I_{EEp} stage (inverse time) of high−sensitivity E/F protection
1205	>E/F Det. on	Switch on earth fault detection for non−earthed system
1206	>E/F Det. off	Switch off earth fault detection for non−earthed system
1207	>E/F Det.bloc	Block earth fault detection for non−earthed system
1208	>E/F annunc.	Earth fault detection only annunciations, no trip
1211	E/F Det. off	Earth fault detection for non−earthed system is switched off
1212	E/F Det.activ	Earth fault detection for non−earthed system is active
1215	UE Fault	Earth fault detected by displacement voltage
1217	UE Trip	Earth fault detection trip
1221	IEE>> Fault	Earth fault detected by highly sensitive protection stage I_{EE}>>
1223	IEE>> Trip	Trip by highly sensitive earth stage I_{EE}>>
1224	IEE> Fault	Earth fault detected by highly sensitive definite time stage I_{EE}>
1226	IEE> Trip	Trip by highly sensitive earth stage I_{EE}> (definite time)
1227	IEEp Fault	Earth fault detected by highly sensitive inverse time stage I_{EEp}
1229	IEEp Trip	Trip by highly sensitive earth stage I_{EEp} (inverse time)
1230	E/F Det.block	Earth fault detection for non−earthed system is blocked
1272	E/F Detec. L1	Earth fault (non−earthed) in phase L1 detected
1273	E/F Detec. L2	Earth fault (non−earthed) in phase L2 detected
1274	E/F Detec. L3	Earth fault (non−earthed) in phase L3 detected
1276	E/F forwards	Earth fault in forward direction detected
1277	E/F reverse	Earth fault in reverse direction detected
1278	E/F undefined	Earth fault direction undefined, not detectable
1401	>B/F on	Switch on breaker failure function
1402	>B/F off	Switch off breaker failure function
1403	>B/F block	Block breaker failure function
1431	>B/F Start	Start breaker failure protection
1451	B/F off	Breaker failure protection is switched off
1452	B/F blocked	Breaker failure protection is blocked
1453	B/F active	Breaker failure protection is active
1456	B/F(int)flt	Breaker failure protection started by internal origin
1457	B/F(ext)flt	Breaker failure protection started by external origin
1458	B/F(man)flt	Breaker failure protection started by manual control
1480	B/F(int)trip	Trip by breaker failure protection due to internal start
1481	B/F(ext)trip	Trip by breaker failure protection due to external start
1482	B/F(man)trip	Trip by breaker failure protection due to manual control
1501	>O/L on	Switch on overload protection
1502	>O/L off	Switch off overload protection
1503	>O/L block	Block overload protection
1504	>O/L alarm	Overload protection: alarm only, no trip
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
1517	O/L pickup Θ	Thermal overload protection fault detection of trip stage
1521	O/L Trip	Thermal overload protection trip by thermal trip stage
1701	>O/C Ph on	Switch on overcurrent protection phases
1702	>O/C Ph off	Switch off overcurrent protection phases
1704	>O/C Ph block	Block overcurrent protection phases
1711	>O/C E on	Switch on overcurrent protection earth
1712	>O/C E off	Switch off overcurrent protection earth
1714	>O/C E block	Block overcurrent protection earth
1721	>I>> block	Block I>> stage of overcurrent protection phases
1722	>I> block	Block I> stage (definite time) of overcurrent protection phases
1723	>Ip block	Block I_p stage (inverse time) of overcurrent protection phases
1724	>IE>> block	Block I_E>> stage of overcurrent protection earth
1725	>IE> block	Block I_E> stage (definite time) of overcurrent protection earth

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

FNo	Abbreviation	Description
1726	>IEp block	Block I_{Ep} stage (inverse time) of overcurrent protection earth
1751	O/C Ph off	Phase overcurrent time protection is switched off
1752	O/C Ph block	Phase overcurrent time protection is blocked
1753	O/C Ph active	Phase overcurrent time protection is active
1756	O/C E off	Earth overcurrent time protection is switched off
1757	O/C E block	Earth overcurrent time protection is blocked
1758	O/C E active	Earth overcurrent time protection is active
1761	O/C Gen.Fault	Overcurrent protection general fault detection
1762	O/C Fault L1	Overcurrent protection fault detection phase L1
1763	O/C Fault L2	Overcurrent protection fault detection phase L2
1764	O/C Fault L3	Overcurrent protection fault detection phase L3
1765	O/C Fault E	Overcurrent protection earth fault detection
1791	O/C Gen.Trip	Overcurrent time protection general trip command
1800	I>> Fault	Phase overcurrent time protection fault detected by I>> stage
1805	I>> Trip	Phase overcurrent time protection trip by I>> stage
1810	I> Fault	Phase overcurrent time protection fault I> stage (definite time)
1815	I> Trip	Phase overcurrent time protection trip by I> stage
1820	Ip Fault	Phase overcurrent time protection fault I_p stage (inverse time)
1825	Ip Trip	Phase overcurrent time protection trip by I_p stage
1831	IE>> Fault	Earth overcurrent time protection fault detected by I_E>> stage
1833	IE>> Trip	Earth overcurrent time protection trip by I_E>> stage
1834	IE> Fault	Earth overcurrent time protection fault I_E> stage (definite time)
1836	IE> Trip	Earth overcurrent time protection trip by I_E> stage
1837	IEp Fault	Earth overcurrent time protection fault I_{Ep} stage (inverse time)
1839	IEp Trip	Earth overcurrent time protection trip by I_{Ep} stage
2601	>dirO/C P on	Switch on directional overcurrent time protection for phase currents
2602	>dirO/C P off	Switch off directional overcurrent time protection for phase currents
2604	>dirO/C P blk	Block directional overcurrent time protection for phase currents
2611	>dirO/C E on	Switch on directional overcurrent time protection for earth currents
2612	>dirO/C E off	Switch off directional overcurrent time protection for earth currents
2614	>dirO/C E blk	Block directional overcurrent time protection for earth currents
2615	>I>>Block dir	Block directional I>> stage of phase O/C protection
2616	>IE>>Bloc dir	Block directional I_E>>stage of earth O/C protection
2621	>I> Block dir	Block directional I> stage (definite time) of phase O/C protection
2622	>Ip Block dir	Block directional I_p stage (inverse time) of phase O/C protection
2623	>IE>Block dir	Block directional I_E>stage (definite time) of earth O/C protection
2624	>IEpBlock dir	Block directional I_{Ep} stage (inverse time) of earth O/C protection
2625	>Blk fw fail.	Blocking signal for forward direction disturbed
2626	>Blk rw fail.	Blocking signal for reverse direction disturbed
2628	FltI>/IpL1 fw	Directional overcurrent time protection: Fault I>/Ip L1 forwards
2629	FltI>/IpL2 fw	Directional overcurrent time protection: Fault I>/Ip L2 forwards
2630	FltI>/IpL3 fw	Directional overcurrent time protection: Fault I>/Ip L3 forwards
2632	FltI>/IpL1 rw	Directional overcurrent time protection: Fault I>/Ip L1 reward
2633	FltI>/IpL2 rw	Directional overcurrent time protection: Fault I>/Ip L2 reward
2634	FltI>/IpL3 rw	Directional overcurrent time protection: Fault I>/Ip L3 reward
2635	FltIE>/IEp fw	Directional overcurrent time protection: Fault I_E>/I_{Ep} forwards
2636	FltIE>/IEp rw	Directional overcurrent time protection: Fault I_E>/I_{Ep} reward
2642	I>> dir.Fault	Directional overcurrent time protection fault detection by I>> stage
2646	IE>>dir.Fault	Directional overcurrent time protection fault detection by I_E>> stage
2649	I>> dir. Trip	Directional overcurrent time protection trip by I>> stage
2651	dir.O/C P off	Directional phase overcurrent time protection is switched off
2652	dir.O/C P blk	Directional phase overcurrent time protection is blocked
2653	dir.O/C P act	Directional phase overcurrent time protection is active
2656	dir.O/C E off	Directional earth overcurrent time protection is switched off
2657	dir.O/C E blk	Directional earth overcurrent time protection is blocked
2658	dir.O/C E act	Directional earth overcurrent time protection is active
2660	I> dir.Fault	Directional overcurrent time protection fault I> stage (definite time)
2665	I> dir. Trip	Directional overcurrent time protection trip by I> stage (def. time)

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

FNo	Abbreviation	Description
2666	Blk fw failed	Blocking signal for forward direction disturbed
2667	Blk rw failed	Blocking signal for reverse direction disturbed
2670	Ip dir.Fault	Directional overcurrent protection fault Ip stage (inverse time)
2675	Ip dir. Trip	Directional overcurrent protection trip by Ip stage (inverse time)
2679	IE>>dir. Trip	Directional overcurrent protection trip by I_E>> stage
2681	IE> dir.Fault	Directional overcurrent protection fault I_E> stage (definite time)
2683	IE> dir. Trip	Directional overcurrent protection trip by I_E> stage (definite time)
2684	IEp dir.Fault	Directional overcurrent protection fault I_{Ep} stage (inverse time)
2686	IEp dir. Trip	Directional overcurrent protection trip by I_{Ep} stage (inverse time)
2691	dir.OC GenFlt	Directional overcurrent protection general fault detection
2692	dir. Fault L1	Directional overcurrent protection fault detection phase L1
2693	dir. Fault L2	Directional overcurrent protection fault detection phase L2
2694	dir. Fault L3	Directional overcurrent protection fault detection phase L3
2695	dir. Fault E	Directional overcurrent protection earth fault detection
2696	dirOC GenTrip	Directional overcurrent time protection general trip command
2701	>AR on	Switch on internal auto–reclose function
2702	>AR off	Switch off internal auto–reclose function
2703	>AR block	Block internal auto–reclose function statically
2704	>AR reset	Reset internal auto–reclose function
2709	>DAR block	Block complete delayed auto–reclose (DAR, further shots)
2711	>Start AR	External start for internal auto–reclose function
2715	>Trip E Fail.	Trip signal earth fault from external protection for auto–reclosure
2716	>Trip Ph Fail	Trip signal phase fault from external protection for auto–reclosure
2730	>CB ready	Circuit breaker ready for AR cycle
2781	AR off	Internal auto–reclose function is switched off
2782	AR on	Internal auto–reclose function is switched on
2783	AR inoperativ	Internal auto–reclose function is not operative
2784	AR not ready	Internal auto–reclose function is not ready for reclose
2785	AR block.dyn.	Internal auto–reclose function is blocked dynamically
2787	CB not ready	Circuit breaker not ready for a trip/reclose cycle
2788	AR T–CB Exp.	Circuit breaker supervision time expired
2801	AR in prog.	Auto–reclose cycle is in progress
2812	RAR T–act.run	Auto–reclose function action time for RAR is running
2813	RAR T–E run.	Auto–reclose function single–phase fault dead time RAR is running
2814	RAR T–Ph run.	Auto–reclose function multi–phase fault dead time RAR is running
2817	RAR Zone Rel.	Internal AR function is ready to permit trip in RAR stage
2832	DAR T–act run	Auto–reclose function action time for DAR is running
2833	DAR T–E run	Auto–reclose function single–phase fault dead time DAR is running
2834	DAR T–Ph run	Auto–reclose function multi–phase fault dead time DAR is running
2837	DAR Zone Rel.	internal AR function is ready to permit trip in DAR stage
2851	AR Close Cmd.	Reclose command by internal auto–reclose function
2853	RAR Close	Reclose command after 3–pole RAR (rapid AR)
2854	DAR Close	Reclose command after 3–pole DAR (delayed AR)
2861	AR T–Recl.run	Auto–reclose function reclaim time is running
2862	AR successful	Auto–reclosure was successful
2863	Definit.Trip	Definitive (final) trip
4601	>CBP Q0 cld	Position feedback signal circuit breaker: Q0 closed
4602	>CBP Q0 opd	Position feedback signal circuit breaker: Q0 opened
4603	>DCP Q1 cld	Position feedback signal bus–bar disconnector: Q1 closed
4604	>DCP Q1 opd	Position feedback signal bus–bar disconnector: Q1 opened
4605	>DCP Q01 cld	Position feedback signal load disconnector: Q01 closed
4606	>DCP Q01 opd	Position feedback signal load disconnector: Q01 opened
4607	>DCP Q5 cld	Position feedback signal operation earthing switch: Q5 closed
4608	>DCP Q5 opd	Position feedback signal operation earthing switch: Q5 opened
4609	>DCP Q6 cld	Position feedback signal measuring earthing switch: Q6 closed
4610	>DCP Q6 opd	Position feedback signal measuring earthing switch: Q6 opened
4611	>DCP Q8 cld	Position feedback signal feeder earthing switch: Q8 closed
4612	>DCP Q8 opd	Position feedback signal feeder earthing switch: Q8 opened

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

FNo	Abbreviation	Description
4613	>DCP Q10 cld	Position feedback signal coupling disconnector: Q10 closed
4614	>DCP Q10 opd	Position feedback signal coupling disconnector: Q10 opened
4615	>DCP Q15 cld	Position feedback signal bus−bar earthing switch: Q15 closed
4616	>DCP Q15 opd	Position feedback signal bus−bar earthing switch: Q15 opened
4617	>DCP Q16 cld	Position feedback signal bus−bar earthing switch: Q16 closed
4618	>DCP Q16 opd	Position feedback signal bus−bar earthing switch: Q16 opened
4619	>DCP Q2 cld	Position feedback signal bus−bar disconnector: Q2 closed
4620	>DCP Q2 opd	Position feedback signal bus−bar disconnector: Q2 opened
4631	>SW.auth.rem	Switching authorization: remote
4632	>SW.auth.bloc.	Switching authorization: blocked
4640	Con. Q0 Close	Circuit breaker Q0 closed by the control
4641	Con. Q0 Trip	Circuit breaker Q0 tripped by the control
4670	abort:sw.auth	Aborted due to missing switching authority
4671	abort:flt.det	Aborted due to fault detection
4672	abort:cw	Aborted due to incorrect code word
4673	abort:entime	Aborted due to expired entry time
4674	abort: set=is	Aborted because required state is actual state
4675	abort:cmd ex.	Aborted because command is being executed
4676	abort:BI dbl	Aborted because of double command via binary input
4677	abort:test	Aborted because test operation is being executed
4682	CR time exp	Command response time expired
4683	sw.auth.loc	Switching authorization: remote
4684	sw.auth.rem	Switching authorization: blocked
4689	err:CB/DC pos	Position feedback signal undefined, general
4690	err:CB pos Q0	Position feedback signal for breaker Q0 undefined
4691	err:DC pos Q1	Position feedback signal for disconnector Q1 undefined
4692	err:DC posQ01	Position feedback signal for disconnector Q01 undefined
4693	err:DC pos Q5	Position feedback signal for disconnector Q5 undefined
4694	err:DC pos Q6	Position feedback signal for disconnector Q6 undefined
4695	err:DC pos Q8	Position feedback signal for disconnector Q8 undefined
4696	err:DC posQ10	Position feedback signal for disconnector Q10 undefined
4697	err:DC posQ15	Position feedback signal for disconnector Q15 undefined
4698	err:DC posQ16	Position feedback signal for disconnector Q16 undefined
4699	err:DC posQ2	Position feedback signal for disconnector Q2 undefined
4801	>MCB trip	Mechanic circuit breaker trip
4802	>SF6 pres fd	SF6 pressure alarm (feeder)
4803	>SF6 pres bb	SF6 pressure alarm (bus−bar)
4804	>HV fuse bl	HV fuse blown
4805	>LV plug rem	LV plug removed
4807	>tempalarm	Temperature alarm
4808	>temptrip	Temperature trip
4820	>MSP on	Switch on motor start protection
4821	>MSP off	Switch off motor start protection
4822	>MSP block	Block motor start protection
4823	MSP emerg st	Motor start protection emergency start
4824	MSP off	Motor start protection is switched off
4825	MSP blocked	Motor start protection is blocked
4826	MSP active	Motor start protection is active
4827	MSP Trip	Trip by motor start protection
5140	>I2 on	Switch on negative sequence protection
5141	>I2 off	Switch off negative sequence protection
5143	>I2 block	Block negative sequence protection
5144	>negative seq	Reversed phase rotation
5151	I2 off	Negative sequence protection is switched off
5152	I2 blocked	Negative sequence protection is blocked

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

FNo	Abbreviation	Description
5153	I2 active	Negative sequence protection is active
5159	I2>> Fault	Negative sequence protection fault detection I_2>> stage
5165	I2> Fault	Negative sequence protection fault detection I_2> stage
5170	I2> Trip	Trip by negative sequence protection
6501	>u/v on	Switch on undervoltage protection
6502	>u/v off	Switch off undervoltage protection
6503	>u/v block	Block undervoltage protection completely
6504	>u/v annunc	Undervoltage protection: annunciations only, no trip
6506	>U< block	Block undervoltage protection stage U<
6507	>U<< s crit	Undervoltage protection start-up criterion
6508	>U<< block	Block undervoltage protection stage U<<
6509	>vt fail feed	VT failure (m.c.b. trip) feeder
6510	>vt fail bb	VT failure (m.c.b. trip) bus-bar
6511	>o/v on	Switch on overvoltage protection
6512	>o/v off	Switch off overvoltage protection
6513	>o/v block	Block overvoltage protection
6514	>o/v annunc.	Overvoltage protection: annunciations only, no trip
6530	u/v off	Undervoltage protection is switched off
6531	u/v blocked	Undervoltage protection is blocked
6532	u/v active	Undervoltage protection is active
6533	U< Fault	Undervoltage protection fault detection U< stage
6534	U< cc Fault	Undervoltage protection fault detection U< and current criterion
6535	U< sc Fault	Undervoltage protection fault detection U< and start-up criterion
6536	U< cc sc Flt	Undervoltage prot. fault detec. U< and current and start-up criterion
6537	U<< Fault	Undervoltage protection fault detection U<< stage
6538	U<< cc Fault	Undervoltage protection fault detection U<< and current criterion
6539	U< Trip	Undervoltage protection trip by U< stage
6540	U<< Trip	Undervoltage protection trip by U<< stage
6565	o/v off	Overvoltage protection is switched off
6566	o/v blk	Overvoltage protection is blocked
6567	o/v active	Overvoltage protection is active
6568	U> Fault	Overvoltage protection fault detection U>
6569	U> cc Flt	Overvoltage protection fault detection U> and current criterion
6570	U> Trip	Overvoltage protection trip by U>
6801	>STRT-SUP blk	Block starting time supervision
6803	>STRT-SUP on	Switch on starting time supervision
6804	>STRT-SUP off	Switch off starting time supervision
6805	>Rotor locked	Rotor locked via binary input
6811	STRT-SUP off	Starting time supervision is switched off
6812	STRT-SUP blk	Starting time supervision is blocked
6813	STRT-SUP act	Starting time supervision is active
6821	STRT-SUP trip	Trip by supervision of starting time
6822	Rotor locked	Rotor is locked
6823	STRT-SUP pu	Starting supervision picked up
6852	>SUP trip rel	Trip circuit supervision: Trip relay
6853	>SUP CB aux.	Trip circuit supervision: CB aux.
6861	SUP off	Trip circuit supervision is switched off
6864	SUP MarshFail	Trip circuit supervision is blocked: Binary input not marshalled
6865	Failure TC	Trip circuit is interrupted

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	RELAY 1	Device FltDet	501	General fault detection of device
6202	RELAY 2	Protect. Trip	519	General trip of protection
6203	RELAY 3	abort:sw.auth abort:flt.det abort:cw abort:entime abort:set=is abort:cmd ex. abort:BI dbl abort:test	4670 4671 4672 4673 4674 4675 4676 4677	Group indication that a command has been aborted
6204	RELAY 4	Failure ΣI Failure ΣUp-p Failure Isymm Failure Usymm Fail.PhSeq I Fail.PhSeq U Fail.Battery err:CB/DC pos	162 166 163 167 175 176 177 4689	Group annunciation of all disturbances in measured quantities and errors in check–back indication

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 with the **MENU**−key → OPERATION MENU 1 → paging with ⩢ to OPERATION MENU 2 → 1: MARSHALLING → 3: MARSHALLING LED INDICATORS, as described in Section 5.5.1. The selection procedure is carried out as described in Section 5.5.1. Multiple annunciations are possible, i.e. one logical annunciation function can be given to several LEDs (see also Section 5.5.1).

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

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

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

.0 unstored indication (not memorized) corresponds to "`nm`" as above,
.1 stored indication (memorized) corresponds to "`m`" as above.

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

The assignment of the LEDs as preset by the factory is shown in the front of the unit (Figure 6.1). The following boxes show, as an example, the assignment for LED 5. Table 5.5 shows all LED indicators as they are preset from the factory.

R ▽

```
6300 MARSHALLING
     LED INDICATORS
```

Beginning of the block "Marshalling of the LED indicators"

The desired LED is reached with the cursor keys ▽△:

F△

```
6305■LED 5
```

Allocations for LED 5,
Meaning: "Failure in measured quantities"

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

△ ▽

```
001 LED 5
    Failure ΣI m

002 Failure ΣUp-p m

003 Failure Isymm m
004 Failure Usymm m
005 Fail.PhSeq I m
006 Fail.PhSeq V m
007 Fail.Battery m
008 not allocated
009 not allocated
 :    :      :
020 not allocated
```

Presettings for LED 5

1st: Failure detected by current sum monitor

2nd: Failure detected by voltage sum monitor (phase−phase)

3rd: Failure detected by current symmetry monitor

4th: Failure detected by voltage symmetry monitor

5th: wrong phase sequence in current path

6th: wrong phase sequence in voltage path

7th: failure of internal back−up battery

8th, etc.: no further annunciation functions allocate to LED 5

The complete presettings for LED indicators are listed in Table 5.5.

Addr	LED	Abbreviation	FNo	Remarks
6301	LED 1	Device FltDet m	501	General fault detection of the device
6302	LED 2	O/C Fault E m	1765	Earth fault detection by overcurrent time protection
6303	LED 3	Protec. Trip m	519	General Trip by any protection function
6304	LED 4	sw.auth.loc nm	4683	Switching authorization local
6305	LED 5 LED 5 LED 5 LED 5 LED 5 LED 5 LED 5	Failure ΣI m Failure ΣUphp m Failure Isymm m Failure Usymm m Fail.PhSeq I m Fail.PhSeq U m Fail. Battery m	162 166 163 167 175 176 177	Group annunciation of failures and errors
6306	LED 6	err:CB/DC pos m	4689	check–back indication faulty

Table 5.5 Preset LED indicators

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

The unit contains 2 or 4 trip relays (depending on model) which are designated TRIP RELAY 1 and TRIP RELAY 2 or TRIP RELAY 1 to TRIP RELAY 4. Each trip relay can be controlled by up to 20 logical commands. The trip relays can be marshalled in the address block 64. The block is reached with the **MENU**–key → OPERATION MENU 1 → paging with ⩔ to OPERATION MENU 2 → 1: MARSHALLING → 4: MARSHALLING COMMAND RELAYS, 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).

Principally, most of the annunciation functions in accordance with Table 5.3 can be marshalled to output trip relays. But those listed in Table 5.7 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 (de–configured).

The assignment of the trip relays as delivered from factory is shown in the general diagrams in Appendix A. The following boxes show an example for marshalling of trip relays 1. Table 5.6 shows all trip relays as preset from the factory.

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

```
R  ║ 6400 MARSHALLING
▽  ║     TRIP RELAYS
```

Beginning of the block ”Marshalling of the trip relays”

Move the cursor to the desired trip relay using the keys △ and ▽, e.g. trip relay 1:

```
F△ ║ 6401 ■TRIP
   ║      RELAY 1
```

Allocations for trip relay 1

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

```
▽  ║ 001 TRIP REL. 1
   ║     Device Trip
```

Trip relay 1 has been preset for:
General trip of device, FNo 511;

```
   ║ 002 TRIP REL. 1
△  ║     not allocated
▽  ║
```

no further functions are preset for trip relay 1

etc.

Leave the selection level with key combination **F** △. You can go then to the next trip relay with the arrow key ▽ or leave marshalling with the keys **R** (return to previous level) or **MENU** (main menu).

Addr	1st display line	2nd display line	FNo	Remarks
6400	MARSHALLING	COMMAND RELAYS		Heading of the address block
6401	TRIP TRIP REL. 1	TRIP REL. 1 Device Trip	511	General **trip** command of device
6402	TRIP TRIP REL. 2	TRIP REL. 2 Device Close	510	General **close** command of the device
6403	TRIP TRIP REL. 3	TRIP REL. 3 not allacated	1	Command relay 3 and 4 only for model 7SJ531★−★★★★**2**; no presetting are accomplished
6404	TRIP TRIP REL. 4	TRIP REL. not allocated	1	

Table 5.6 Preset command functions for trip relays

FNo	Abbreviation	Description
1	not allocated	no function allocated
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
391	>Buchh. Warn	Warning stage from Buchholz protection
392	>Buchh. Trip	Tripping stage from Buchholz protection
501	Device FltDet	General fault detection of the device
510	Device Close	General close command of the device
511	Device Trip	General trip command of the device
519	Protect. Trip	Trip of any protection function
561	Manual Close	Manual close indication of circuit breaker
1181	CB Test Trip	Trip by internal circuit breaker test function
1217	UE Trip	Earth fault detection trip
1226	IEE> Trip	Trip by highly sensitive earth stage $I_{EE}>$ (definite time)
1229	IEEP Trip	Trip by highly sensitive earth stage I_{EEp} (inverse time)
1480	B/F(int)trip	Trip by breaker failure protection due to internal start
1481	B/F(ext)trip	Trip by breaker failure protection due to external start
1482	B/F(man)trip	Trip by breaker failure protection due to manual control
1521	O/L Trip	Thermal overload protection trip by thermal trip stage
1761	O/C Gen.Fault	Overcurrent time protection general fault detection
1791	O/C Gen.Trip	Overcurrent time protection general trip command
1805	I>> Trip	Phase overcurrent time protection trip by I>> stage
1815	I> Trip	Phase overcurrent time protection trip by I> stage (definite time)
1825	Ip Trip	Phase overcurrent time protection trip by I_p stage (inverse time)
1833	IE>> Trip	Earth overcurrent time protection trip by $I_E>>$ stage
1836	IE> Trip	Earth overcurrent time protection trip by $I_E>$ stage (definite time)
1839	IEp Trip	Earth overcurrent time protection trip by I_{Ep} stage (inverse time)
2649	I>> dir. Trip	Directional overcurrent time protection trip by I>> stage
2665	I> dir. Trip	Directional overcurrent time protection trip by I> stage (def. time)
2675	Ip dir. Trip	Directional overcurrent protection trip by Ip stage (inverse time)
2679	IE>>dir. Trip	Directional overcurrent protection trip by $I_E>>$ stage
2683	IE> dir. Trip	Directional overcurrent protection trip by $I_E>$ stage (definite time)
2686	IEp dir. Trip	Directional overcurrent protection trip by I_{Ep} stage (inverse time)
2691	dir.OC GenFlt	Directional overcurrent protection general fault detection
2696	dirOC GenTrip	Directional overcurrent time protection general trip command
2851	AR Close Cmd.	Reclose command by internal auto−reclose function
2853	RAR Close	Reclose command after 3−pole RAR (rapid AR)
2854	DAR Close	Reclose command after 3−pole DAR (delayed AR)
4640	Con Q0 Close	Circuit breaker Q0 closed by the control
4641	Con Q0 Trip	Circuit breaker Q0 tripped by the control
6539	U< trip	Undervoltage protection trip by U< stage
6540	U<< trip	Undervoltage protection trip by U<< stage
6570	U> trip	Overvoltage protection trip by U>

Table 5.7 Command functions

5.5.6 Marshalling of the LCD indications − address block 67

The procedure for marshalling the indication of operational measured values and spontaneous fault annunciations in the display is equivalent to the marshalling of the relays, LEDs or binary inputs, in address block 67. This block is addressed with the **MENU**−key through OPERATION MENU (page 2) → **1**: MARSHALLING → **5**: MARSHALLING LCD−ANNOUNCEMENT, as described under Section 5.5.1. By means of the cursor at first the selected address is activated − as usual.

5.5.6.1 General view of operational measured values

Operation of the keys **F** and △ shows in the display instead of the address number and the headline the first of the 10 marshallable measured values (see right hand side in Figure 5.13). With △ all 10 measured values can be shown in the display one after the other.

After code word entry for code level 3, all options can be shown in the display using the ”No”−key **N**; thus a maximum of 10 measured values can be selected out of all the measured values as per Section 6.4.7. The selected option is confirmed with the entry key **E**. The numbers in front (001 to 010) mark the sequence in which the operations measured values are indicated in the display ”GENERAL VIEW MEASURED VALUES” (in basic diagram 2). Return to the address number with the key combination F and △.

```
6700 MARSHALLING
     LCD−ANNOUNCEMENT
6701■MARSHALLING
     SPONT. VALUES
6702 MARSHALLING
     SPONT. MESSAGES
```

F, △

```
6700 MARSHALLING
     LCD−ANNOUNCEMENT
001 VALUES
    IL1     =
6702 MARSHALLING
     SPONT. MESSAGES
```

Figure 5.13 Marshalling of the LCD announcements (measured values and spontaneous fault annunciations)

The example on the right hand side shows the general view of the operations measured values which can be called up in accordance with the pre−set marshalling. It can be called up after operating the reset key (selection of basic diagram 1) and then by operating the ⩢ key.

```
GENERAL VIEW
 ⩡ MEASURED VALUES
IL1      = 0  A
IL2      = 0  A
IL3      = 0  A
IEa      = 0  A
UL1E     = 0  kV
UL2E     = 0  kV
UL3E     = 0  kV
Pa       = 0.0  MW
Pr       = 0.0  MVAR
f  [Hz]  = ****
```

5.5.6.2 Spontaneous fault messages

Under address 6702 fault messages are selected, which shall appear spontaneously in the display at the front plate of the relay after a fault in the network. A maximum of six messages can be selected. Operation of the keys **F** and △ shows in the display instead of the address number and the headline the first of the 6 marshallable messages. With △ all 6 messages can be shown in the display one after the other. The numbers in front (001 to 006) mark the sequence in which the messages are indicated in the display "SPONTANEOUS PLANT ANNUNCIAT". After code word entry for code level 3 the possible messages can be shown in the display by repeated operation of the "No"−key **N**; the selected message is confirmed by the entry key **E**.

```
6702 MARSHALLING
     SPONT. MESSAGES
```

The following messages are displayed after a fault

```
001 MESSAGES
    Fault Type
```

the fault type, i.e. the concerned phases with overcurrent time protection,

```
002 MESSAGES
    Trip Type
```

the trip type i.e. the stage which has tripped,

```
003 MESSAGES
    Prot.Pick-up
```

the protection function which has picked up,

```
004 MESSAGES
    Prot.Trip
```

the protection function which has tripped,

```
005 MESSAGES
    T-Drop
```

the elapsed time from pick−up until drop−off,

```
006 MESSAGES
    T-Trip
```

the elapsed time from pick−up until trip command.

During operation, the spontaneous messages will be shown instead of basic diagram 1 or 2 in case of a fault. The spontaneous messages can be acknowledged by the RESET−key. After acknowledgement, the stationary indication (basic diagram 1) or the general view of operations measured values (basic diagram 2) are again displayed.

```
SPONTANEOUS
 ≙ PLANT ANNUNCIAT.
IE> Fault
IE> Trip
O/C Gen.Fault
O/C Gen.Trip
T-Drop 2032 ms
T-Trip 2003 ms
```

Example of spontaneous fault annunciations

6 Operating instructions

6.1 Safety precautions

⚠ Warning

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

⚠ Caution!

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

6.2 Dialog with the relay

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

6.2.1 Membrane keyboard and display panel

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

For the display a liquid crystal graphical display is provided, size 77 mm x 66 mm (128 x 112 pixel). In the text mode, the character size, which can be displayed, is 8 x 6 pixel. Thus a maximum of 21 characters per line and a maximum of 14 lines can be shown.

During normal operation condition, the display shows the feeder mimic diagram of the switchgear bay and a bar diagram for the largest phase current (basic diagram 1). During parameterization the display shows for the dialog four−digit numbers followed by a short text explaining the parameter's meaning. The number indicates the **setting address**. The first two digits define the operation **block**, followed by a two−digit **sequence number**. For relays with selectable parameter sets, the indicating letter for the parameter set leads the setting address.

The keyboard comprises 29 keys with numbers, Yes/No and control buttons. The significance of the keys is explained in detail in the following.

Numerical keys for the input of numerals:

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

Yes/No keys for text parameters:

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

Keys for scrolling in the display:

△	Moving the cursor upwards, line by line: selection of the previous item or scrolling down the displayed message (the bottom line disappears, a new top line appears)
▽	Moving the cursor downwards, line by line: selection of the next item or scrolling up the displayed message (the top line disappears, a new bottom line appears)

Keys for paging in the display:

⏶⏶	Paging backwards within a menu level or to the previous (older) annunciations
⏷⏷	Paging forwards within a menu level or to the next (youngest) annunciations

Confirmation key:

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

Control and special keys:

CW	Codeword: prevents unauthorized access to setting programs
R	Backspace key with following functions: – going back in the menu structure, – going back in the lists of text parameters, – backspace erasure of erroneous entries
F	Function key; explained when used
DA	Direct addressing; you can reach the direct addressing mode with ⩯ and leave this mode with the MENU key
MENU	Call–up of the main menu

The four keys which are situated next to the main keyboard signify the following:

I	Control: breaker CLOSE
O	Control: breaker TRIP
✓	Control release
	Reset: erasure and acknowledgement of stored LED indicators, fault annunciations, and return to the basic display 1

6.2.2 Operation with a personal computer

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

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

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

6.2.3 Operational preconditions

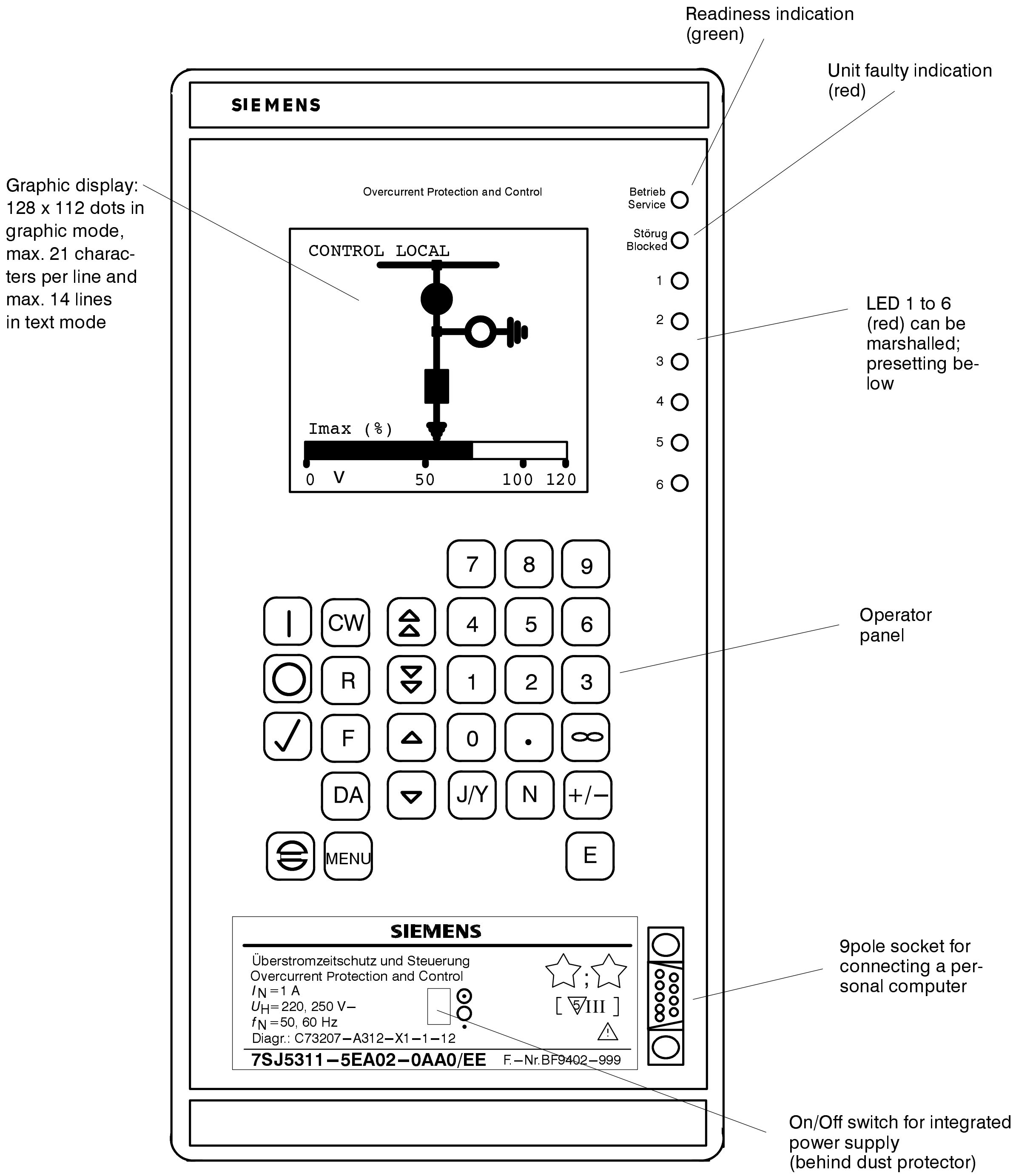
For most operational functions, the input of a codeword is necessary. This applies for all entries via the membrane keyboard or front interface which concern the operation on the relay.

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

In the 7SJ531, up to four different code words can be defined to establish different operating levels. For parameterization code level 2 is required.

The preparation instructions under Section 5.3 describe in detail the entry of the codeword, adaptation of the operation interface to local conditions (operating language, matching of the system interface, selection of the regular and spontaneous messages in the display).

6.2.4 Representation of the relay (front view)



Factory presetting LEDs:

1 General fault detection of device
2 O/C earth fault detection
3 General trip of protection
4 Switching authorization: local
5 Group annunciation of all disturbances in meas. quantities
6 Check−back indication faulty

Figure 6.1 Front view of operating key board and display panel

6.3 Setting the functional parameters

6.3.1 Introduction

6.3.1.1 Parameterizing procedure

The key **MENU** leads to the operating menu selection. The key ⇊ scrolls to page 2 of the operating menu selection, where under sequential number 1 the parameterization is called up (see Figure 6.2). Entry of the numerical key **1** opens the sub−menu parameterization, and the corresponding picture appears in the display.

Further parameter blocks follow, if the corresponding functions were configured as EXIST. The required parameter block is selected out of the offered options and shown in the display by operating the corresponding numerical key. For example numerical key 2 opens the parameterization level of the overcurrent time protection for phase currents. In case of a definite time overcurrent protection the parameters are shown as in Figure 6.3.

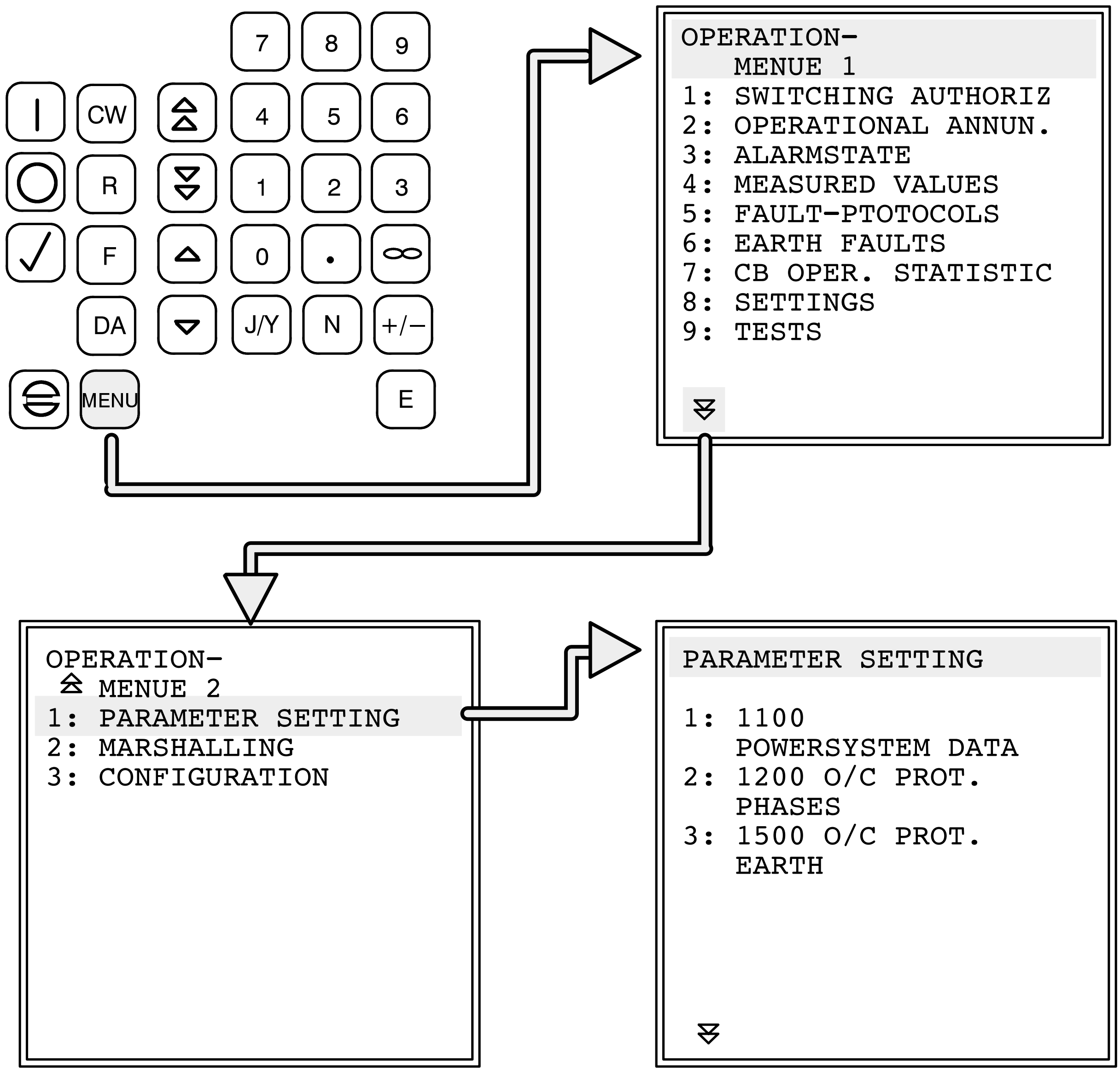


Figure 6.2 Menu selection for parameterizing

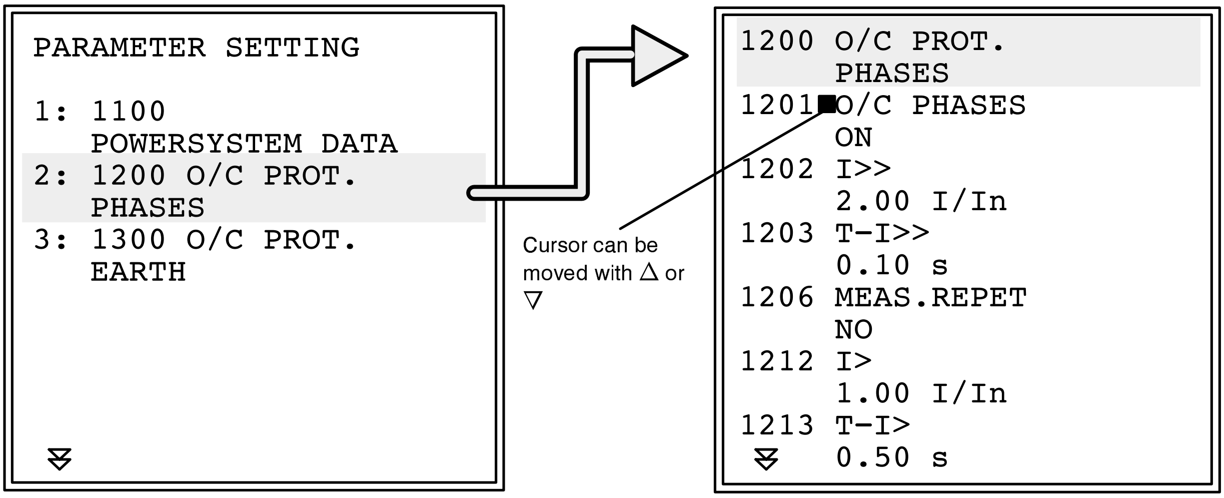


Figure 6.3 Addresses of an address block

For setting the functional parameters it is necessary to enter the codeword with code level 2 (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 and explained. If an address block takes more than one display page, paging on is possible with the key ⇊. The cursor is moved within a page by using the keys ▽ and △. Besides the address which forms the heading of the address block (e.g. **12**00 for block **12**), the following forms of parameters are used:

– Addresses which require numerical input

  The display shows the four–digit address, i.e. block and sequence number (e.g. **1202** for block **12**, sequence number **2**). Behind this appears the meaning of the required parameter, in the second address 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 move the cursor up or down within the block using the scrolling keys △ and ▽ to another parameter or go to the higher menu PARAMETER SETTING with the key **R**. 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 this 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 move the cursor up or down within the block using the scrolling keys △ and ▽ to another parameter or go to the higher menu PARAMETER SETTING with the key **R**. 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 symbols 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.

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 11 to 39) by using the **R**−key or the **MENU**−key after a parameter has been altered, 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 **MENU**, the OPERATION MENU reappears.

6.3.1.2 Selectable parameter sets

Up to 2 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 second set is set B. The parameter addresses (address 1100 to 3900) are then assigned with the leading character A or B. Each of these sets is adjusted one after the other.

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

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

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

All parameter sets can be accessed in a similar manner:

- Key combination **F 1**:
  access to parameter set **A**

- Key combination **F 2**:
  access to parameter set **B**.

Input of the codeword of code level 2 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.

Addr.	Copy from	Copy to
8510	ORIG.SET	SET A
8511	ORIG.SET	SET B
8514	SET A	SET B
8517	SET B	SET A

Table 6.1 Copying parameter sets

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.

This address is reached through the operating menu selection (key **MENU**) and opening of the sub−menu SETTINGS (key **8**). If the parameter change−over under address 7885 is configured as *EXIST*, then the address 8500 PARAMETER CHANGE−OVER appears in level SETTINGS under item 4. Key **4** opens this address, and the headline of the block for configuring the parameter sets appears.

Key ∇ moves the cursor to the individual addresses. For the keys released in this menu and the corresponding actions the same procedure applies which is described under Section 6.3.1.1 for parameterization. The copying options are listed in Table 6.1.

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

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

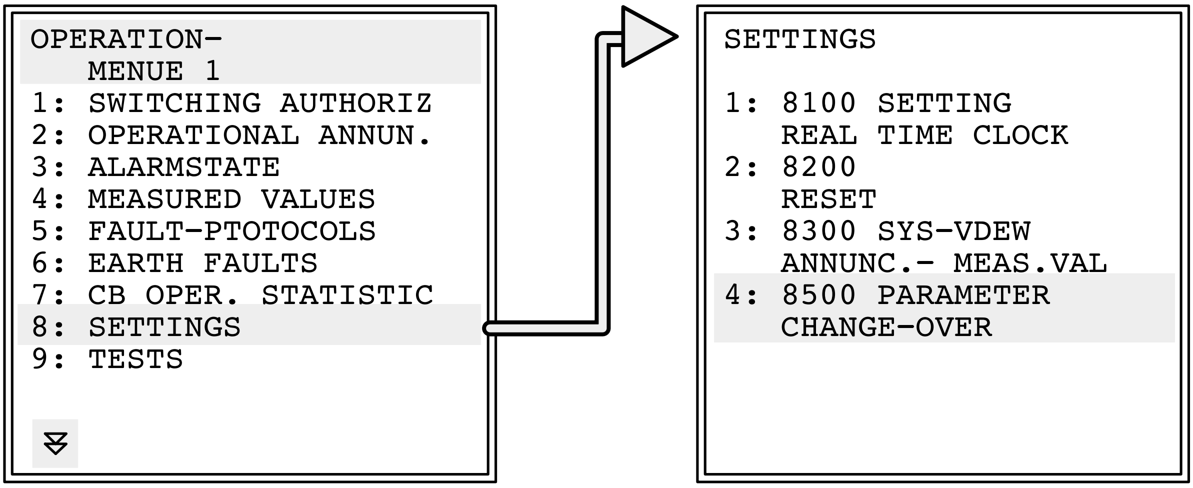


Figure 6.4 Menu selection for parameter change over

6.3.1.3 Setting of date and time

The date and time can be set as long as the real time clock is available. Setting is carried out using block 81 with the keys **MENU** → OPERATION MENU 1 → **8**: SETTINGS → **1**: SETTING REAL TIME CLOCK. Input of the codeword of code level 1 is required to change the data.

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

The date and time are entered with dots as separator sign 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.

R	8100 SETTING REAL TIME CLOCK	Beginning of the block ”Setting the real time clock” Continue with ▽.
▽	8101 ■04.02.1997 10:24:58	At first, the actual date and time are displayed. Continue with ▽.
△ ▽	8102 DATE	Enter the new date: 2 digits for day, 2 digits for month and 4 digits for year (including century); use the order as configured under address 7102 (Section 5.3.2), but always use a dot for separator: **DD.MM.YYYY** or **MM.DD.YYYY**
△ ▽	8103 TIME	Enter the new time: hours, minutes, seconds, each with 2 digits, separated by a dot: **HH.MM.SS**
△	8104 DIFF. TIME	Using the difference time, the clock is set forwards by the entered time, or backwards using the +/− key. The format is the same as with the time setting above.

6.3.2 Initial displays − address block 00

When the relay is switched on, firstly the basic diagram 1 appears (feeder mimic diagram). To look up the address 0 and the type identification of the relay, the double−arrow key ⮅ is used to get the basic diagram 0. All Siemens relays have an MLFB (machine readable type number).

MENU

```
0■7SJ531        V3.**
7SJ531**********
```

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

After pressing the key **MENU** the main menu appears: OPERATION MENU 1. Change with ⮇ to OPERATION MENU 2. Select PARAMETER SETTING with item no. **1** (refer also to Figure 6.2). The functional parameters begin at address 1100. If parameter change−over is used then the addresses are assigned with a leading character which indicates the parameter set (refer also to Section 6.3.1.2). Further address possibilities are listed under ”Annunciations” and ”Tests”.

6.3.3 Power system data − address block 11

6.3.3.1 General data

The relay requests basic data of the power system and the switchgear. The address block 11 is selected with menu item **1** from the menu level PARAMETER SETTING.

R

```
 1100
     POWERSYSTEM DATA
```

Beginning of the block ”Power system data”

▽

```
1101■CT STARPNT 1)
     TOWARDS LINE
```

N

```
     TOWARDS BUSBAR
```

Current transformer polarity [1]):
Line − c.t. star−point towards line
BUSBAR − c.t. star−point towards bus−bar
This setting determines the measurement direction of the relay (forwards = line direction)

Note: Changing the polarity reverses all current inputs including I_E and I_{EE}.

▽

```
 1103■Un PRIMARY
     110.0 kV
```

Voltage transformer primary voltage (line−to−line)
Smallest setting value: **0.2** kV
Largest setting value: **400.0** kV

△ ▽

```
 1104■Un SECOND.
     100 V
```

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

△ ▽

```
1105■In PRIMARY
     400 A
```

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

[1]) only for model 7SJ531★−★★★★2−★★★★

With address 1110 to 1114, the device is instructed as to how the earth current and voltage transformer are connected. This information is important for the treatment of earth faults (in earthed networks), earth leakage (in unearthed networks) and the monitoring of measured values.

If the voltage transformer set has e−n (open−delta) windings, and if these are connected to the device, then this has to be recorded in address 7911 (refer Section 5.4.6). Since the ratio of the voltage transformers is normally

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

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

Two possibilities exist for the earth current path:

– Connection of the earth current from the star point of the current transformers (standard circuit arrangement, see also Appendix B, Figure B.1 or B.2):

  Address 1112 is set as Ie/Iph = 1.000

– Connection of the earth current from a separate earth current detection transformer (e.g. window type current transformer for earth fault detection, see also Appendix B, e.g. Figure B.5).
  Address 1112 is set as

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

Example:

Phase current transformers	500A/5A
Window type summation transformer	300A/5A

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

```
△ 1110 ■Uph/Udelta 1)
▽      1.73
```

Matching factor for residual voltage [1]):

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

normally 1.73

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

```
△ 1112 ■Ie/Iph
▽      1.000
```

Matching factor for earth current:

1 for connection in c.t. starpoint;

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

for connection to separate earth current transformer

Smallest setting value: **0.010**
Largest setting value: **5.000**

An additional earth current input is available for high−sensitivity earth fault detection in models 7SJ531★−★★★★2−0 and −1; connection from a separate earth current transformer (e.g. window type current transformer, see also Appendix B, e.g. Figure B.7).

Address 1114 is set as:

$$Iee/Iph = \frac{\text{(window−type) earth c.t. ratio}}{\text{(phase) c.t. ratio}}$$

Example:

Phase current transformers	300A/5A
Window type summation transformer	60A/1A

$$IEE/Iph = \frac{60/1}{300/5} = 1.000$$

[1]) only for model 7SJ531★−★★★★2−★★★★

△ ▽ 1114 ■IEE/IPH [1]) [2]) 1.000	Matching factor for high−sensitivity earth current input [1]) [2]): $\frac{\text{(window−type) earth c.t. ratio}}{\text{(phase) c.t. ratio}}$ kleinster Einstellwert: **0,001** größter Einstellwert: **5,000**

6.3.3.2 Line data, general [1])

The following parameters are relevant only for fault location. If this function is not used, leave these addresses unchanged.

Matching of the earth impedance ratio is achieved by entering the resistance ratio R_E/R_L and the reactance ratio X_E/X_L. These are purely formally calculated and are not identical with real and imaginary parts of Z_E/Z_L. **No** complex calculation is necessary!

The setting parameters can be determined from the line data using the following formulae:

Resistance ratio

$$\boxed{\frac{R_E}{R_L} = \frac{1}{3} \cdot \left(\frac{R_0}{R_1} - 1\right)}$$

Reactance ratio

$$\boxed{\frac{X_E}{X_L} = \frac{1}{3} \cdot \left(\frac{X_0}{X_1} - 1\right)}$$

Whereby
- R_0 – Zero sequence line resistance
- X_0 – Zero sequence line reactance
- R_1 – Positive sequence line resistance
- X_1 – Positive sequence line reactance

It is unimportant whether total line values or values per unit length are used, since the ratios are independent of the line length.

Calculation Example

110 kV overhead line Alu/Steel 240/40 mm^2 with the line parameters

s (length) = 60 km

$R_1/s = 0.13\ \Omega/\text{km}$
$X_1/s = 0.39\ \Omega/\text{km}$) Pos. seq. impedance

$R_0/s = 0.38\ \Omega/\text{km}$
$X_0/s = 1.15\ \Omega/\text{km}$) Zero seq. impedance

Current transformers 600 A/5 A
Voltage transformers 110 kV/0.1 kV

For the earth impedance ratio we have:

$$\frac{R_E}{R_L} = \frac{1}{3} \cdot \left(\frac{R_0}{R_1} - 1\right) = \frac{1}{3} \cdot \left(\frac{0.38\,\Omega/\text{km}}{0.13\,\Omega/\text{km}} - 1\right) = 0.64$$

$$\frac{X_E}{X_L} = \frac{1}{3} \cdot \left(\frac{X_0}{X_1} - 1\right) = \frac{1}{3} \cdot \left(\frac{1.15\,\Omega/\text{km}}{0.39\,\Omega/\text{km}} - 1\right) = 0.65$$

△ ▽ 1117 ■RE/RL [1]) 1.00	Matching of earth impedance, resistance ratio [1]) Smallest setting value: **−0.33** Largest setting value: **7.00**
△ ▽ 1118 ■XE/XL [1]) 1.00	Matching of earth impedance, reactance ratio [1]) Smallest setting value: **−0.33** Largest setting value: **7.00**

[1]) only for model 7SJ531★−★★★★2−★★★★

[2]) only for model 7SJ531★−★★★★★−0★★★ and −1★★★

The reactance per unit line length (address 1122 or 1123) is entered as secondary value. This can be derived from the primary value using the formula

$$X_{sec} = \frac{N_{ct}}{N_{vt}} \cdot X_{prim}$$

Where N_{ct} – c.t. ratio
N_{vt} – v.t. ratio

The values can be entered in Ω/mile under address 1122 or in Ω/km under address 1123. The length unity had been entered during configuration (see Section 5.3.1, address 7103). Dependent on that configuration, only address 1122 or 1123 will appear here.

△ ▽	1122 ▮X SEC [1] 1.000 Ω/mile [5]	Line reactance per unit line length, secondary, only for fault location (refer to Section 6.3.18) [1] Smallest setting value: **0.010** Ω/mile [5] Largest setting value: **5.000** Ω/mile [5]
△ ▽	1123 ▮X SEC [1] 0.620 Ω/km [5]	Line reactance per unit line length, secondary, only for fault location (refer to Section 6.3.18) [1] Smallest setting value: **0.005** Ω/km [5] Largest setting value: **6.215** Ω/km [5]

6.3.3.3 Additional plant data

Under addresses 1134 and 1135, some additional general device data are entered to the protection relay, to match it to the switch gear conditions.

Under address 1134, the minimum trip command duration can be set. This is then valid for all functions of the device which can issue a trip signal.

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

△ ▽	1134 ▮T TRIP 0.15 s	Minimum duration of **trip** command Smallest setting value: **0.01** s Largest setting value: **32.00** s
△	1135 ▮T-CLOSE 1.00 s	Maximum duration of **close** command Smallest setting value: **0.01** s Largest setting value: **32.00** s

[1]) only for model 7SJ531★–★★★★2–★★★★

[5]) The setting range and the presettings are reduce by the factor 1/5 in relays with rated current 5 A

Some of the protection and supplementary functions (e.g. voltage protection with current criterion, breaker failure protection, overload protection and restart lockout for motors) require information about the position of the circuit breaker to operate optimally. Address 1160 determines, below which current threshold above which the circuit breaker is regarded to be closed. The set value is valid for all three phases. This value should be set with respect to the actually used protection functions.

Concerning the breaker failure protection, this setting must be smaller than the smallest expected fault current to be detected (approximately 10 % below). 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.

When the relay is used as motor protection, the current threshold is taken as discriminator between stand−still of the machine and running. When the value is undershot, the machine is assumed to stand still: the overload protection operates with the stand−still time constant of the motor like does the restart lockout. Thus, the setting value should be smaller than the smallest expected load current of the motor.

```
△ 1160 ■BRK CLOSED
▽     0.04 I/In
```

Current threshold above which the circuit breaker is assumed to be closed
Smallest setting value: **0,04** · I_N
Largest setting value: **1,00** · I_N

Address 1165 I−STRT−DET is also used for motor protection and determines above which current threshold the motor is assumed to be starting up. This parameter is processed by the start−up time supervision, the thermal overload protection, and the restart lockout protection. The value should be selected such that it is safely exceeded by the real start−up current under all load and voltage conditions but not exceeded during normal operation including admissible overloads.

It should further be noted that the thermal replica of the thermal overload protection is ”frozen”, i.e. kept constant, as long as the motor is regarded to run up. This means that the operation range of the thermal overload protection is limited by this parameter I−STRT−DET.

```
△ 1165 ■I-STRT-DET 1)
▽     2.50  I/In
```

Current threshold for start−up criterion of the motor; used for start−up time monitoring [1])
Smallest setting value: **0,60** I_N
Largest setting value: **10,00** I_N
(referred to rated device current I_N)

[1]) only for model 7SJ531★−★★★★2−★★★★

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

R	1200 O/C PROT. PHASES	Beginning of block ”Overcurrent time protection for phase faults”
▽	1201 ■O/C PHASES ON	Switching *ON* of the phase fault overcurrent time protection
N	OFF	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 overcurrent 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

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

The I>> stage should not be exceeded by inrush current or be delayed accordingly.

If the relay is intended to operate with auto−reclosure the the I>> stage can be used as a rapid tripping stage before auto−reclosure: As long as the 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. 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 faults on an outgoing feeder.

The set times for definite time stages are pure delay times which do not include the operating time of the protection. If a stage is not used it can be set ineffective: Either the stage itself can be set to ∞ or the time delay, as shown in the parameter explanation.

△ ▽	1202 ■I>> 2.00 I/In	Pick−up value of the high−set stage I>> for phase faults Setting range: **0.10** to **25.00** · I_N
△ ▽	1203 ■T-I>> 0.10 s	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)
△ ▽	1206 ■MEAS.REPET NO	Measurement repetition: With setting *YES* a further half a.c. period is evaluated before the protection picks up. This is intended for difficult measuring conditions.
N	YES	

7SJ531 can be used as definite time overcurrent protection or inverse time overcurrent protection. A choice can be made whether the inverse time characteristics meet the IEC standards or the ANSI standards.This function mode has been selected during configuration in Section 5.4.2 (address 7812). In this block 12, only those parameters are available which are associated with the function mode of the selected overcurrent time protection.

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, the pick−up value I> can be set to ∞ so that the stage is completely ineffective. When setting only the time delay T−I> to ∞, the stage operates and annunciates pick−up but does not trip because the time will never elapse.

```
△ 1212 ■I>
▽     1.00 I/In
```

For definite time overcurrent protection only:

Pick−up value of the overcurrent stage I> for phase faults
Setting range: **0.10** to **25.00** · I_N
and ∞ (no pick−up with I> for phase faults)

```
△ 1213 ■T-I>
⩢     0.50 s
```

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 to 1219 are relevant only in case an **inverse time** characteristic has been chosen under address 7812 (CHARAC. PH = *INV. TIME IEC*, *INV. TIME ANSI* or *USER CHARACTER.,* refer to Section 5.4.2). It must be considered that, according to IEC 255−3 or ANSI/IEEE, the protection picks up only when at least 1.1 times the set value is exceeded.

Depending on the selected characteristics, the time multipliers can be found under address 1215 (for the characteristics according IEC and the user specified characteristic), or under address 1216 (for the characteristics according to ANSI/IEEE [1]).

If the overcurrent stage I_p is not used, the pick−up value Ip can be set to ∞ so that the stage is completely ineffective. When setting only the time multiplier T−Ip or D−Ip [1]) to ∞, the stage operates and annunciates pick−up but does not trip because the time will never elapse.

```
⩡ 1214 ■Ip
▽     1.00 I/In
```

For inverse time overcurrent protection only:

Pick−up value of the inverse time overcurrent stage I_p for phase faults
Setting range: **0.10** to **4.00** · I_N
and ∞ (no pick−up with I_p for phase faults)

[1]) only for model 7SJ531★−★★★★2−★★★★

For inverse time overcurrent protection only:

```
△ ║ 1215 ■T-Ip      ║
▽ ║      0.50 s     ║
```

Time multiplier for the inverse time overcurrent stage I_p according to *IEC* and user specified characteristic (address 7812 [1])
Setting range: **0.05** s to **3.20** s;
and ∞ (no trip with I_p for phase faults)

```
△ ║ 1216 ■D Ip 1)   ║
▽ ║      5.00       ║
```

Time multiplier for the inverse time overcurrent stage I_p according to *ANSI* (address 7812 [1])
Setting range: **0.50** to **15.00**;
and ∞ (no trip with I_p for phase faults)

With the definite time characteristic the fundamental waves of the measured currents are evaluated for pick−up. When one of the **inverse time** characteristics is selected, a choice can be made whether the *FUNDAMENTAL* waves of the measured currents are formed for evaluation, or if the *TRUE RMS* values are calculated. As the relay is used as short−circuit protection, the preset value is recommended. If the time grading is to be coordinated with conventional relays which operate with true r.m.s. values, then *TRUE RMS* may be advantageous (address 1217).

Addresses 1217 and the further are found on page 2 of the sub−menu O/C PROT. PHASES which can be reached with ⩔.

For inverse time overcurrent protection only:

```
△ ║ 1217 ■RMS FORMAT  ║
▽ ║   FUNDAMENTAL     ║
N │     TRUE RMS      │
```

The fundamental waves of the measured currents are evaluated

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

---

If the function mode is "*INV. TIME IEC*", one of three inverse time characteristics defined in IEC 255−3 can be selected (address 1218).

For "IEC inverse" only:
Characteristic of the overcurrent stage I_p for phase faults, can be

```
△ ║ 1218■CHARACTER.        ║
▽ ║     NORMAL INVERSE     ║
N │     VERY INVERSE       │
  │     EXTREMELY INVERS   │
```

NORMAL *INVERSE*	time lag acc. IEC 255−3 (type A)
VERY INVERSE	time lag acc. IEC 255−3 (type B)
*EXTREMELY INV*ERS	time lag acc. IEC 255−3 (type C)

In model 7SJ531★⁻★★★★**2**−★★★★ and if the function mode is "*ANSI inverse*". one of the following eight inverse time characteristics can be selected (address 1219).

---

[1]) only for model 7SJ531★−★★★★2−★★★★

△ ▽	1219■CHARACTER. [1]) INVERSE	**For ”ANSI inverse” [1]) only**: Characteristic for phase faults, can be normal *INVERSE* time lag acc. ANSI/IEEE
	SHORT INVERSE	*SHORT INVERSE* time lag acc. ANSI/IEEE
	LONG INVERSE	*LONG INVERSE* time lag acc. ANSI/IEEE
N	MODERATELY INV.	*MODERATELY INV.* time lag acc. ANSI/IEEE
	VERY INVERSE	*VERY INVERSE* time lag acc. ANSI/IEEE
	EXTREMELY INV.	*EXTREMELY INV.* time lag acc. ANSI/IEEE
	DEFINITE INV.	*DEFINITE INVERS* time lag acc. ANSI/IEEE
	I-SQUARED-T	*I−SQUARED−T*

When closing the circuit breaker onto a faulty line section, it is in most cases desirable to trip the line as fast as possible. With manual closing control, this is taken care of by parameterization of address 1221 for the reaction of the relay in case of a fault. Here it is defined which pick−up value is effective with which time delay, when the circuit breaker is manually closed.

When the manual closing command is not given by the 7SJ531, neither through the integrated control nor via the LSA interface, but directly from a control−discrepancy switch, then this command has to be connected to a binary input of the 7SJ531 including the corresponding marshalling (”>Manual Close”). Thus the stage for MAN.CLOSE becomes effective. *INEFFECTIVE* means that all stages operate according to their parameterization.

△ ▽	1221■MAN.CLOSE I>> UNDELAYED	Overcurrent stage which is effective during manual closing of the circuit breaker: *I>>* i.e. I>> stage (address 1202) but without delay (address 1203)
N	I>/Ip UNDELAYED	*I>/Ip* i.e. I> stage (definite time, address 1212) or I_p stage (inverse time, address 1214) but without delay (address 1213 or 1215 or 1216)
	INEFFECTIVE	*INEFFECTIVE*, i.e. stages operate as parameterized

Under address 1223 it can be defined whether the I>> stages shall be influenced by a release signal of the internal or an external auto−reclosing (AR) or not. In case of a fault the I>> stages of the protection relays on one feeder shall trip simultaneously with short time delay, when auto−reclosing is provided. As the auto−reclose relay permits a rapid auto−reclosing (RAR) for the first auto−reclosing cycle, the release signal from the AR for the I>> stages is present, so that they can trip. If the fault still persists after the reclosing, then the I> stages shall operate with their time−graded tripping times. This is effected from the auto−reclosing by cancellation of the RAR release signal and thus by blocking of the I>> stages.

[1]) only for model 7SJ531★−★★★★2−★★★★

△	1223 ■RAR st. ph I>> ALWAYS	AR function (if configured) operates with the I>> stage: *I>> ALWAYS* i.e. I>> stage operates always, independent on the AR function
N	I>> W. RAR ONLY	*I>> WITH AR* i.e. I>> is released only if AR is ready

With model 7SJ531★−★★★★**2**−★★★★, one user specified current time characteristic can be defined. Up to 20 pairs of values of current and time can be entered to the relay under address 1230. By entering these pairs of values any desired current−time characteristic can be realized.

In order to enter the value pairs, one must switch over to the table definition level with key combination **F**△, i.e. depressing the function key **F** followed by the arrow key △. During this change−over (i.e. from pressing the **F** key until pressing the △ key) the bar behind the address number is replaced by 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 ★ at the beginning of the second display line indicates that the relay expects the first current value. After input of this value it **must be confirmed by pressing the key E**! Then, the ★ appears in the middle of the second display line where the first time value is expected. Enter this value and **confirm with the enter key E**. Corrections can be made using the backspace key **R**, as usual.

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

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

Up to 20 pairs of values can be defined. It is permitted to enter less pairs: In most cases, approximately 10 pairs of values are enough to define a sufficiently exact current time curve.

The current values are entered in multiple of setting value I_p (address 1214). The entered time values can be influenced by the time multiplier T_p (address 1215).

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

Note: When the relay is delivered, all current values I/Ip are preset with the value ∞. That means that all values are invalid and the relay never will trip by this characteristic. It is possible to define less than 20 pairs of values; but in this case, the remaining must be set to I/Ip = ∞ so that they are marked to be invalid.

△ ▽	1230 ■USER DEF. [1]) CHARACTERISTIC	**For inverse time stage ”USER DEFINED” [1]) only**: trip characteristic for phase currents maximum 20 pairs of values I/I_p and T/TI_p can be defined for the user specified characteristic

[1]) only for model 7SJ531★−★★★★2−★★★★

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

F△
```
001 ■I/Ip - T/TIp
★          ★
```
Space for I/Ip   Space for T/TIp

Pair of values No 001; for current I/Ip and time T/TIp

Setting range for current value I/Ip: **1.00** to **20.00** and ∞ (no pick−up)

Presetting for all values I/I_p is ∞, i.e. no pick−up and therefore no trip. If less than 20 pairs of values are defined, the remaining must be left in factory setting ∞!
Setting range for time value T/TIp: **0.01** to **999.00**

Presetting for all T/TIp: 1.00

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

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

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

Example after entry of the time value:

△▽
```
001 ■I/Ip - T/TIp
★ 1.00      11.60
```
Pair of values No 001; for current I/Ip and time T/TIp
e.g. first current value: I/Ip = 1.00
first time value: T/TIp = 11.60
(zeroes after decimal point can be omitted)

Continue with △

△▽
```
002 ■I/Ip - T/TIp
★ 1.10      11.34
```
Pair of values No 002; for current I/Ip and time T/TIp
e.g. second current value: I/Ip = 1.10
second time value: T/TIp = 11.34

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

F△
```
1230■USER DEF. 1)
     CHARACTERISTIC
```
Definition of the user specified current time characteristic for phase faults [1])

[1]) only for model 7SJ531★−★★★★2−★★★★

6.3.5 Settings for earth fault overcurrent time protection – address block 13

	Display	Description
R	1300 O/C PROT. EARTH	Beginning of the block "Overcurrent time protection for earth faults"
▽	1301 ■O/C EARTH ON	Switching *ON* of the earth fault overcurrent time protection
N	OFF	Switching *OFF* of the earth fault overcurrent time protection

At first, the high–set overcurrent stage I_E>> is set under addresses 1302 to 1306, if used; if not used, set T–IE>> (address1303) to ∞. For determination of the setting values similar considerations are valid as for the phase fault stage I>> (refer to Section 6.3.4).

	Display	Description
△ ▽	1302 ■IE>> 0.50 I/In	Pick–up value of the high–set stage I_E>> for earth faults Setting range: **0.05** to **25.00** · I_N
△ ▽	1303 ■T-IE>> 0.10 s	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)
△ ▽	1306 ■MEAS.REPET NO	Measurement repetition: With setting *YES* a further half a.c. period is evaluated before the protection picks up. This is intended for difficult measuring conditions.
N	YES	

7SJ531 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 7813). In this block 13, only those parameters are available which are associated with the function mode of the selected overcurrent time protection for earth faults.

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

Addresses 1312 and 1313 are relevant only in case the **definite time** characteristic has been chosen under address 7813 (CHARAC. E = *DEFINITE TIME*). The minimum earth fault current determines the setting of the overcurrent stage I_E>.

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, the pick–up value IE> can be set to ∞ so that the stage is completely ineffective. When setting only the time delay T–IE> to ∞, the stage operates and annunciates pick–up but does not trip because the time will never elapse.

For definite time overcurrent protection only:

```
△ 1312 ■IE>
▽     0.20 I/In
```

Pick−up value of the overcurrent stage I_E> for earth faults
Setting range: **0.05** to **25.00** · I_N
and ∞ (no pick−up with I_E> for earth faults)

```
△ 1313 ■T-IE>
⩡     0.50 s
```

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 1314 to 1319 are relevant only in case an **inverse** time characteristic has been chosen under address 7813 (CHARAC. E = *INV. TIME IEC*, *INV. TIME ANSI* or *USER CHARACTER.*, Section 5.4.2). It must be considered that, according to IEC 255−3 or ANSI/IEEE, the protection picks up only when 1.1 times the set value is exceeded.

Depending on the selected characteristics, the time multipliers can be found under address 1315 (for the characteristics according IEC and the user specified characteristic), or under address 1316 (for the characteristics according to ANSI/IEEE [1]).

If the overcurrent stage I_{Ep} is not used, the pick−up value IEp can be set to ∞ so that the stage is completely ineffective. When setting only the time multiplier T−IEp or D−IEp [1]) to ∞, the stage operates and annunciates pick−up but does not trip because the time will never elapse.

For inverse time overcurrent protection only:

```
⩠ 1314 ■IEp
▽     0.20 I/In
```

Pick−up value of the inverse time overcurrent stage I_{Ep} for earth faults
Setting range: **0.05** to **4.00** · I_N
and ∞ (no pick−up with I_{Ep} for earth faults)

```
△ 1315 ■T-IEp
▽     0.50 s
```

Time multiplier for the inverse time overcurrent stage I_{Ep} according to *INV. TIME IEC* or *USER* defined *CHARACTER*istic (address 7813)
Setting range: **0.05** s to **3.20** s;
and ∞ (no trip with I_{Ep} for earth faults)

```
△ 1316 ■D-IEp 1)
▽     5.00
```

Time multiplier for the inverse time overcurrent stage I_{Ep} according to *INV. TIME ANSI* [1]) (address 7813)
Setting range: **0.50** to **15.00**;
and ∞ (no trip with I_{Ep} for earth faults)

With the definite time characteristic the fundamental waves of the measured currents are evaluated for pick−up. When one of the **inverse time** characteristics is selected, a choice can be made whether the *FUNDAMENTAL* waves of the measured currents are formed for evaluation, or if the *TRUE RMS* values are calculated. As the relay is used as short−circuit protection, the preset value is recommended. If the time grading is to be coordinated with conventional relays which operate with true r.m.s. values, then *TRUE RMS* may be advantageous (address 1317).

---

[1]) only for model 7SJ531★−★★★★2−★★★★

△ ▽	1317 ■RMS FORMAT FUNDAMENTAL	**For inverse time overcurrent protection only**: The fundamental wave of the measured current is evaluated
N	TRUE RMS	The true r.m.s. value of the measured current is evaluated

If the function mode is ”*INV. TIME IEC*”, one of three inverse time characteristics defined in IEC 255−3 can be selected (address 1318).

△ ▽	1318 ■CHARACTER. NORMAL INVERSE	**For inverse time overcurrent protection only**: Characteristic of the overcurrent stage I_{Ep} for earth faults, can be *NORMAL INVERSE* time lag (IEC 255−3 type A)
N	VERY INVERSE	*VERY INVERSE* time lag (IEC 255−3 type B)
	EXTREMELY INVERS	*EXTREMELY INVERS*e time lag (IEC 255−3 type C)
	LONG EARTH FAULT	*LONG* time *EARTH FAULT* characteristic

In model 7SJ531★−★★★★**2**−★★★★ and if the function mode is ”*ANSI inverse*”. one of the following eight inverse time characteristics can be selected (address 1319).

△ ▽	1319 ■CHARACTER. 1) INVERSE	**For ”INV. TIME ANSI” only** 1): Characteristic of the overcurrent stage I_{Ep} for earth faults, can be normal *INVERSE* time lag ANSI/IEEE
	SHORT INVERSE	*SHORT INVERSE* time lag ANSI/IEEE
	LONG INVERSE	*LONG INVERSE* time lag ANSI/IEEE
N	MODERATELY INV.	*MODERATELY INV.* time lag ANSI/IEEE
	VERY INVERSE	*VERY INVERSE* time lag ANSI/IEEE
	EXTREMELY INV.	*EXTREMELY INV.* time lag ANSI/IEEE
	DEFINITE INV.	*DEFINITE INVERS* time lag ANSI/IEEE
	I-SQUARED-T	*I−SQUARED−T*

When closing the circuit breaker onto a faulty line section, it is in most cases desirable to trip the line as fast as possible. With manual closing control, this is taken care of by parameterization of address 1321 for the reaction of the relay in case of a fault. Here it is defined which pick−up value is effective with which time delay, when the circuit breaker is manually closed.

When the manual closing command is not given by the 7SJ531, neither through the integrated control nor via the LSA interface, but directly from a control−discrepancy switch, then this command has to be connected to a binary input of the 7SJ531 including the corresponding marshalling (”>Manual Close”). Thus the stage for MAN.CLOSE becomes effective. *INEFFECTIVE* means that all stages operate according to their parameterization.

1) only for model 7SJ531★−★★★★2−★★★★

```
△ ║ 1321■MAN.CLOSE          ║
▽ ║     IE>> UNDELAYED      ║
```

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

IE>> i.e. I_E>> stage (address 1302) but without delay (address 1303)

```
N │     IE>/Iep UNDELAY.    │
```

IE>/IEp i.e. I_E> stage (definite time, address 1312) or I_{Ep} stage (inverse time, address 1314) but without delay TIE> (address 1313) or T−IEp (1315) or D−IEp (1316)

```
  │     INEFFECTIVE         │
```

INEFFECTIVE, i.e. stages operate as parameterized

Under address 1323 it can be defined whether the I_E>> stage shall be influenced by a release signal of the internal or an external auto−reclosing (AR) or not. In case of a fault the I_E>> stages of the protection relays on one feeder shall trip simultaneously with short time delay, when auto−reclosing is provided. As the auto−reclose relay permits a rapid auto−reclosing (RAR) for the first auto−reclosing cycle, the release signal from the AR for the I_E>> stage is present, so that it can trip. If the fault still persists after the reclosing, then the I_E> stage shall operate with its time−graded tripping time. This is effected from the auto−reclosing by cancellation of the RAR release signal and thus by blocking of the I_E>> stage.

AR function (if configured) operates with the I_E>> stage:

```
△ ║ 1323■RAR st. e          ║
  ║     IE>> ALWAYS         ║
```

IE>> ALWAYS i.e. IE>> stage operates always, inde− pendent on the AR function

```
N │     IE>> W. RAR ONLY    │
```

IE>> WITH AR i.e. IE>> is released only if AR is ready

With model 7SJ531★−★★★★2−★★★★, one user specified current time characteristic can be defined. Up to 20 pairs of values of current and time can be entered to the relay under address 1330. By entering these pairs of values any desired current−time characteristic can be realized.

The current values are entered in multiple of setting value I_{Ep} (address 1314). The entered time values can be influenced by the time multiplier T_{IEp} (address 1315).

The procedure of definition of a user specified characteristic for earth currents is the same as described in Section 6.3.4 for phase currents.

Note: When the relay is delivered, all current values I/IEp are preset with the value ∞. That means that all values are invalid and the relay never will trip by this characteristic. It is possible to define less than 20 pairs of values; but in this case, the remaining must be set to I/IEp = ∞ so that they are marked to be invalid.

```
△ ║ 1330■USER DEF. 1)       ║
▽ ║     CHARACTERISTIC      ║
```

For inverse time stage "USER DEFINED" [1]) only: trip characteristic for earth currents

maximum 20 pairs of values I/IEp and T/TIEp can be defined for the user specified characteristic

---

[1]) only for model 7SJ531★−★★★★2−★★★★

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

F△ ‖ 001 ■I/Ip – T/TIp ★ ★ Space for I/IEp Space for T/TIEp ‖	Pair of values No 001; for current I/IEp and time T/TIEp Setting range for current value I/Ip: **1.00** to **20.00** and ∞ (no pick–up) Presetting for all values I/IEp is ∞, i.e. no pick–up and therefore no trip. If less than 20 pairs of values are defined, the remaining must be left in factory setting ∞! Setting range for time value T/TIp: **0.01** to **999.00** Presetting for all T/TIp: 1.00

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

F△ ‖ 1330 ■USER DEF. [1] CHARACTERISTIC ‖	Definition of the user specified current time characteristic for earth faults [1]

[1] only for model 7SJ531★–★★★★2–★★★★

6.3.6 Settings for directional phase fault overcurrent time protection − address block 14 [1])

In contrast to the main protective functions: non−directional overcurrent time protection for phase and earth currents, all other protective functions are configured ineffective upon delivery of the relay. Before setting the parameters for the directional overcurrent protection and all further protective functions, they have to be configured *EXIST* (see Section 5.4.2). Only then the corresponding block addresses appear on the general view level PARAMETER SETTING and can be changed there.

R	1400 OVERCURR.− DIRECTIONAL PH	Beginning of block ”Directional overcurrent time protection for phase faults”
▽	1401 ■O/C DIR.PH OFF	Switching *OFF* of the phase fault directional overcurrent time protection
N	ON	Switching *ON* of the phase fault directional overcurrent time protection

At first, the high−set overcurrent stage I>> DIR is set under addresses 1402 to 1406. For determination of the setting values similar considerations are valid as for the non−directional phase fault stage I>> (refer to Section 6.3.4).

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

△ ▽	1402 ■I>> DIR. 2.00 I/In	Pick−up value of the directional high−set stage I>> for phase faults Setting range: **0.10** to **25.00** · I_N
△ ▽	1403 ■T−I>> DIR. 0.10 s	Trip time delay of the high−set stage I>> DIR Setting range: **0.00** s to **60.00** s; or ∞ (no trip with I>> DIR for phase faults)

The directional stages can be used as definite time overcurrent protection or inverse time overcurrent protection. A choice can be made whether the inverse time characteristics meet the IEC standards or the ANSI standards or a user specified characteristic. This function mode has been selected during configuration in Section 5.4.2 (address 7814). In this block 14, only those parameters are available which are associated with the function mode of the selected overcurrent time protection.

Addresses 1412 and 1413 are relevant only in case the **definite time** characteristic has been chosen under address 7814 (O/C DIR.PH = *DEFINITE TIME*). The maximum load current determines the setting of the overcurrent stage I> DIR. 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 delay time T−I> DIR (address 1413 for definite time) is set shorter than that of the non−directional stage (address 1203). Thus, the non−directional stage is superimposed on the directional stage and acts as backup stage.

For single−end fed parallel transformers, the delay on the non−feeding end can be set to 0.

[1]) only for model 7SJ531★−★★★★2−★★★★

If the directional overcurrent stage I> DIR is not used, the pick–up value can be set to ∞ so that the stage is completely ineffective. When setting only the time delay T–I> DIR to ∞, the stage operates and annunciates pick–up but does not trip because the time will never elapse.

```
△ ║ 1412 ■I> DIR.        ║
▽ ║      1.00 I/In       ║
```

For definite time directional overcurrent protection only:

Pick–up value of the overcurrent stage I> for phase faults
Setting range: **0.10** to **25.00** · I_N
and ∞ (no pick–up with I> DIR for phase faults)

```
△ ║ 1413 ■T-I> DIR.      ║
▽ ║      0.50 s          ║
```

For definite time directional 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> DIR for phase faults)

Addresses 1414 to 1416 are relevant only in case an **inverse time** characteristic has been chosen under address 7814 (O/C DIR.PH = *INV. TIME IEC* or *INV. TIME ANSI*, refer to Section 5.4.2).

It must be considered that, according to IEC 255–3 or ANSI/IEEE, the protection picks up only when at least 1.1 times the set value is exceeded.

Depending on the selected characteristics, the time multipliers can be found under address 1415 (for the characteristics according IEC and the user specified characteristic), or under address 1416 (for the characteristics according to ANSI/IEEE.

If the overcurrent stage Ip DIR is not used, the pick–up value Ip DIR can be set to ∞ so that the stage is completely ineffective. When setting only the time multiplier T–Ip or D–Ip to ∞, the stage operates and annunciates pick–up but does not trip because the time will never elapse.

```
△ ║ 1414 ■Ip DIR.        ║
▽ ║      1.00 I/In       ║
```

For inverse time overcurrent protection only:

Pick–up value of the inverse time overcurrent stage I_p for phase faults
Setting range: **0.10** to **4.00** · I_N
and ∞ (no pick–up with $I_{p\ DIR}$ for phase faults)

```
△ ║ 1415 ■T-Ip DIR.      ║
▽ ║      0.50 s          ║
```

Time multiplier for the inverse time overcurrent stage I_p according to *IEC* or *USER CHARACTER.* (address 7814)
Setting range: **0.05** s to **3.20** s;
and ∞ (no trip with $I_{p\ DIR}$ for phase faults)

```
△ ║ 1416 ■D-Ip DIR.      ║
▽ ║      5.00            ║
```

Time multiplier for the inverse time overcurrent stage I_p according to *ANSI* (address 7814)
Setting range: **0.50** to **15.00**;
and ∞ (no trip with I_p for phase faults)

With the definite time characteristic the fundamental waves of the measured currents are evaluated for pick–up. When one of the **inverse time** characteristics is selected, a choice can be made whether the *FUNDAMENTAL* waves of the measured currents are formed for evaluation, or if the *TRUE RMS* values are calculated. As the relay is used as short–circuit protection, the preset value is recommended. If the time grading is to be coordinated with conventional relays which operate with true r.m.s. values, then *TRUE RMS* may be advantageous (address 1417).

△ ⩔	1417 ■RMS FORMAT FUNDAMENTAL	**For inverse time overcurrent protection only**: The fundamental waves of the measured currents are evaluated
N	TRUE RMS	The true r.m.s. values of the measured currents are evaluated

If the function mode is ”*INV. TIME IEC* ”, one of three inverse time characteristics defined in IEC 255−3 can be selected (address 1418).

Addresses 1418 and the further are found on page 2 of the sub−menu OVERCURR.−DIRECTIONAL PH.

⩓ ▽	1418■CHAR.DIR. NORMAL INVERSE	**For ”INV. TIME IEC” only**: Characteristic of the overcurrent directional stage $I_{p\ DIR}$ for phase faults, can be *NORMAL INVERSe*	time lag acc. IEC 255−3 (typeA)
N	VERY INVERSE	*VERY INVERSE*	time lag acc. IEC 255−3 (typeB)
	EXTREMELY INVERS	*EXTREMELY INVERS*	time lag acc. IEC 255−3 (typeC)

If the function mode is ”*INV. TIME ANSI*”. one of the following eight inverse time characteristics can be selected (address 1419).

⩓ ▽	1419■CHAR.DIR. INVERSE	**For ”INV. TIME ANSI” only**: Characteristic for phase faults (directional stage), can be normal *INVERSE*	time lag acc. ANSI/IEEE
	SHORT INVERSE	*SHORT INVERSE*	time lag acc. ANSI/IEEE
	LONG INVERSE	*LONG INVERSE*	time lag acc. ANSI/IEEE
N	MODERATELY INV.	*MODERATELY INV.*	time lag acc. ANSI/IEEE
	VERY INVERSE	*VERY INVERSE*	time lag acc. ANSI/IEEE
	EXTREMELY INV.	*EXTREMELY INV.*	time lag acc. ANSI/IEEE
	DEFINITE INV.	*DEFINITE INVERS*	time lag acc. ANSI/IEEE
	I−SQUARED−T	*I−SQUARED−T*	

When closing the circuit breaker onto a faulty line section, it is in most cases desirable to trip the line as fast as possible. With manual closing control, this is taken care of by parameterization of address 1421 for the reaction of the relay in case of a fault. Here it is defined which pick−up value is effective with which time delay, when the circuit breaker is manually closed.

When the manual closing command is not given by the 7SJ531, neither through the integrated control nor via the LSA interface, but directly from a control−discrepancy switch, then this command has to be connected to a binary input of the 7SJ531 including the corresponding marshalling (”`>Manual Close`”). Thus the stage for MAN.CLOSE becomes effective. *INEFFECTIVE* means that all stages operate according to their parameterization.

```
△ ║ 1421 ■MAN.CLOSE      ║
▽ ║     I>> DIR. UNDEL  ║

N │     I>/IpDIR.UNDEL  │

  │     INEFFECTIVE     │
```

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

I>> i.e. I>> DIR stage (address 1402) but without delay (address 1403)

I>/Ip i.e. I>DIR stage (definite time, address 1212) or I_{pDIR} stage (inverse time, address 1214) but without delay (address 1413 or 1415 or 1416)

INEFFECTIVE, i.e. stages operate as parameterized

Under address 1423 it can be defined whether the I>> DIR stages shall be influenced by a release signal of the internal or an external auto−reclosing (AR) or not. In case of a fault the I>> stages of the protection relays on one feeder shall trip simultaneously with short time delay, when auto−reclosing is provided. As the auto−reclose relay permits a rapid auto−reclosing (RAR) for the first auto−reclosing cycle, the release signal from the AR for the I>> stages is present, so that they can trip. If the fault still persists after the reclosing, then the I> stages shall operate with their time−graded tripping times. This is effected from the auto−reclosing by cancellation of the RAR release signal and thus by blocking of the I>> stages.

```
△ ║ 1423 ■RAR STAGE       ║
  ║     I>> DIR. ALWAYS  ║

N │     I>> DIR.W.RAR    │
```

AR function (if configured) operates with the I>> stage:

I>> DIR.ALWAYS i.e. I>> stage operates always, independent on the AR function

I>> DIR.W.RAR i.e. I>> is released only if AR is ready

The operating direction of the directional stage can be changed in address 1425. Normally, this stage operates in the direction of the protected object (line, transformer). When the relay is correctly connected to the current and voltage transformers according one of the connection diagrams in Appendix B, this is the *FORWARDS* direction.

```
△ ║ 1425 ■DIRECTION  ║
▽ ║     FORWARDS    ║

N │     REVERSE     │
```

Operating direction for the directional phase current stage

FORWARDS forward direction, normally line or transformer

REVERSE reverse direction, normally bus−bar

Direction discrimination is carried out with quadrature voltages for all types of fault. When the voltage which is decisive for direction discrimination is too small (three−phase fault), stored voltages are used from two periods before. When this voltage is either insufficient for direction discrimination, then the protection decides the direction according to the setting under address 1426:

− Either: Direction is negative, i.e. not the direction as parameterized in address 1425. No direction annunciation, no trip is output. As soon as the measured voltage reverts to a sufficient amount, direction determination is carried out again provided overcurrent fault detection has remained. This corresponds to a dead zone in forward direction in this case.

– Or: Direction is positive, i.e. the direction as parameterized in address 1425. Direction annunciations and trip are output. This corresponds to a live zone in negative direction.

```
△║ 1426 ■NO DIR INF      ║
▽║     NO PICKUP         ║

N │     NON–DIR MODE      │
```

When direction discrimination is not possible:

NO PICKUP	the direction is defined as negative; no directional annunciation and trip
NON–DIR MODE	the direction is defined as positive; annunciation and trip

When the *USER* defined *CHARACTER*istic is configured, the user specified current time characteristic can be defined. Up to 20 pairs of values of current and time can be entered to the relay under address 1430. By entering these pairs of values any desired current–time characteristic can be realized.

In order to enter the value pairs, one must switch over to the table definition level with key combination **F**△, i.e. depressing the function key **F** followed by the arrow key △. During this change–over (i.e. from pressing the **F** key until pressing the △ key) the bar behind the address number is replaced by 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 ★ at the beginning of the second display line indicates that the relay expects the first current value. After input of this value it **must be confirmed by pressing the key E**! Then, the ★ appears in the middle of the second display line where the first time value is expected. Enter this value and **confirm with the enter key E**. Corrections can be made using the backspace key **R**, as usual.

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

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

Up to 20 pairs of values can be defined. It is permitted to enter less pairs: In most cases, approximately 10 pairs of values are enough to define a sufficiently exact current time curve.

The current values are entered in multiple of setting value I_p (address 1414). The entered time values can be influenced by the time multiplier T_p (address 1415).

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

Note: When the relay is delivered, all current values I/Ip are preset with the value ∞. That means that all values are invalid and the relay never will trip by this characteristic. It is possible to define less than 20 pairs of values; but in this case, the remaining must be set to I/Ip = ∞ so that they are marked to be invalid.

△ ▽ ‖ 1430■USER DEF. CHARACTERISTIC ‖	**For "USER CHARACTER" only**: User specified current time characteristic for phase faults Up to 20 pairs of values of I/I_p and T/TI_p can be defined.

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

F△ ‖ 001 ■I/Ip – T/TIp ★ ★ ‖ Space for I/Ip Space for T/TIp	Pair of values No 001; for current I/Ip and time T Setting ranges for current value I/Ip: **1.00** to **20.00** and ∞ (no pick–up) Presetting for all values I/I_p is ∞, i.e. no pick–up and therefore no trip. If less than 20 pairs of values are defined, the remaining must be left in factory setting ∞! Setting range for time value T/TIp: **0.01** to **999.00** Presetting for all T/TIp: 1.00
△ ▽ ‖ 001 ■I/Ip – T/TIp ★ ‖	Pair of values No 001; for current I/Ip and time T e.g. first current value: I/Ip = 1.00 (zeroes after decimal point can be omitted)

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

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

Example after entry of the time value:

△ ▽ ‖ 001 ■I/Ip – T/TIp ★ 1.00 11.60 ‖	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/TIp = 11.60 (zeroes after decimal point can be omitted)

Continue with △

△ ▽ ‖ 002 ■I/Ip – T/TIp ★ 1.10 11.34 ‖	Pair of values No 002; for current I/Ip and time T e.g. second current value: I/Ip = 1.10 second time value: T/TIp = 11.34

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

F△ ‖ 1430■USER DEF. CHARACTERISTIC ‖	Definition of user specified current time characteristic for phase faults

6.3.7 Settings for directional earth fault overcurrent time protection – address block 15 [1])

A precondition for the use of the directional earth overcurrent time protection is that the phase–to–earth voltages are connected to the relay, and that the relay is informed about this connection during configuration (address 7911, see Section 5.4.6). Otherwise, address block 15 is not available.

	Display	Explanation
R	1500 OVERCURR.- DIRECTIONAL E	Beginning of the block "Directional overcurrent time protection for earth faults"
▽	1501 ■DIREC. IE> OFF	Switching *OFF* of the earth fault directional overcurrent time protection
N	ON	Switching *ON* of the earth fault directional overcurrent time protection

At first, the high–set overcurrent stage I_E>> DIR is set under addresses 1502 and 1503, if used; if not used, set T–IE>>DIR (address1503) to ∞. For determination of the setting values similar considerations are valid as for the non–directional stage I>> (refer to Section 6.3.5).

	Display	Explanation
△ ▽	1502 ■IE>> DIR. 0.50 I/In	Pick–up value of the high–set stage I_E>>DIR for earth faults Setting range: **0.05** to **25.00** · I_N
△ ▽	1503 ■T-IE>>DIR. 0.10 s	Trip time delay of the high–set stage I_E>> DIR Setting range: **0.00** s to **60.00** s; or ∞ (no trip with I_E>> DIR for earth faults)

7SJ531 can be used as definite time directional overcurrent protection or inverse time directional 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 earth faults, all parameters of the overcurrent time protection can be set separately and independently. This allows separate time grading for earth faults with e.g. shorter times.

Addresses 1512 and 1513 are relevant only in case the **definite time** characteristic has been chosen under address 7815 (O/C DIR. E = *DEFINITE TIME*). The minimum earth fault current determines the setting of the overcurrent stage I_E> DIR.

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

If the overcurrent stage IE> DIR is not used, the pick–up value IE> DIR can be set to ∞ so that the stage is completely ineffective. When setting only the time delay T–IE> to ∞, the stage operates and annunciates pick–up but does not trip because the time will never elapse.

[1]) only for model 7SJ531★–★★★★2–★★★★

△ ▽ 1512 ■IE> DIR. 0.20 I/In	**For definite time directional overcurrent protection only**: Pick−up value of the overcurrent stage I_E> for earth faults Setting range: **0.05** to **25.00** · I_N and ∞ (no pick−up with I_E> DIR for earth faults)
△ ▽ 1513 ■T-IE> DIR. 0.50 s	Trip time delay for the overcurrent stage I_E> Setting range: **0.00** s to **60.00** s; and ∞ (no trip with I_E> DIR for earth faults)

Addresses 1514 to 1516 are relevant only in case an **inverse** time characteristic has been chosen under address 7815 (O/C DIR. E = *INV. TIME IEC* or *INV. TIME ANSI*, Section 5.4.2).

It must be considered that, according to IEC 255−3 or ANSI/IEEE, the protection picks up only when 1.1 times the set value is exceeded.

Depending on the selected characteristics, the time multipliers can be found under address 1515 (for the characteristics according IEC and the user specified characteristic), or under address 1516 (for the characteristics according to ANSI/IEEE.

If the overcurrent stage IEp DIR is not used, the pick−up value IEp DIR can be set to ∞ so that the stage is completely ineffective. When setting only the time multiplier T−IEp or D−IEp to ∞, the stage operates and annunciates pick−up but does not trip because the time will never elapse.

△ ▽ 1514 ■IEp> DIR. 0.20 I/In	**For inverse time directional overcurrent protection only**: Pick−up value of the inverse time directional overcurrent stage $I_{Ep\ DIR}$ for earth faults Setting range: **0.05** to **4.00** · I_N and ∞ (no pick−up with $I_{Ep\ DIR}$ for earth faults)
△ ▽ 1515 ■T-IEp DIR. 0.50 s	Time multiplier for the inverse time overcurrent stage I_{Ep} according to *INV. TIME IEC* or *USER CHARACTER.* (address 7815) Setting range: **0.05** s to **3.20** s; and ∞ (no trip with $I_{Ep\ DIR}$ for earth faults)
△ ▽ 1516 ■D-IEp DIR. 5.00	Time multiplier for the inverse time overcurrent stage I_{Ep} according to *INV. TIME ANSI* (address 7815) Setting range: **0.50** to **15.00**; and ∞ (no trip with $I_{Ep\ DIR}$ for earth faults)

With the definite time characteristic the fundamental waves of the measured currents are evaluated for pick−up. When one of the **inverse time** characteristics is selected, a choice can be made whether the *FUNDAMENTAL* waves of the measured currents are formed for evaluation, or if the *TRUE RMS* values are calculated. As the relay is used as short−circuit protection, the preset value is recommended. If the time grading is to be coordinated with conventional relays which operate with true r.m.s. values, then *TRUE RMS* may be advantageous (address 1517).

△ ⩡	1517 ■RMS FORMAT FUNDAMENTAL	**For inverse time directional overcurrent protection only**: The fundamental wave of the measured current is evaluated
N	TRUE RMS	The true r.m.s. value of the measured current is evaluated

If the function mode is "*INV. TIME IEC* ", one of three inverse time characteristics defined in IEC 255−3 can be selected (address 1518).

For inverse time directional overcurrent protection only:

Characteristic of the overcurrent stage I_{Ep} for earth faults, can be

⩠ ▽	1518■CHAR.DIREC NORMAL INVERSE	*NORMAL INVERSE*	time lag (IEC 255−3 type A)
N	VERY INVERSE	*VERY INVERSE*	time lag (IEC 255−3 type B)
	EXTREMELY INVERS	*EXTREMELY INVERSe*	time lag (IEC 255−3 type C)
	LONG EARTH FAULT	*LONG* time *EARTH FAULT* characteristic	

If the function mode is "*INV. TIME ANSI*". one of the following eight inverse time characteristics can be selected (address 1519).

For "INV. TIME ANSI" only:
Characteristic for earth faults, can be

△ ▽	1519■CHAR.DIREC INVERSE	normal *INVERSE*	time lag ANSI/IEEE
	SHORT INVERSE	*SHORT INVERSE*	time lag ANSI/IEEE
	LONG INVERSE	*LONG INVERSE*	time lag ANSI/IEEE
N	MODERATELY INV.	*MODERATELY INV.*	time lag ANSI/IEEE
	VERY INVERSE	*VERY INVERSE*	time lag ANSI/IEEE
	EXTREMELY INV.	*EXTREMELY INV.*	time lag ANSI/IEEE
	DEFINITE INV.	*DEFINITE INVERS*	time lag ANSI/IEEE
	I−SQUARED−T	*I−SQUARED−T*	

When closing the circuit breaker onto a faulty line section, it is in most cases desirable to trip the line as fast as possible. With manual closing control, this is taken care of by parameterization of address 1521 for the reaction of the relay in case of a fault. Here it is defined which pick−up value is effective with which time delay, when the circuit breaker is manually closed.

When the manual closing command is not given by the 7SJ531, neither through the integrated control nor via the LSA interface, but directly from a control−discrepancy switch, then this command has to be connected to a binary input of the 7SJ531 including the corresponding marshalling ("`>Manual Close`"). Thus the stage for MAN.CLOSE becomes effective. *INEFFECTIVE* means that all stages operate according to their parameterization.

```
△║ 1521■MAN.CLOSE        ║
▽║     IE>> UNDELAYED    ║

N│      IE>/Ip UNDELAYED │

 │      INEFFECTIVE      │
```

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

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

IE>/Ip i.e. I_E> DIR stage (definite time, address 1512) or I_{Ep} stage (inverse time, address 1514) but without delay TIE> (address 1513) or T−IEp DIR (1515) or D−IEp DIR (1516)

INEFFECTIVE, i.e. stages operate as parameterized

Under address 1523 it can be defined whether the I_E>> DIR stage shall be influenced by a release signal of the internal or an external auto−reclosing (AR) or not. For determination of the setting values similar considerations are valid as for the phase fault stage I>> (refer to Section 6.3.4).

```
△║ 1523■RAR ST. E        ║
▽║     IE>> DIR. ALWAYS  ║

N│     IE>> DIR.W.RAR    │
```

AR function (if configured) operates with the I_E>> DIR stage:

IE>> DIR ALWAYS i.e. IE>> stage operates always, independent on the AR function

*IE>> DIR.*With *RAR* i.e. IE>> is released only if AR is ready

---

The operating direction can be changed for earth overcurrent time protection in address 1525. Direction definition is the same as for phase faults.

```
△║ 1525■DIRECTION        ║
▽║     FORWARDS          ║

N│     REVERSE           │
```

Operating direction for the directional earth current stage

When the displacement voltage which is decisive for direction discrimination of earth currents is too small, the protection decides the direction according to the setting under address 1526:

− Either: Direction is negative, i.e. not the direction as parameterized in address 1525. No direction annunciation, no trip is output. As soon as the measured voltage reverts to a sufficient amount, direction determination is carried out again provided earth current fault detection has remained.

− Or: Direction is positive, i.e. the direction as parameterized in address 1425. Direction annunciations and trip are output. This corresponds to a live zone in negative direction.

```
△║ 1526■NO DIR INF       ║
▽║     NO PICKUP         ║

N│     NON-DIR MODE      │
```

When direction discrimination is not possible:

NO PICKUP the direction is defined as negative; no directional annunciation and trip

NON−DIR MODE the direction is defined as positive; annunciation and trip

When the *USER* defined *CHARACTER*istic is configured, the user specified current time characteristic can be defined. Up to 20 pairs of values of current and time can be entered to the relay under address 1530. By entering these pairs of values any desired current−time characteristic can be realized.

The current values are entered in multiple of setting value I_{Ep} (address 1514). The entered time values can be influenced by the time multiplier T_{IEp} (address 1515).

The procedure of setting a user specified characteristic is the same as described in Section 6.3.6 for phase currents.

Note: When the relay is delivered, all current values I/IEp are preset with the value ∞. That means that all values are invalid and the relay never will trip by this characteristic. It is possible to define less than 20 pairs of values; but in this case, the remaining must be set to I/IEp = ∞ so that they are marked to be invalid.

```
△ ║ 1530■USER DEF.        ║
▽ ║     CHARACTERISTIC    ║
```

For "USE CHARACTER." only:
User specified current time characteristic for earth currents

Up to 20 pairs of values of I/I_{Ep} and T/TI_{Ep} can be defined.

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

```
F△║ 001 ■I/Ip - T/TIp     ║
  ║ ★           ★         ║
```

Space for I/IEp   Space for T/TIEp

Pair of values No 001; for current I/IEp and time T/TIEp

permissible ranges
for current value I/IEp: **1.00** to **20.00**
and ∞ (no pick−up)

Presetting for all values I/IE_p is ∞, i.e. no pick−up and therefore no trip. If less than 20 pairs of values are defined, the remaining must be left in factory setting ∞!
Setting range for time value T/TIp: **0.01** to **999.00**

Presetting for all T/TIEp: 1.00

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

```
F△║ 1530■USER DEF.        ║
  ║     CHARACTERISTIC    ║
```

Definition of user specified current time characteristic for earth faults

6.3.8 Settings for undervoltage protection − address block 16

R	1600 UNDER- VOLTAGE	Beginning of the block ”Undervoltage protection”
▽	1601 ■UNDERVOLTG OFF	Switching *ON* of the undervoltage protection
N	ON	Switching *OFF* of the undervoltage protection
	ALARM ONLY	undervoltage protection operates but issues *ALARM ONLY*, no trip, no fault event

Under address 7911 it has been determined whether phase−to−earth voltages or phase−to−phase voltages are connected to the relay as measuring quantities and which voltages shall be evaluated. When phase−to−earth voltages are connected, then the relay can calculate the phase−to−phase voltages and use them optionally for calculation by the protection function, too. Dependent on the configuration under address 7911, only the relevant parameters (addresses 1602, 1604 and 1610 for phase−to−earth voltages, or 1603, 1605 and 1611 for phase−to−phase voltages) are shown.

For the settings no generally applicable values can be given. Taking into account that the protection shall in the first place protect consumers from the consequences of voltage drops and prevent stability problems, the setting values will be between 60% and 75% of the rated voltage. The time delays have to be set such that voltage drops, which endanger the stability, are tripped. The time delays should, however, be long enough to avoid tripping for permissible short−time voltage drops.

△ ▽	1602 ■U< (PH−E) 43 V	Pick−up threshold of the U< stage of the undervoltage protection, when the phase−to−ground voltages are processed Setting range: **30** V to **120** V
△ ▽	1603 ■U< (PH−PH) 75 V	Pick−up threshold of the U< stage of the undervoltage protection, when the phase−to−phase voltages are processed Setting range: **30** V to **120** V

The undervoltage protection has two stages. A short time delay can be assigned to the low−set stage (U<<) and a longer time delay to the high−set stage (U<). Thus the stability characteristic of the consumer can be approximately matched.

While the reset threshold of the U<< stage is fixed at 1.05 times pick−up threshold, the reset threshold of the U< stage can be parameterized through the reset ratio r = U_{reset}/U_{pickup} (addresses 1604 and 1605). The following limitation should be observed:

r x (parameterized pick−up threshold U<) $\leq$ 130 V.

Note: If the reset threshold (= pick−up threshold x reset ratio) is erroneously set to a value larger than 130 V, then it is automatically limited to 130 V. No alarm is given.

△ ▽	1604 ■r (PH−E) 1.20	Reset ratio r, when the phase−to−ground voltage is processed Setting range: **1.05** to **3.00**

△ ▽	1605 ■r (PH-PH) 1.20	Reset ratio r, when the phase–to–phase voltage is processed Setting range: **1.05** to **3.00**
△ ▽	1606 ■T-U< 1.50 s	Trip delay of undervoltage stage U< Setting range: **0.00** s to **60.00** s; and ∞ (no trip with U< stage)

Dependent on a start–up criterion, the U< stage allows furthermore to activate a start threshold instead of the normal pick–up threshold. When the start–up criterion is activated under address 1607, then the start–up threshold is:

$$\text{start–up threshold} = \frac{\text{r} \cdot \text{parametr. pick–up threshold}}{1.05}$$

Thus, the start–up threshold is always larger or identical to the normal pick–up threshold. The reset ratio for the start–up threshold is fixed at 1.05. This means both thresholds have the same reset ratio.

The U<< stage and the U< stage can commonly be made dependent on a current criterion. When the current criterion is activated under address 1620, then the release condition of the current criterion has to be fulfilled additionally to the undervoltage condition. This means a minimum current, which can be parameterized (BRK CLOSED, address 1160), has to flow for protection pick–up. The minimum current stage LS I> is common for this voltage protection, the breaker failure protection, the thermal overload protection and the restart lockout protection for motors.

The set time T–U<< is an additional time delay, which does not include the protection function's inherent operating time.

△ ▽	1607 ■START.CRIT OFF	Start–up criterion for increased undervoltage pick–up is switched *OFF* or
N	ON	switched *ON*
△ ▽	1608 ■SC I< 0.05 I/In	Pick–up value of start–up criterion (current) Setting range: **0.05** to **1.00** · I_N
△ ▽	1609 ■T-SC 10.00 s	Prolongation of the start–up criterion Setting range: **0.00** s to **60.00** s
△ ▽	1610 ■U<< (PH-E) 40 V	Pick–up threshold of the U<< stage of the undervoltage protection, when the phase–to–ground voltage is processed Setting range: **30** V to **120** V
△ ▽	1611 ■U<< (PH-PH) 70 V	Pick–up threshold of the U<< stage of the undervoltage protection, when the phase–to–phase voltage is processed Setting range: **30** V to **120** V
△ ▽	1612 ■T-U<< 0.50 s	Trip delay of undervoltage stage U<< Setting range: **0.00** s to **60.00** s; and ∞ (no trip with U<< stage)
△ ▽	1620 ■C CRIT U/V ON	Current criterion of undervoltage protection is switched *ON* or
N	OFF	switched *OFF*

6.3.9 Settings for overvoltage protection – address block 17

R	1700 OVER VOLTAGE	Beginning of the block "Overvoltage protection"
▽	1701 ■OVERVOLTG OFF	Switching *ON* of the overvoltage protection
N	ON	Switching *OFF* of the overvoltage protection
	ALARM ONLY	overvoltage protection operates but issues *ALARM ONLY*, no trip, no fault event

Under address 7911 it has been determined whether phase–to–earth voltages or phase–to–phase voltages are connected to the relay as measuring quantities and which voltages shall be evaluated. When phase–to–earth voltages are connected, then the relay can calculate the phase–to–phase voltages and use them optionally for calculation by the protection function, too. Dependent on the configuration under address 7911, only the relevant parameters (address 1702 for phase–to–earth voltages, or 1703 for phase–to–phase voltages) are shown.

For the settings no generally applicable values can be given. Taking into account that the protection shall in the first place prevent switchgear and consumers from excessive insulation stress, the setting values will be between 110% and 115% of the rated voltage. The time delay has to be selected such that tripping for permissible short–time voltage peaks is avoided.

The set time T–U> is an additional time delay, which does not include the protection function's inherent operating time.

△▽	1702 ■U> (PH–E) 64 V	Pick–up threshold of the overvoltage protection, when the phase–to–ground voltages are processed Setting range: **40** V to **130** V
△▽	1703 ■U> (PH–PH) 110 V	Pick–up threshold of the overvoltage protection, when the phase–to–phase voltages are processed Setting range: **40** V to **130** V
△▽	1704 ■T–U> 0.50 s	Trip delay of overvoltage stage U> Setting range: **0.00** s to **60.00** s; and ∞ (no trip with U>)

The U> stage can be made dependent on a current criterion. When the current criterion is activated under address 1710, then the release condition of the current criterion has to be fulfilled additionally to the overvoltage condition. This means a minimum current, which can be parameterized (address 1160), has to flow for protection pick–up. The minimum current stage LS I> is common for this voltage protection, the breaker failure protection, the thermal overload protection and the restart lockout protection for motors.

△▽	1710 ■C CRIT O/V OFF	Current criterion of overvoltage protection is switched *OFF* or
N	ON	switched *ON*

6.3.10 Settings for unbalanced load protection – address block 18 [1])

Model 7SJ531★–★★★★**2**–★★★★ provides an unbalanced load protection (see Section 4.5). This function can operate when it has been configured as EXIST in address 7818 (Section 5.4.2).

R

```
1800 NEGATIVE
     SEQUENCE PROT.
```

Beginning of the block "Negative sequence protection"

▽

```
1801 ■NEG. SEQ.
     OFF
```

Switching *OFF* of the negative sequence protection

N

```
     ON
```

Switching *ON* of the negative sequence protection

The unbalanced load protection measures the negative sequence current and is of dual stage design. The high negative sequence current stage I2>> is shortly delayed and the stage I2> is normally assigned with a longer delay time. These stages can be matched to the capability of unbalanced load of the protected object, e.g. a motor. The preset values are adequate in most cases. If values about the permissible negative sequence current are available (as stated by the motor manufacturer), these should be considered. Note that the stated values are referred to the motor's rated current. If, for example, the maximum continuously permissible negative sequence current of the motor is known, it is converted to the setting value I2> as follows:

$$\text{Setting value } I_2 > \; = \frac{I_{2\,max\,c}}{I_{N\,motor}} \cdot \frac{I_{N\,motor}}{I_{N\,prim}}$$

with

$I_{2\,max\,c}$	max. continuous negative sequence current of the motor
$I_{N\,motor}$	rated current of the motor
$I_{N\,prim}$	primary rated current of the current transformers

The I2>> stage can be set to trip in short time after a total phase failure. When running on two phases, the motor's negative sequence current amounts to

$$\frac{I_2}{I_N} = \frac{1}{\sqrt{3}} \cdot \frac{I}{I_N} = 0.58 \cdot \frac{I}{I_N}$$

Example:

Motor: $I_N = 545$ A
$I_{2\,max\,c} = 11$ %
$I_{2\,max} = 55$ % for $T_{max} = 1$ s

Current transformer: 600 A/1 A

$$\text{Setting value } I_2 > \; = 11\% \cdot \frac{545\,A}{600\,A} = 10\%$$

$$\text{Setting value } I_2>> \; = 55\% \cdot \frac{545\,A}{600\,A} = 50\%$$

The negative sequence protection detects, additionally, interruptions, short–circuits, and swopped phase connections of the current transformer circuits. Single–phase and two–phase short–circuits can be detected even when the fault current is too small to be detected by the overcurrent time protection. The following considerations are valid:

– a two–phase fault with fault current I produces a negative sequence current of

$$\frac{I_2}{I_N} = \frac{1}{\sqrt{3}} \cdot \frac{1}{I_N} = 0.58 \cdot \frac{I}{I_N}$$

– a single–phase fault with fault current I produces a negative sequence current of

$$\frac{I_2}{I_N} = \frac{1}{3} \cdot \frac{1}{I_N} = 0.33 \cdot \frac{I}{I_N}$$

[1]) only for model 7SJ531★–★★★★2–★★★★

△ ▽ `1802 ■I2>` `10 %`	Pick–up value for stage I_2> Setting range: **5** % to **80** % (referred to rated current of the relay I_N)
△ ▽ `1803 ■T–I2>` `5.00 s`	Time delay for stage I2> Setting range: **0.00** s to **60.00** s
△ ▽ `1804 ■I2>>` `50 %`	Pick–up value for stage I_2>> Setting range: **5** % to **80** % (referred to rated current of the relay I_N)
△ ▽ `1805 ■T–I2>>` `1.00 s`	Time delay for stage I2>> Setting range: **0.00** s to **60.00** s

6.3.11 Settings for start–up time supervision – address block 21 [1])

Model 7SJ531★–★★★★2–★★★★ incorporates a start–up supervision (refer to Section 4.6), which represents a useful supplement in case of motors. This function can operate only when it is configured as "*EXIST*" (refer to Section 5.4.2) and switched "*ON*" under address 2101.

The start–up time supervision provides a current dependent stage and a definite time stage. Precondition for detection of a motor start–up is that the current threshold I–STRT–DET (address 1165, see Section 6.3.3.3) is exceeded. The first stage is valid during normal run–up of the motor with rotating rotor (not locked). The value $I^2 \cdot t$ (i.e. inverse time) is decisive (refer also to Section 4.6). This takes into consideration that longer start–up times are permissible when the motor runs up with reduced voltage. The parameters I–STRT–MAX and the corresponding time T–STRT–SUP at normal start–up condition are decisive for this stage. The protection calculates the permissible $I^2 \cdot t$–limit and trips when it is exceeded.

The definite time stage operates as locked–rotor protection. It is started by the start–up current threshold I–STRT–DET. An external speed monitor must be available which is connected to a binary input of the relay. When the rotor is locked, the thermal capability of the motor is reduced because of missing ventilation (self–ventilated machines). The start–up monitor prevents overheating by tripping of the motor before the start–up time for normal run–up of the motor has expired.

The start–up criterion is the increased current that the motor takes during start–up. Consequently, the critical current value $I_{STRT-DET}$ (address 1165) must be such that it is exceeded by the start–up current under all load and voltage conditions. It releases both stages. On the other hand, this value must not be exceeded by permissible short–term overloads.

When the motor is started and the permissible locked rotor time T–LOCK–ROT has expired, the binary input is interrogated. When the motor is still standing, trip command is output.

The time T–LOCK–ROT is set such that, during normal run–up of the motor, the binary input "`>Rotor locked`" (FNo `6805`) is de–energized before this time is expired. Thus, a shorter trip time is ensured when the machine is started with locked rotor.

Note: Start–up detection I–STRT–DET is an internal pick–up signal and not annunciated in any way. No fault report is initiated. The reason is that this start–up detection operates at every start–up of the motor regardless whether it is successful (which should be the normal case) or not.

Note: The overload protection is active during start–up but the thermal replica is not actualized during this time, i.e. the calculated temperature rise is kept constant.

[1]) only for model 7SJ531★–★★★★2–★★★★

R	2100 START−TIME SUPERVISION	Beginning of the block ”Supervision of start−up time for motors”
▽	2101 ■START SUPV OFF	Switching *OFF* the supervision of start−up time
N	ON	Switching *ON* the supervision of start−up time
△ ▽	2102 ■I−STRT−MAX 5.00 I/In	Base value of the permissible start−up current Setting range : **1.00** I/I_N to **16.00** I/I_N (referred to rated current of the relay I_N)
△ ▽	2103 ■T−STRT−SUP 10.0 s	Setting value of the permissible start−up time $T_{STRT-SUP}$ at $I_{STRT-MAX}$ Setting range: **1.0** s to **180.0** s
△ ▽	2104 ■T−LOCK−ROT 2.0 s	Trip time delay with locked rotor Setting range: **0.5** s to **120.0** s and ∞ (no trip with definite characteristic)

6.3.12 Settings for thermal overload protection − address block 27

The relay includes a thermal overload protection function (refer to Section 4.7). 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 protection, control, and supervision device 7SJ531 includes an overload function with a thermal trip characteristic which can be matched to the overload capacity of the protected object.

The overload protection function can be set to be inoperative or to initiate an alarm or tripping (including alarm) (address 2701).

```
R  2700 THERMAL
        OVERLOAD PROT.
```

Beginning of block ”Thermal overload protection”

```
▽  2701 ■THERMAL OL
        OFF
N       ON
        ALARM ONLY
```

Thermal overload protection can be set to

be switched *OFF* or

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

be switched *ALARM ONLY*, i.e. alarm is given but no trip signal and no fault annunciations

---

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 unit computes the temperature rise according to the thermal differential equation the solution of which is an e−function, under steady−state conditions. The time constant τ determines the time after which the limit temperature rise is reached and, thus, the time instant when the relay will trip.

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

Setting value τ [min] =

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

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

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

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

```
△  2702 ■K-FACTOR
▽       1.10
```

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

```
△  2703 ■T-CONSTANT
▽       100.0 min
```

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

By setting a warning temperature rise (address 2704), an alarm can be output before the trip temperature rise is reached, so that, for example, by prompt load shedding tripping may be prevented. this warning stage represents equally the drop−off threshold of the tripping stage. Only when the calculated temperature rise has fallen below the warning threshold, the protection will reset so that renewed closing is possible now.

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

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

△ ▽	2704■Θ WARN 90 %	Thermal warning stage, in % of trip temperature rise $\Theta_{warn}/\Theta_{trip}$ Setting range: **50** % to **100** %
△ ▽	2705■I WARN 1.00 I/In	Current warning stage; set as a multiple of I_N Setting range: **0.10** · I_N to **4.00** · I_N
△	2706■O/L-CALCUL Θ MAX	Calculation method decisive for thermal stages *MAX*imum of the *temperature rises* of the three conductors
N	Θ MEAN	*MEAN* value of the *temperature rises* of the three conductors

---

The time constant as set under address 2703 is valid for the running machine. When the motor is at stand−still, the cooling−down time constant may strongly differ from the heating−up time constant, if the motor is self−ventilated. This can be taken in account by the following parameter, which represents the factor how much times the cooling−down time constant exceeds the heating−up time constant (kτ−FACTOR, address 2709).

In model 7SJ531★−★★★★2−★★★★, stand still of the motor is assumed when the current has fallen below the "breaker closed"−value as set under address 1160 (BRK CLOSED).

If no distinction is made between cooling−down and heating−up time constant (e.g. forced−ventilated machines, transformers, cables), leave the prolongation factor k_τ at the value 1 (presetting).

△ ▽	2709■kτ−FACTOR [1)] 1.0	Prolongation factor of the time constant at stand−still referred to the time constant during running[1)] Setting range: **1.0** to **10.0**

[1)] only for model 7SJ531★−★★★★2−★★★★

6.3.13 Settings for motor restart lockout − address block 28 [1])

Model 7SJ531★−★★★★2−★★★★ incorporates a motor restart lockout function which prevents the rotor from thermal stress caused by repeated start−up (see Section 4.8). This can operate only when it is configured to MOTOR START = *EXIST* under address 7828 during configuration of the device functions (refer to Section 5.4.2).

	Display	Description
R	2800 MOT. START PROTECTION	Beginning of the block ”Motor restart lockout protection”
▽	2801■MOT. START OFF	Switching *OFF* the motor restart protection
N	ON	Switching *ON* the motor restart protection

The motor restart lockout has the duty to avoid a renewed start of the motor when it can be assumed that the thermal rotor limits would be exceeded during start−up. The protection simulates the thermal rotor conditions and outputs a lockout command until a renewed start is permissible. The motor cannot be started as long as this lockout command is present.

Lockout is cancelled when *one* more restart would be permissible. The time which is necessary to permit a restart depends on the thermal history of of the rotor. The parameters of this protection are the characteristics of the motor as stated by the manufacturer. These are: The start−up current, the start−up time, the number of permissible starts from the cold state n_C and the number of permissible starts from the hot state n_W of the motor.

	Display	Description
△ ▽	2802■IA/IB 4.5	Start−up current referred to the rated current of the motor Setting range: **3.0** to **10.0**
△ ▽	2803■T STRT MAX 10 s	Start−up time of the motor Setting range: **3** s to 3**20** s

The number of permissible restarts as stated by the motor manufacturer assumes that the motor is not re−energized before it has come to stand−still because of the different heat spots of the rotor. The motor should be restarted only when the rotor temperature has come to a thermal equilibrium after the time T EQUAL has expired. The time T EQUAL is started each time the motor is switched off. The total lockout time is composed of the time calculated by the thermal replica plus T EQUAL.

The motor is assumed to be switched off, when the current has fallen below the ”breaker closed”−value as set under address 1160 (BRK CLOSED).

The higher cooling−down time constant during stand−still of a self−ventilated machine can be considered by a factor k_τ. The motor is assumed to stand still as before. In case of forced−ventilated machines is $k_\tau = 1$.

[1]) only for model 7SJ531★−★★★★2−★★★★

△ ▽	2804 ■T EQUAL 1.0 min	Time of thermal equilibrium of the rotor Setting range: **0.0** min to **320.0** min
△ ▽	2805 ■IB/IN 1.0	Rated current of the motor referred to the rated current of the current transformers Setting range: **0.2** to **1.2**
△ ▽	2806 ■nw 2	Max. permissible number of hot startups, i.e. after steady−state operation of the motor Setting range: **1** to **4**
△ ▽	2807 ■nc−nw 1	Difference between the permissible number of cold start−ups n_c and the permissible number of hot start−ups n_w Setting range: **1** to **2**
△ ▽	2808 ■kτ−FACTOR 2	Prolongation factor of the time constant at stand−still referred to the time constant during running Setting range: **1** to **10**

6.3.14 Settings for measured value monitoring − address block 29

The different monitoring functions of the protective relay are described in Section 4.18.4. 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 6.3.3.1), especially the parameter concerning the earth current matching factors (addresses 1112 and 1114).

R	2900 MEAS.VALUE SUPERVISION	Beginning of block ”Measured value supervision”
▽	2901 ■SYM.Uthres 50 V	Voltage threshold (phase−phase) above which the symmetry monitoring is effective (refer to Figure 4.40) Smallest setting value: **10** V Largest setting value: **100** V

2902 ■SYM.Fact.U 0.75	Symmetry factor for the voltage symmetry = slope of the symmetry characteristic (refer to Figure 4.40) Smallest setting value: **0.58** Largest setting value: **0.90**
2903 ■SYM.Ithres 0.50 I/In	Current threshold above which the symmetry monitoring is effective (refer to Figure 4.39) Smallest setting value: **0.10** $\cdot I_N$ Largest setting value: **1.00** $\cdot I_N$
2904 ■SYM.Fact.I 0.50	Symmetry factor for the current symmetry = slope of the symmetry characteristic (see Figure 4.39) Smallest setting value: **0.10** Largest setting value: **0.95**
2905 ■SUM.Ithres 0.10 I/In	Current threshold above which the summation monitoring (refer to Figure 4.38) reacts (absolute content, referred to I_N only) Smallest setting value: **0.05** $\cdot I_N$ Largest setting value: **2.00** I_N
2906 ■SUM.Fact.I 0.10	Relative content (related to the maximum conductor current) for operation of the current summation monitoring (refer to Figure 4.38) Smallest setting value: **0.00** Largest setting value: **0.95**

The measured values of the phase currents and the earth current can be monitored during normal operation, independent on the actual overcurrent and overload protection functions. When the set limit thresholds are exceeded, an alarm is given. This supervision uses the steady−state values so that it cannot be used as warning stage for overcurrent time protection.

2930 ■LIMIT IL1 2.00 I/In	Limit value of current I_{L1} which should initiate an alarm Smallest setting value: **0.10** Largest setting value: **25.00**
2931 ■LIMIT IL2 2.00 I/In	Limit value of current I_{L2} which should initiate an alarm Smallest setting value: **0.10** Largest setting value: **25.00**
2932 ■LIMIT IL3 2.00 I/In	Limit value of current I_{L3} which should initiate an alarm Smallest setting value: **0.10** Largest setting value: **25.00**

△ 2933 ■LIMIT IE 2.00 I/In	Limit value of earth current I_E which should initiate an alarm Smallest setting value: **0.05** Largest setting value: **25.00**

In model 7SJ531★−★★★★2−★★★★, further measured values can be monitored. These may be used for operational messages or alarms, or as sensors for operational limits.

⩢ ▽ 2934 ■LIMIT IL< [1]) 0.50 I/In	Limit value of current below which alarm is output; the smallest phase current is decisive [1]) Smallest setting value: **0.10** Largest setting value: **4.00** and 0 (limit value monitor ineffective)
⩢ ▽ 2935 ■LIMITcosφ< 1) 0.80	Limit value of power factor cos φ below which alarm is output [1]) Smallest setting value: **0.40** Largest setting value: **1.00**
△ ▽ 2936 ■LIMIT Pa [1]) 500000 kW	Limit value of active power above which alarm is output [1]) Smallest setting value: **1** kW Largest setting value: **500000** kW
△ ▽ 2937 ■LIMIT Pr [1]) 500000 kVAr	Limit value of reactive power above which alarm is output [1]) Smallest setting value: **1** kVAr Largest setting value: **500000** kVAr

[1]) only for model 7SJ531★−★★★★2−★★★★

6.3.15 Settings for highly sensitive earth fault protection – address block 30 [2])

Highly sensitive earth fault detection can be used in isolated or arc compensated networks to detect an earth fault. The function is only possible if the respective configuration parameter (Section 5.4.2, address 7830) is set to *EXIST*.

If the relay is connected to the phase–to–earth voltages and adequately configured (address 7911, Section 5.4.6) earth fault detection can be used to determine the earth faulted phase.

Models 7SJ531⋆–⋆⋆⋆⋆2–0⋆⋆⋆ and –1⋆⋆⋆ provide an additional highly sensitive earth current input so that earth fault direction discrimination is possible in systems with isolated and arc–compensated star–point. In effectively grounded or low–impedance earthed networks, detection of high–resistance earth faults with very small fault currents is possible. Because of its high sensitivity it is not suited for detection of higher earth fault currents (from 1.5 A and above at the relay terminals for high–sensitivity earth fault protection). For those applications use the overcurrent time protection for earth currents as described in Sections 6.3.5 and 6.3.7.

R
```
3000 EARTHFAULT
     DETECTION
```
Beginning of block ”Earth fault detection for non–earthed systems”

▽
```
3001■E/F PROTEC
     OFF
```
Earth fault detection in non–earthed systems is

OFF switched off

N
```
     ON
```
ON switched on and will trip

```
     ALARM ONLY
```
required to give *ALARM ONLY* (no trip)

The high reactive current component in **compensated** networks and the unavoidable air gap of the window–type current transformers often make compensation of the angle error of the current transformer necessary. This is possible through addresses 3002 to 3005. The maximum angle error F1 of the c.t. with its associated current I1 as well as another c.t. operating point I2/F2 above which the angle error remains practically constant, are entered, for the actually connected burden. The relay then approximates, with adequate accuracy, to the characteristic of the transformer. In **isolated** or **earthed** networks this angle error compensation is not necessary.

△▽
```
3002■CT ERR. I1 1)
     0.050 A
```
Secondary current for max. error angle of current transformer [1])

Smallest setting value	**0.003**	A
Largest setting value	**1.600**	A

△▽
```
3003■CT ERR. F1 1)
     0.0 °
```
Error angle of current transformer at I1 [1])

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

[1]) only for model 7SJ531⋆–⋆⋆⋆⋆2–⋆⋆⋆⋆

[2]) only for model 7SJ531⋆–⋆⋆⋆⋆⋆–0⋆⋆⋆ and –1

3004 ■CT ERR. I2m [1] 1.000 A	Secondary current above which the angle error is practically constant [1] Smallest setting value: **0.003** A Largest setting value: **1.600** A
3005 ■CT ERR. F2 [1] 0.0 °	Error angle of current transformer at I2 [1] Smallest setting value: **0.0** deg Largest setting value: **5.0** deg

The function "earth fault detection" comprises residual voltage detection, determination of the earth–faulted phase using the magnitude of the phase–to–earth voltages and direction discrimination which latter is possible only in model 7SJ531★–★★★★**2–0** or **–1**.

The residual voltage $U_E>$ initiates earth fault detection. It is set in addresses 3009 or 3010 and releases the direction determination. If the voltage inputs of the relay are connected to three star–connected voltage transformers, the residual voltage is calculated from the three phase–to–earth voltages such that it corresponds to the rated voltage at full displacement of the voltage triangle. The following is valid:

$$\underline{U}_E = (\underline{U}_{L1} + \underline{U}_{L2} + \underline{U}_{L3}) / \sqrt{3} = \sqrt{3} \cdot \underline{U}_0$$

If the voltage inputs of the relay are connected to two phase–earth connected voltage transformers (U_{L1-E}, U_{L3-E}) and the displacement voltage U_{EN}, then the displacement voltage is immediately measured. The missing voltage U_{L2-E} is then calculated. The pick–up value U_E in address 3009 corresponds to this voltage whereby a higher sensitivity is allowed when the displacement voltage is directly connected. Dependent on the configuration under address 7911, either address 3009 (for direct connection) or address 3010 (for calculated displacement voltage) is available.

Since, for earth faults in **isolated** or **compensated** networks, the full displacement voltage appears, the setting value is not critical; it should lie between 30 V an 60 V. Earth fault is detected and annunciated only when the displacement voltage has been stayed for the duration T–E/F (address 3011). In **earthed** networks, the set value of the earth voltage Ue> can be more sensitive (smaller); but it shall not be exceeded by operational asymmetry of the voltages of the power system.

For phase determination Uph< (address 3006) is the criterion for the earth–faulted phase, when simultaneously the other two phase voltages have exceeded Uph> (address 3007). Accordingly, Uph< must be set lower than the minimum operational phase–earth voltage. This setting is, however, also not critical, 40 V (factory setting) should always be adequate. Uph> must lie above the maximum operational phase–earth voltage, but below the minimum operational phase–phase voltage, therefore, for example, 75 V at U_N = 100 V. These parameters are **irrelevant in earthed** systems.

Pick–up by the displacement voltage can be used for time delayed trip command. Pre–condition is that the EARTH FAULT detection is switched *ON* in address 3001; further E FLT DET = WITH UE OR IEE must be configured under address 7930. Trip delay is then set under address 3012 T–UE. Note, that the total command time is composed of the inherent measuring time (approximately 60 ms) plus pick–up delay T–E/F (address 3011) plus trip delay T–UE (address 3012).

3006 ■Uph< 40 V	Phase–earth voltage of a faulted phase which will be safely undershot under earth fault conditions Smallest setting value: **10** V Largest setting value: **100** V

[1]) only for model 7SJ531★–★★★★2–★★★★

△ ▽ 3007 ■Uph> 75 V	Phase−earth voltage of healthy phases which will safely be exceeded under earth fault conditions Smallest setting value: **10** V Largest setting value: **100** V
△ ▽ 3009 ■Ue> meas. [1]) 40.0 V	Threshold value for measured displacement voltage Ue> [1]) Smallest setting value: **1.8** V Largest setting value: **130.0** V
△ ▽ 3010 ■Ue> cal. 40 V	Threshold value for the calculated displacement voltage Ue> (= $\sqrt{3} \cdot U_0$). Smallest setting value: **6.0** V Largest setting value: **130.0** V
△ ▽ 3011 ■T−E/F 1.00 s	Duration of displacement voltage after which earth fault is detected and annunciated Smallest setting value: **0.04** s Largest setting value: **320.00** s and ∞ (no alarm)
△ 3012 ■T−UE 10.00 s	Time delay for tripping with Ue> (only if switched *ON*) Smallest setting value: **0.10** s Largest setting value: **40000.00** s and ∞ (no trip)

In model 7SJ531★−★★★★2−★★★★, a two−stage current time characteristic can be set in order to detect earth currents, under addresses 3013 to 3021. Each stage can operate directional or non−directional. The magnitude of the earth current is decisive for pick−up of these stages. They are used in cases where the magnitude of the earth current is the mean criterion of the earth fault, therefore, preferably in **solidly earthed** or **low−impedance earthed** systems, or for **electrical machines** in bus−bar connection with isolated systems, where the high capacitive current of the system can be expected in case of machine earth fault but only an insignificant earth current in case of a system earth fault because of the low machine capacitance.

The position of the directional characteristics can be set under addresses 3023 and 3024 to suit the application. Explanations are given below, before the illustration of these parameter addresses.

The high−value stage is designated with IEE>> (pick−up value in address 3013). It can be delayed by T−IEE>> (address 3014) and lead to annunciation or even to trip. The latter is only possible if trip has been set, i.e. under address 3001 E/F PROTEC = *ON*. The direction of this stage can be set to *FORWARDS*, *REVERSE*, or *NON−DIRECTIONAL* under address 3015.

△ ▽ 3013 ■IEE>> [1]) 0.300 A	Threshold value for I_{EE}>> stage [1]) Smallest setting value: **0.003** A Largest setting value: **1.500** A

[1]) only for model 7SJ531★−★★★★2−★★★★

3014 ■T-IEE>> [1] 1.00 s	Time delay for tripping with the I_{EE}>> stage [1] (only if trip: E/F PROTEC = *ON* in address 3001) Smallest setting value: **0.00** s Largest setting value: **320.00** s and ∞ (no trip)
3015 ■IEE>> DIR. [1] FORWARDS	Operating direction for the I_{EE}>> stage [1] *FORWARDS* forward direction, normally line or transformer
REVERSE	*REVERSE* reverse direction, normally bus−bar
NON-DIRECTIONAL	*NON−DIRECTIONAL* in either direction; in this case, no displacement volt−age is necessary

The low−value stage can operate with a definite time lag or user specified inverse time lag characteristic. This depends on selection for earth faults during configuration in Section 5.4.2 (address 7830). In addresses 3017 to 3020, only those parameters are available which are associated with the selected function mode of the earth fault protection.

Addresses 3017 and 3018 are relevant only in case the **definite time** characteristic has been chosen under address 7830 (EARTH FAULT = *DEFINITE TIME*).

If the stage IEE> is not used then set the time T−IEE> to ∞.

Addresses 3019 and 3020 are relevant only in case an **user specified inverse** time characteristic has been chosen under address 7830 (EARTH FAULT= *USER CHARACTER.*

If the stage I_{EEp} is not used then set the time T−IEEp to ∞.

3017 ■IEE> [1] 0.100 A	**Only for definite time mode** [1]): Threshold value for I_{EE}> stage Smallest setting value: **0.003** A Largest setting value: **1.500** A
3018 ■T-IEE> [1] 2.00 s	Time delay for tripping with the I_{EE}> stage [1] (only if trip function has been parameterized, address 3001 E/F PROTEC = *ON*) Smallest setting value: **0.00** s Largest setting value: **320.00** s and ∞ (no trip)
3019 ■IEEp [1] 0.100 A	**Only for user specified inverse time mode** [1]): Threshold value for I_{EEp} stage Smallest setting value: **0.003** A Largest setting value: **1.400** A
3020 ■T-IEEp [1] 2.00 s	Time multiplier for tripping with the I_{EEp} stage [1] (only if trip: E/F PROTEC = *ON* in address 3001) Smallest setting value: **0.00** s Largest setting value: **4.00** s and ∞ (no trip)

[1]) only for model 7SJ531★−★★★★2−★★★★

△▽ 3022 ■IEE> DIR. [1])	FORWARDS	Operating direction for the I_{EE}> (definite time) or I_{EEp} (inverse time) stage [1])	
		FORWARDS	forward direction, normally line or transformer
	REVERSE	*REVERSE*	reverse direction, normally bus−bar
	NON−DIRECTIONAL	*NON−DIRECTIONAL*	in either direction

Addresses 3023 to 3025 are decisive for direction determination.

The current value IEE>/pDIR (address 3023) represents the release threshold for directional determination. In this case, it is the current component which is rectangular to the directional characteristic. The position of the directional characteristic itself is determined in addresses 3024 and 3025.

If address 3024 is set to PHI CORR = 0.0° then

– address 3025 E/F MEAS = *COS PHI* means that only the active component of the earth current is decisive for the threshold IEE>/p DIR (Figure 6.2),

– address 3025 E/F MEAS = *SIN PHI* means that only the capacitive component of the earth current is decisive for the threshold IEE>/p DIR (Figure 6.6).

Based on this definition, the directional characteristic can be shifted by ±45°. Examples are illustrated in Figures 6.7 and 6.8.

In **isolated** systems earth fault measurement with *SIN PHI* is used because the capacitive current is decisive for the earth fault direction.

In **compensated** systems earth fault measurement with *COS PHI* is used because the ohmic current is decisive for the earth fault direction.

In **earthed** systems earth fault measurement with *COS PHI* is used with a correction angle of −45° because the earth current is ohmic−inductive (Figure 6.7).

In **electrical machines** in bus−bar connection with an isolated system, *COS PHI* measurement can be selected with a correction angle of approximately +45° because the earth current is often composed of a capacitive component from the system and an active component from a earth fault load resistor (Figure 6.8).

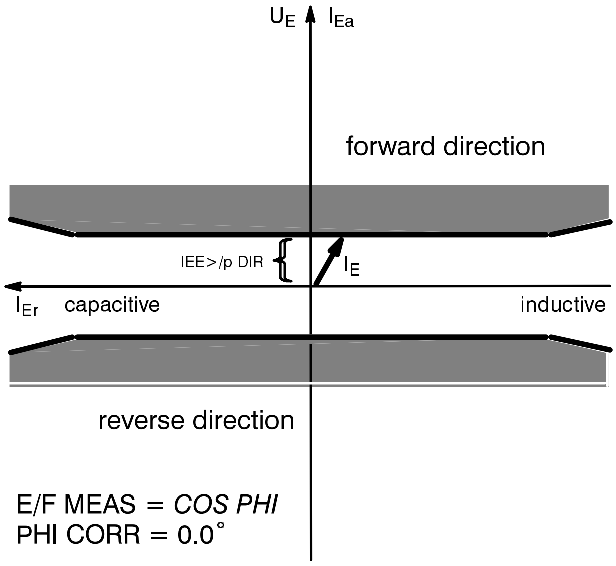


Figure 6.5 Directional characteristic with cos φ measurement

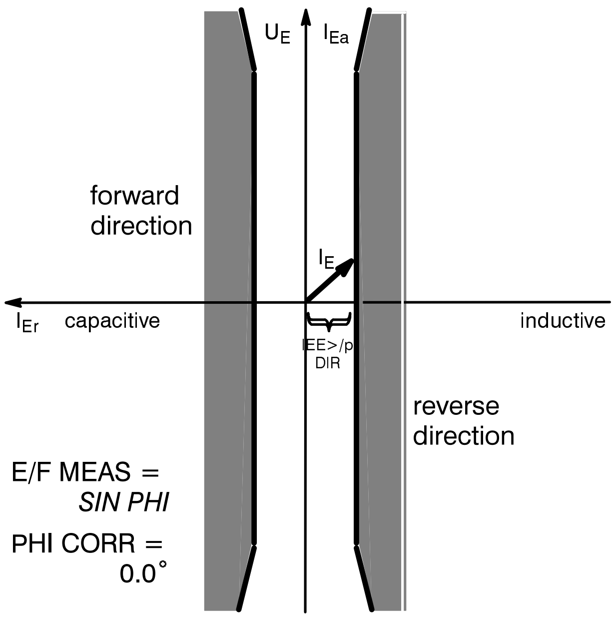


Figure 6.6 Directional characteristic with sin φ measurement

[1]) only for model 7SJ531★−★★★★2−★★★★

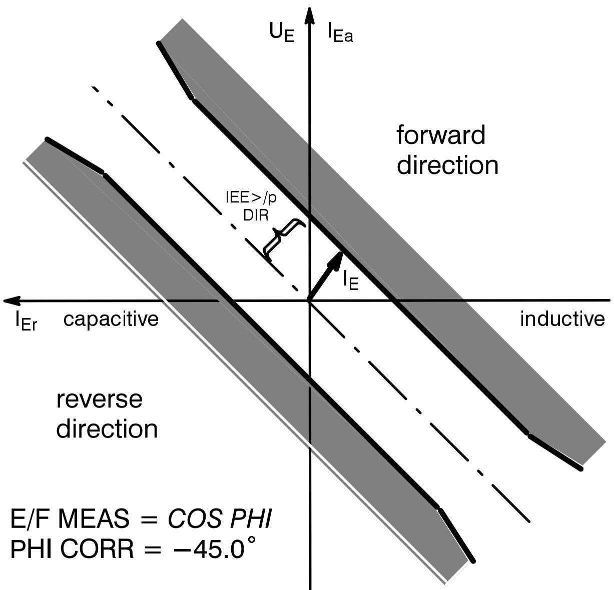


Figure 6.7 Directional characteristic with cos φ measurement and correction angle of −45°

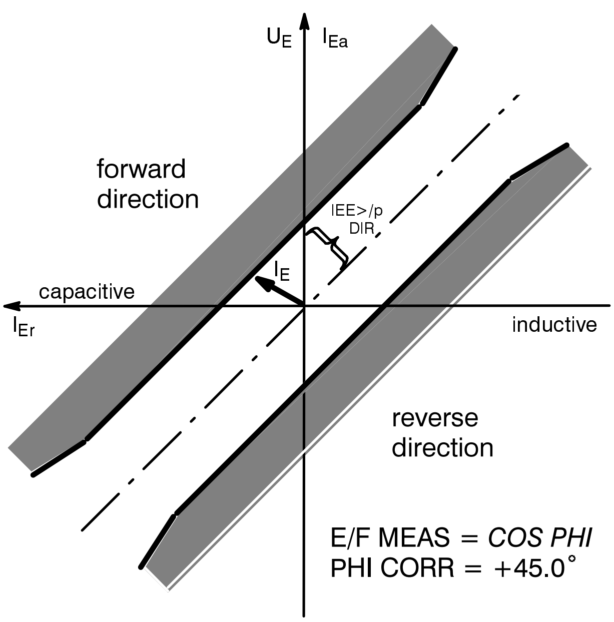


Figure 6.8 Directional characteristic with cos φ measurement and correction angle of +45°

For determination of the direction of the earth fault, in general, the threshold current (address 3023) should be set as high as possible to prevent faulty operation due to asymmetrical currents in the network and through the current transformers (particularly in Holmgreen connection).

In **isolated** networks an earth fault in a cable will allow the total capacitive earth fault currents of the entire electrically connected network, with the exception of the faulted cable itself, to flow through the measuring point. It is normal to use half the value of this earth fault current as the threshold value.

In **compensated** networks directional determination is made more difficult since a much larger reactive current of capacitive or inductive character is superimposed on the critical wattmetric current. The total earth current available to the relay can therefore, dependent upon the network configuration and location of the compensation coil, assume very different values in magnitude and phase angle. The relay, however, must evaluate only the real component of the earth fault current, that is, I_E x cos φ. This demands extremely high accuracy, particularly with regard to phase angle accuracy of all the instrument transformers. Also, the relay should not be set unnecessarily sensitive. When used in compensated networks therefore, reliable directional determination is only expected when core balance window−type transformers are used. Here also, use the thumb rule: setting at half the expected measured current, whereby only the residual wattmetric current is applicable. This residual wattmetric current is provided principally by the losses in the Petersen coil.

In **earthed** networks the threshold IEE>/p DIR is set slightly below the minimum expected earth fault current. Note that only the current component rectangular to the directional characteristic is decisive for pick−up of the IEE>/p DIR stage.

Generally the following applies: If directional determination is used in conjunction with one of the sensitive earth current stages as described above (address 3013 etc. for IEE>> or address 3017 etc. for IEE> or IEEp), then only a value smaller than the pick−up value of one of the above stages is meaningful for IEE>/p DIR.

The detected direction is annunciated (forward/reverse or undefined). These annunciations are stabilized against ”chattering” by a reset delay time T DIR STAB (address 3026).

△ ▽ 3023 ■IEE>/pDIR. [1]) 0.010 A	Threshold value for directional determination [1]) – capacitive component of earth fault current for isolated systems – ohmic earth fault current component for arc compensated systems – ohmic–inductive component of earth current according to the setting 3024 and 3025 Smallest setting value: **0.003** A Largest setting value: **1.200** A
△ ▽ 3024 ■PHI CORR [1]) 0.0 °	Correction angle for directional determination [1]), based on the measurement direction as defined under address 3025 Smallest setting value: **–45.0** deg Largest setting value: **45.0** deg
△ ▽ 3025 ■E/F MEAS. [1]) COS PHI	Measurement mode for directional determination [1]) *COS PHI* the ohmic current component is decisive for directional determination; for use in arc–compensated and earthed systems
SIN PHI	*SIN PHI* the capacitive current component is decisive for directional determination; for use in systems with isolated neutral
△ ▽ 3026 ■T DIR STAB [1]) 1 s	Reset delay of direction annunciations [1]) Smallest setting value: **0** s Largest setting value: **60** s

In model 7SJ531⋆–⋆⋆⋆⋆2, one user specified current time characteristic can be defined. Up to 20 pairs of values of current and time can be entered to the relay under address 3030.

In order to enter the value pairs, one must switch over to the table definition level with key combination **F**△, i.e. depressing the function key **F** followed by the arrow key △. During this change–over (i.e. from pressing the **F** key until pressing the △ key) the bar behind the address number is replaced by 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 ★ at the beginning of the second display line indicates that the relay expects the first current value. After input of this value it **must be confirmed by pressing the key E**! Then, the ★ appears in the middle of the second display line where the first time value is expected. Enter this value and **confirm with the enter key E**. Corrections can be made using the backspace key **R**, as usual.

Page on with the arrow key △ to the next value pair.

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

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

Up to 20 pairs of values can be defined. It is permitted to enter less pairs: In most cases, approximately 10 pairs of values are enough to define a sufficiently exact current time curve.

The current values are entered in multiple of setting value I_{EEp} (address 3019). The entered time values can be influenced by the time multiplier T_{IEEp} (address 3020).

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

[1]) only for model 7SJ531⋆–⋆⋆⋆⋆2–⋆⋆⋆⋆

Note: When the relay is delivered, all current values I/IEEp are preset with the value ∞. That means that all values are invalid and the relay never will trip by this characteristic. It is possible to define less than 20 pairs of values; but in this case, the remaining must be set to I/IEEp = ∞ so that they are marked to be invalid.

```
△ ‖ 3030■USER DEF. 1)      ‖
▽ ‖     CHARACTERISTIC     ‖
```

For "USER CHARACTER." only [1]):
Characteristic of the highly sensitive earth fault detection

Up to 20 pairs of values I/I_{EEp} and T/TI_{EEp} can be defined.

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

```
F△ ‖ 001 ■I/Ip - T/TIp    ‖
   ‖ ★          ★         ‖
```

Space for $I/I_{EE}p$ Space for $T/TI_{EE}p$

Pair of values No 001; for current I/Ip and time T

Setting range for current value $I/I_{EE}p$: **1.00** to **20.00** and ∞ (no pick−up)

Presetting for all values I/IEEp is ∞, i.e. no pick−up and therefore no trip. If less than 20 pairs of values are defined, the remaining must be left in factory setting ∞!
Setting range for time value $T/TI_{EE}p$: **0.01** to **999.00**

Presetting for all T/TIp: 1.00

```
△ ‖ 001 ■I/Ip - T/TIp    ‖
▽ ‖ ★                    ‖
```

Pair of values No 001; for current $I/I_{EE}p$ and time T/TI_{EEp}
e.g. first current value: $I/I_{EE}p$ = 1.00
(zeroes after decimal point can be omitted)

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

```
△ ‖ 001 ■I/Ip - T/TIp    ‖
▽ ‖   1.00     ★         ‖
```

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

Example after entry of the time value:

```
△ ‖ 001 ■I/Ip - T/TIp    ‖
▽ ‖ ★ 1.00      11.60    ‖
```

Pair of values No 001; for current I/Ip and time T
e.g. first current value: I/I_{EEp} = 1.00
first time value: T/TI_{EEp} = 11.60
(zeroes after decimal point can be omitted)

Continue with △

```
△ ‖ 002 ■ I/Ip - T/TIp   ‖
▽ ‖ ★ 1.10       11.34   ‖
```

Pair of values No 002; for current I/I_{EEp} and time T/TI_{EEp}
e.g. second current value: I/I_{EEp} = 1.10
second time value: T/TI_{EEp} = 11.34

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

```
F△ ‖ 3030■USER DEF. 1)     ‖
   ‖     CHARACTERISTIC    ‖
```

Definition of the user specified characteristic for the highly sensitive earth fault detection [1])

[1]) only for model 7SJ531★−★★★★2−★★★★

6.3.16 Settings for auto−reclosure − address block 34 [3])

The internal auto−reclose function is effective only if configured as *EXIST* under address 7834 (refer to Section 5.4.2).

When no auto−reclosure is to be carried out on the feeder which is protected by the relay 7SJ531 (e.g. cables, transformers, motors, etc.), then the internal AR function must be configured as *NON−EXIST* in address 7834 (refer to Section 5.4.2). The AR function is then not effective at all, i.e. 7SJ531 does not process the AR function. No corresponding annunciations are given, binary inputs for auto−reclosure are ignored. All parameters in block 34 are irrelevant and unavailable.

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

When switching manually on a dead fault, either via a binary input or from the integrated control facilities, it is normally desired that the AR function is blocked. Thus, address 3403 should remain in position M/C BLK = *YES*.

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

The lock−out time T−LOCK (address 3406) is the time period during which after an unsuccessful auto−reclosure further reclosures by 7SJ531 are blocked. This time must be longer than the renewed readiness for operation of the circuit breaker. If this time is set to ∞, reclose command is locked. It can be unlocked only when the binary input "`>AR Reset`" (FNo `2704`) is energized. It must be ensured that this binary input is accordingly assigned (refer to Section 5.5.2).

If any of the protection functions of 7SJ531 detects a fault within the set time for T−BLOC M/C (address 3407), definitive trip command is issued and reclosure is blocked provided M/C BLOCK (address 3403, see above) is switched *ON*.

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

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

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

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

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

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

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

[3]) only for model 7SJ531★−★★★★★−0★★★ and −2★★★

	Display	Explanation
R	3400 AUTO- RECLOSE FUNCTION	Beginning of block "Auto−reclose functions"
▽	3401 ■AR FUNCT OFF	Auto−reclose function is *OFF* switched off
N	ON	*ON* switched on
△ ▽	3403 ■M/C BLK YES	Blocking of reclosing after manual close of the circuit breaker (via binary input or internal control facility) normal setting: *YES*
N	NO	
△ ▽	3405 ■T-RECLAIM 3.00 s	Reclaim time after successful AR cycle Smallest setting value: **0.50** s Largest setting value: **320.00** s
△ ▽	3406 ■T-LOCK 3.00 s	Lock−out time after unsuccessful AR; any close command is blocked Smallest setting value: **0.50** s Largest setting value: **320.00** s and ∞ (locked until ">AR Reset" via binary input)
△ ▽	3407 ■T-BLOC M/C 1.00 s	Reclaim time after manual closing of circuit breaker Smallest setting value: **0.50** s Largest setting value: **320.00** s
△ ⩡	3412 ■CB? 1.TRIP NO	CB ready interrogation at the first trip command Presetting: *NO*
N	YES	*YES* − normal setting, if a readiness information is available from the circuit breaker
⩢ ▽	3413 ■CB? CLOSE CB? NEVER	CB ready interrogation before reclosing *NEVER* no CB ready interrogation be−fore reclosing
N	CB? WITH EACH AR	*WITH EACH AR* CB ready interrogation before each reclosing
	CB? WITH 2nd AR	*WITH EACH 2nd AR* CB ready interrogation before 2nd, 4th, 6th, etc. reclosing (RAR or DAR)
△ ▽	3415 ■T-CB-SUPV 3.00 s	CB supervision time within which CB must be ready Smallest setting value: **0.10** s Largest setting value: **320.00** s

For RAR (first auto−reclose cycle), addresses 3424 to 3426 are to be set.

When setting the action time RAR T−ACT (address 3424), it must be ensured that this time is at least as long as the command time of the protective relay. It can also be used to avoid auto−reclosure when a protection function has tripped a fault in a back−up time.

The dead times can be individually set after trip following a multi−phase fault (address 3425) and after trip of a single−phase fault (address 3426). The duration of the dead times is determined by the application philosophy. For long lines it should be long enough to ensure that the fault arc is extinguished and the air surrounding the arc is de−ionized, so that auto−reclosure can be successful. (0.9 s to 1.5 s). With multiple−end fed lines the stability of the network is the important consideration. Since the disconnected line can no longer produce any synchronizing power, only a short dead time is permitted in most cases. Conventional values lie between 0.3 s and 0.6 s. In radial networks a longer time can be tolerated.

For DAR (further auto−reclose cycles), parameters are set under addresses 3443 to 3447.

The number of DARs can be set differently for single−phase faults (address 3443) and for multi−phase faults (address 3444). This type of fault is decided with fault detection of the first fault.

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

Different dead times can be set for trip after single−phase faults (address 3446) and trip after multi−phase faults (address 3447).

```
△ ║ 3424 ■RAR T-ACT. ║
▽ ║      0.20 s      ║
```

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

```
△ ║ 3425 ■RAR T-PHA. ║
▽ ║      0.50 s      ║
```

Dead time for RAR cycle following multi−phase fault
Smallest setting value: **0.01** s
Largest setting value: **320.00** s

```
△ ║ 3426 ■RAR T-EAR. ║
▽ ║      0.50 s      ║
```

Dead time for RAR cycle following single−phase fault
Smallest setting value: **0.01** s
Largest setting value: **320.00** s

```
△ ║ 3443 ■DAR SHOT E ║
⩢ ║      1           ║
```

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

```
⩣ ║ 3444 ■DAR SHOT P ║
▽ ║      1           ║
```

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

```
△ ║ 3445 ■DAR T-ACT. ║
▽ ║      0.20 s      ║
```

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

```
△ ║ 3446 ■DAR T-EAR. ║
▽ ║      0.80 s      ║
```

Dead time for DAR cycle following single−phase fault
Smallest setting value:
Largest setting value: **0.01** s
1800.00 s

```
△ ║ 3447 ■DAR T-PHA. ║
  ║      0.80 s      ║
```

Dead time for DAR cycle following multi−phase fault
Smallest setting value: **0.01** s
Largest setting value: **1800.00** s

6.3.17 Settings for trip circuit supervision – address block 37 [1])

7SJ531 includes a breaker failure protection with integrated current monitor in model 7SJ531⋆–⋆⋆⋆⋆2–⋆⋆⋆⋆ (refer Section 4.11), which requires one or two binary inputs. This can operate provided it has been configured using one (”*BYPASS RESISTOR*” or two (”*WITH 2 BI*”) binary inputs under address 7839 (refer to Section 5.4.2) and if it is switched *ON* (address 3701).

Note: If one binary input is used, trip circuit faults like interruption or control voltage failure can be detected but not trip circuit fault which occur during closed trip relay of the device. Therefore, the alarm must be delayed such that the longest possible duration of the trip command is safely bridged. Thus, the bridging time T FAIL TC (address 3702) must be set longer than the longest expected trip command in the trip circuit which is monitored.

Note: If the monitored trip circuit is exclusively energized by the 7SJ531 relay, then a relatively short bridging time T FAIL TC (address 3702) is permissible since the trip circuit monitor is inoperative during a fault. But this time should be longer than the minimum trip duration as set for T TRIP under address 1134 in order to ensure that no alarm is produced after clearance of the fault when the minimum trip command duration is still running.

Details about the function of this supervision are given in Section 4.11. Section 5.2.5.3 contains information about connection and dimensioning hints as to the resistor in case of supervision with one single binary input.

△▽	`3700 ■TRIP CIR'T` `SUPERVISION`	Beginning of the block ”Trip circuit supervision”

△▽	`3701 ■TRIP SUP` `OFF`	Trip circuit supervision is *OFF* switched off
N	`ON`	*ON* switched on

Address 3802 is relevant only in case trip circuit supervision is carried out with one single binary input; address 7837 is then configured: TRIP SUPERV = *BYPASS RESISTOR*.

△▽	`3702 ■T FAIL TC` `2 s`	Bridging time (= alarm delay) for trip circuit supervision with one single binary input Smallest setting value: **1** s Largest setting value: **900** s

---

[1]) only for model 7SJ531⋆–⋆⋆⋆⋆**2**⋆–⋆⋆⋆⋆

6.3.18 Settings for fault location − address block 38 [1])

Distance to fault will be calculated as long as FAULT LOCAT = *EXIST* has been set in address 7838 during configuration (see Section 5.4.2).

Normally fault location calculation is initiated at the instant when a tripping command is issued. It can, however, also be started on fault detection drop−off (address 3802) if, for example, another protection device clears the fault. Additionally, fault location can be initiated by an external command via a binary input (FNo `1106`, ”`>Start FltLoc`”, refer Section 5.5.2), provided, the protection has picked up.

To calculate the distance in miles or kilometers, the device requires the reactance value per unit line length in Ω/mile or in Ω/km as a secondary value. Conversion from primary to secondary value is made by using the formula:

$$X_{sec} = \frac{N_{Ct}}{N_{vt}} \cdot X_{prim}$$

where N_{ct} – c.t. ratio
N_{vt} – v.t. ratio
X_{prim} – primary reactance per unit line length

If one puts in the reactance value of the line in Ω/mile for X_{prim} one obtains the required setting value X SEC (address 1122). If one puts the reactance value in Ω/km for X_{prim} one obtains the required setting value X SEC (address 1123). The distance unity has been decided during configuration in address 7103 (Section 5.3.2).

<u>Example:</u>

110 kV overhead line Alu/Steel 240/40 mm^2 with the characteristics:

X_{prim}	= 0.39 Ω/km
s (length)	= 60 km
c.t.	600 A/5 A
v.t.	110 kV/0.1 kV

$$X_{sec} = \frac{N_{Ct}}{N_{vt}} \cdot X_{prim}$$

$$= \frac{600/5}{110/0.1} \cdot 0.39\,\Omega/\text{km}$$

$$= 0.0425\,\Omega/\text{km}$$

If, for example, a fault reactance of 2.30 Ω primary (= 0.25 Ω sec.) is calculated, this example gives us the fault location data

Xpri = 2.30 Ω
X_{sec} = 0.25 Ω

$$d = \frac{0.25\,\Omega}{0.0425\,\Omega/\text{km}} = 5.88\,\text{km}$$

R

```
3800 ■
     FAULT LOCATION
```

Beginning of block ”Fault location”

△ ▽

```
3802 ■START
     DROP-OFF or TRIP

     TRIP COMMAND
```

Start−to−measure of fault location is initiated

− by *DROP−OFF* of the fault detector or by *TRIP* command

− only by *TRIP COMMAND*

---

[1]) only for model 7SJ531★−★★★★**2**★−★★★★

6.3.19 Settings for circuit breaker failure protection – address block 39

7SJ531 includes a breaker failure protection with integrated current monitor. This can operate provided it has been configured as *EXIST* under address 7839 (refer to Section 5.4.2) and if it is switched *ON* (address 3901).

Three sources are available for initiation of the circuit breaker failure protection, which can be switched on and off by parameters of their own (addresses 3902 to 3904).

Address 3905 determines whether the breaker auxiliary contact, fed in through a binary input, shall be considered for formation of the pick–up or not. When this parameter is *ON*, then the current criterion and/or the auxiliary contact criterion are used. This gains importance when the current despite of a closed circuit breaker is smaller than the selectable current threshold (BRK CLOSED, address 1160). This may happen, when the protection trip originates from a voltage measurement (e.g. UE Trip, U> Trip, U< Trip). Without the auxiliary contact criterion, the circuit breaker failure protection could not be activated in this case.

Setting of the current threshold (BRK CLOSED, address 1160) of the breaker failure protection is common for all three poles. The current threshold is set such that it responds to the minimum expected short–circuit current. Thus, it should be 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 6.9.

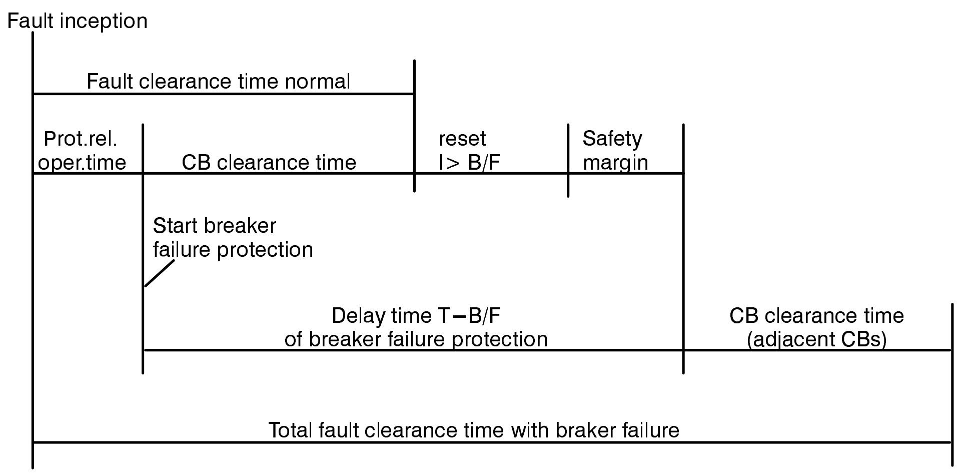


Figure 6.9 Time sequence for normal clearance of a fault, and with circuit breaker failure

R	3900 BREAKER FAILURE PROTEC.	Beginning fo the block ”Circuit breaker failure protection”
▽	3901■B/F PROT. OFF	Switching *OFF* of the circuit breaker failure protection
N	ON	Switching *ON* of the circuit breaker failure protection
△ ▽	3902■INT ORIGIN ON	Start by <u>internal protection function</u>: Switching *ON* or
N	OFF	Switching *OFF*
△ ▽	3903■EXT ORIGIN ON	Start by <u>external protection</u> via binary input: Switching *ON* or
N	OFF	Switching *OFF*
△ ▽	3904■CONTR ORIG OFF	Start by trip by internal <u>local control</u> command Switching *OFF* or
N	ON	Switching *ON*
△ ▽	3905■AUX CONT. OFF	<u>Breaker auxiliary contact</u> position is not processed as CB position indication
N	ON	<u>Breaker auxiliary contact</u> position is processed as CB position indication
△	3907■T-B/F 0.25 s	Trip delay time of the circuit breaker failure protection Setting range: **0.06** s to **60.00** s; or ∞ (no trip)

6.4 Annunciations

6.4.1 Introduction

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

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

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

– LED indications in the front plates 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 system interface to local or remote control facilities (if available).

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

For configuration of the transfer of annunciations via the serial interfaces, the necessary data are entered in address block 72 (see Section 5.3.4).

To call up annunciations on the operator panel proceed as follows:

Press the button **MENU**: the first page of the OPERATION MENU appears (refer Figure 6.10). Since not all menu options are available on one page, one can use the paging key ⩔ to get to the second page; back paging is possible with ⩓. But all annunciations can be accessed on the first page. Within this menu page, the option number is entered to select one of the menu options.

The backspace key **R** is used to return to the upper menu. If the **R**–key is pressed in the main menu OPERATION MENU, the basic picture is displayed again.

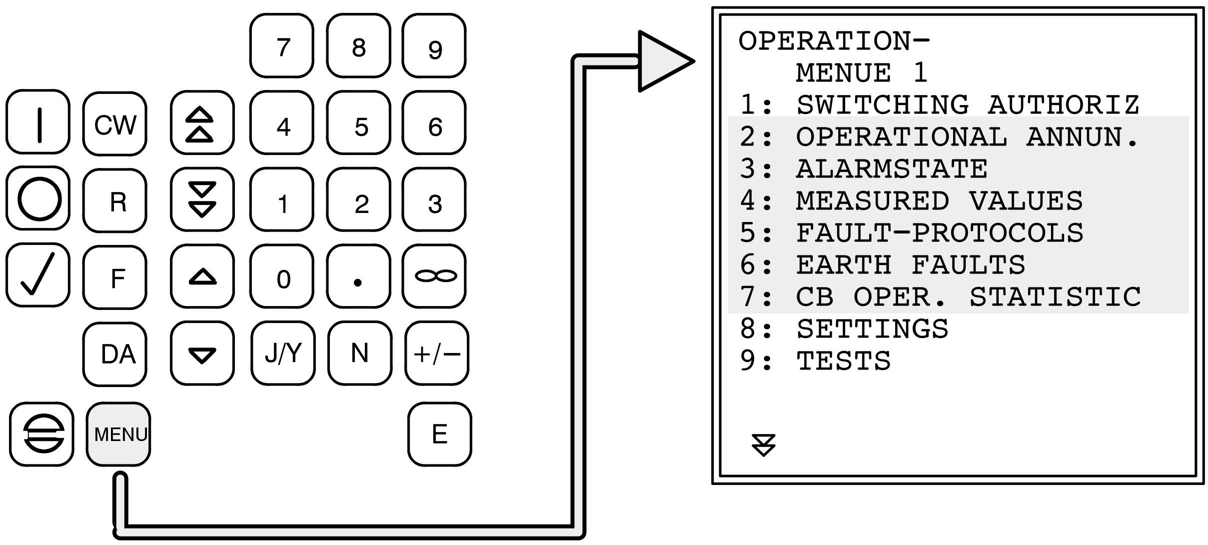


Figure 6.10 Operation menu and selection of annunciations

The annunciations are arranged as follows and can be selected by the assigned number:

Option **2**: Operational annunciations; these are messages which can appear during the operation of the relay: information about events and condition of relay functions, measurement data etc.

Option **3**: Alarm state annunciations; these are status messages which are active at present: information about condition of relay functions, measurement data etc.

Option **4**: Indication of operational measured values (currents, voltages, powers, frequency etc.).

Option **5**: Event annunciations of network faults; the last 8 fault are listed. As defined, a network fault begins with pick−up of any fault detector. If auto−reclose is carried out, the network fault ends after expiry of the last reclaim time; thus an AR−shot (or all shots) occupy only one fault data store. Within a network fault, several fault events can occur, from pick−up of any fault detection until drop−off.

Option **6**: Annunciations of an earth fault report.

Option **7**: Annunciations of circuit breaker operation statistics, that is counters for first AR (RAR), second or further AR (DAR), number of CB operations (trip and close), operating hours of the protected object (load flow) as well as the date when the counters have been reset the last time.

A comprehensive list of the possible annunciations and output functions with the associated function number FNo is given in Appendix F. It is also indicated to which device each annunciation can be routed. Functions which are not available in the relay or ”de−configured”, generate, of course, no annunciations.

6.4.2 Operational annunciations

Operational and status annunciations contain information which the unit provides during operation and about the operation. These annunciations are selected with the **MENU**−key → OPERATION−MENU 1 → option **2**: OPERATIONAL ANNUN. When no massages are present, the display shows *TABLE EMPTY*.

Otherwise, important events and status changes are chronologically listed, starting with the oldest message (see Figure 6.11 as an example of operational annunciations). The most recent messages is situated at the bottom of the list. Time information is shown in hours, minutes, and seconds (with 3 decimal digits).

Up to 80 operational indications can be stored. New annunciations are listed at the end. If more than 100 occur, the oldest are erased in sequence. This is indicated by the message ”`TABLE OVERFLOW`”. When the capacity of the store is not yet exhausted, the last message is ”`END OF TABLE`”. The operational annunciations are not actualized during read−out.

Scrolling through the annunciations is possible with the keys ▽ and △. The paging key ⩯ takes you to the previous 6 annunciations, key ⩮ to the next 6 annunciations.

Faults in the network are only indicated as ”`System Flt`” together with the sequence number of the fault. Detailed information about the history of the fault is contained in blocks ”Fault annunciations”, refer to Section 6.4.4.

Earth fault are indicated with ”`E/F Det`”; detailed information can be found in the earth fault report (refer to Section 6.4.5).

The input of the codeword is not required.

The boxes below show all available operational annunciations. In each specific case, of course, only the associated annunciations appear in the display. The annunciations which are indicated by a leading ”>” sign, represent the direct confirmation of the binary inputs.

Next to the boxes below, the abbreviated forms are explained. It is indicated whether an event is announced on occurrence (**C** = ”**C**oming”) or a status is announced ”**C**oming” and ”**G**oing” (**C**/**G**). The first listed message is, as example, assigned with date and time in the first line; the second line shows the beginning of a condition with the character **C** to indicate that this condition occurred at the displayed time.

You can change back to the operation menu with the backspace key **R** or with the **MENU** key.

```
OPERATIONAL ANNUN.
 ⇑
04.10.94 16:08:38,263
   B/F off    :C
04.10.94 16:08:49,422
   LED reset  :C
04.10.94 16:09:17,106
   CB in Test :C
04.10.94 16:16:33,337
   Failure 15V:C
04.10.94 16:17:27,282
   Failure 15V:G
04.10.94 16:21:15,974
 ⇓ System Flt 11:C
```

```
OPERATIONAL ANNUN.
 ⇑
04.10.94 16:23:14,734
   B/F off    :G
04.10.94 16:34:51,09
   LED reset  :C
04.10.94 16:42:48,88
   err:DC pos Q8 :C
04.10.94 16:59:36,00
   CB in Test :G
04.10.94 17:22:33,87
   Failure Isymm: C
04.10.94 17:23:00,12
 ⇓ Failure Isymm: G
```

Figure 6.11 Example of operational annunciations; left hand: page 1, right hand: page 2

```
△ 04.07.95 14:10:38,263
▽    B/F off    :C
```

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

2nd line: Annunciation text, in the example **C**oming

If the real time clock is not available the date is replaced by ⋆⋆.⋆⋆.⋆⋆, the time is given as relative time from the last re−start of the processor system.

Direct response from binary inputs:

>Start FltRec	Fault recording started via binary input (C)
>Annunc. 1	User definable annunciation No 1 received via binary input (C/G)
>Annunc. 2	User definable annunciation No 2 received via binary input (C/G)
>Annunc. 3	User definable annunciation No 3 received via binary input (C/G)
>Annunc. 4	User definable annunciation No 4 received via binary input (C/G)

>Sys-Test	System interface messages and measured values are marked with "Test operation" (C/G)
>Sys-MM-block	System interface messages and measured values are blocked" (C/G)
>Manual Close	Manual close signal from discrepancy switch (C/G)
>Manual Trip	Manual trip signal from discrepancy switch (C/G)
>RAR Release	Release RAR stages from external AR device (C)
>Buchh. Warn	Buchholz protection warning stage (C/G)
>Buchh. Trip	Buchholz protection tripping stage (C/G)
>UE block	Block displacement voltage trip (C/G)
>E/F annunc.	Switch earth fault detection to give annunciations only (C/G)
>IEE>> block	Block I_{EE}>> stage of highly sensitive earth fault detection from an external device (C/G)
>IEE> block	Block I_E> stage (definite time) of highly sensitive earth fault detection from an external device (C/G)
>IEEp block	Block I_{Ep} stage (user specified) of highly sensitive earth fault detection from an external device (C/G)
>O/L alarm	Switch thermal overload protection to give annunciations only (C/G)
>MSP emerg st	Block restart lockout in order to allow an emergency start (K/G)
>I>> block	Block I>> stage of phase overcurrent protection from an external device (C/G)
>I> block	Block I> stage (definite time) of phase overcurrent protection from an external device (C/G)
>Ip block	Block I_p stage (inverse time) of phase overcurrent protection from an external device (C/G)
>IE>> block	Block I_E>> stage of earth overcurrent protection from an external device (C/G)
>IE> block	Block I_E> stage (definite time) of earth overcurrent protection from an external device (C/G)
>IEp block	Block I_{Ep} stage (inverse time) of earth overcurrent protection from an external device (C/G)
>I>>Block dir	Block directional I>> stage of phase overcurrent protection from an external device (C/G)
>I> Block dir	Block directional I> stage of phase overcurrent protection from an external device (C/G)
>Ip Block dir	Block directional I_p stage (inverse time) of phase overcurrent protection from an extern. device (C/G)
>IE>>Bloc dir	Block directional I_E>> stage of earth overcurrent protection from an external device (C/G)
>IE>Block dir	Block directional I_E> stage (definite time) of earth overcurrent protection from an extern. device (C/G)

>IEpBlock dir	Block directional I_{Ep} stage (inverse time) of earth overcurrent protection from an external device (C/G)
>AR block	Block internal auto−reclose function (C/G)
>AR reset	Reset internal auto−reclose function (C)
>DAR block	Block DAR via binary input (C/G)
>Start AR	Starting signal from external protection for internal AR (C)
>Trip E Fail.	Trip signal after single−phase fault from external protection for internal AR (C)
>Trip Ph Fail	Trip signal after multi−phase fault from external protection for internal AR (C)
>SUP trip rel	Trip circuit supervision: input in parallel to trip relay contact (C/G)
>SUP CB aux.	Trip circuit supervision: input in parallel to circuit breaker auxiliary contact (C/G)
>Start FltLoc	Start fault locator by external command via binary input (C)
>MCB trip	Miniature circuit breaker has tripped (C/G)
>SF6 pres fd	SF6 pressure alarm feeder side (C/G)
>SF6 pres bb	SF6 pressure alarm bus−bar side (C/G)
>HV fuse bl	High−voltage fuse blown (C/G)
>LV plug rem	Low−voltage plug removed (C/G)
>tempalarm	Temperature alarm (C/G)
>temptrip	Temperature trip (C/G)
>u/v annunc	Undervoltage protection only annunciations (no trip) (C/G)
>u< block	Block U< stage of undervoltage protection (C/G)
>u<< s crit	Start−up criterion for undervoltage protection stage U<< via binary input (C/G)
>u<< block	Block U<< stage of undervoltage protection (C/G)
>vt fail feed	Voltage transformer secondary circuit failure (m.c.b. tripped) on feeder side (C/G)
>vt fail bb	Voltage transformer secondary circuit failure (m.c.b. tripped) on bus−bar side (C/G)
>o/v annunc.	Undervoltage protection only annunciations (no trip) (C/G)
>o/v block	Block U> stage of overvoltage protection (C/G)

`>SW.auth.rem`	Switching authorization: remote (C/G)
`>SW.auth.bloc`	Switching authorization: blocked (C/G)

General operational annunciations of the device:

`Dev.operative`	Device operative (C/G)
`Prot. operat.`	At least one protection function is active (C/G)
`Initial start`	Initial start of the processor system (C)
`LED reset`	Stored LED indications reset (C)
`Param.running`	Parameters are being set (C/G)
`Param. Set A`	Parameter set A is active (C/G)
`Param. Set B`	Parameter set B is active (C/G)
`System Flt`	Network system fault (C/G), detailed information in the fault annunciations
`E/F Det.`	Earth fault detected (in non−earthed system) (C/G), detailed information in the earth fault report
`CB in Test`	Circuit breaker test is in progress (C/G)

Operational annunciations of monitoring functions:

`Wrong SW-vers`	Software version of the device is wrong (C)
`Wrong dev. ID`	Device identification number is wrong (C)
`Annunc. lost`	Annunciations lost (buffer overflow) (C)
`Annu. PC lost`	Annunciations for operating (PC) interface lost (C)
`Oper.Ann.Inva`	Operational annunciations invalid (C/G)
`Flt.Ann.Inval`	Fault annunciations invalid (C/G)
`E/F Prot.Inva`	Earth fault report (for non−earthed systems) invalid (C/G)
`Stat.Buff.Inv`	Buffer for operation statistics invalid (C/G)
`LED Buff.Inva`	Buffer for stored LEDs invalid (C/G)

VDEW StateInv	VDEW state invalid (for protocol acc. IEC 870−5−103) (C/G)
Chs Error	Check−sum error detected (C/G)
Chs A Error	Check−sum error detected for parameter set A: no operation possible with this set (C/G)
Chs B Error	Check−sum error detected for parameter set B: no operation possible with this set (C/G)
Failure 24V	Failure in internal supply voltage 24 V (C/G)
Failure 15V	Failure in internal supply voltage 15 V (C/G)
Failure 0V	Failure in offset voltage 0 V (C/G)
Failure I/O 1	Failure on first input/output module (C/G)
Fail. TripRel	Supervision trip circuit (C/G)
Fail.Battery	Failure of internal back−up battery (C/G)
LSA disrupted	LSA−link disrupted (system interface) (C/G)
Failure ΣI	Failure detected by current plausibility monitor ΣI (C/G)
Fail.ΣI (IEE)	Failure detected by current plausibility monitor ΣI_{EE} (C/G)
Failure Isymm	Failure detected by current symmetry monitor (C/G)
Failure ΣUp-p	Failure detected by voltage plausibility monitor ΣU_{ph-ph} (C/G)
Failure Usymm	Failure detected by voltage symmetry monitor (C/G)
Fail.PhSeq I	Failure detected by phase sequence monitor of currents (C/G)
Fail.PhSeq V	Failure detected by phase sequence monitor of voltages (C/G)
Flt.RecDatDel	Fault recording data deleted (C)
Flt.Rec.viaBI	Fault recording triggered via binary input (C)
Flt.Rec.viaKB	Fault recording triggered via the front keyboard (C)
Flt.Rec.viaPC	Fault recording triggered via operating (PC) interface (C)
IL1 exceeded	Limit value of phase current monitor L1 exceeded (C/G)
IL2 exceeded	Limit value of phase current monitor L2 exceeded (C/G)

`IL3 exceeded`	Limit value of phase current monitor L3 exceeded (C/G)
`IE exceeded`	Limit value of earth current monitor exceeded (C/G)
`IL< alarm`	Limit value of undercurrent monitor fallen below (C/G)
`cosφ alarm`	Limit value of power factor monitor cos ϕ< fallen below (C/G)
`Pa exceeded`	Limit value of active power monitor exceeded (C/G)
`Pr exceeded`	Limit value of reactive power monitor exceeded (C/G)
`err:CB pos Q0`	Position feedback signal for the circuit breaker Q0 is undefined (C/G)
`err:DC pos Q1`	Position feedback signal for the bus−bar disconnector Q1 is undefined (C/G)
`err:DC posQ01`	Position feedback signal for the disconnector Q01 is undefined (C/G)
`err:DC pos Q5`	Position feedback signal for the operation earthing switch Q5 is undefined (C/G)
`err:DC pos Q6`	Position feedback signal for the measuring earthing switch Q6 is undefined (C/G)
`err:DC pos Q8`	Position feedback signal for the feeder earthing switch Q8 is undefined (C/G)
`err:DC posQ10`	Position feedback signal for the coupling disconnector Q10 is undefined (C/G)
`err:DC posQ15`	Position feedback signal for the bus−bar earthing switch Q15 is undefined (C/G)
`err:DC posQ16`	Position feedback signal for the bus−bar earthing switch Q16 is undefined (C/G)
`err:DC pos Q2`	Position feedback signal for the bus−bar disconnector Q2 is undefined (C/G)

Operational annunciations of highly sensitive earth fault detection:

`E/F Det. off`	Earth fault detection is switched off (C/G)
`E/F Det.block`	Earth fault detection is blocked (C/G)

Operational annunciations of breaker failure protection:

`B/F off`	Circuit breaker failure protection is switched off (C/G)
`B/F blocked`	Circuit breaker failure protection is blocked (C/G)
`B/F(man)trip`	Trip by circuit breaker failure protection after manual trip of the local breaker (C)

Operational annunciations of thermal overload protection:

O/L Prot. off	Thermal overload protection is switched off (C/G)
O/L blocked	Thermal overload protection is blocked (C/G)
O/L Warn I	Thermal overload protection: current warning stage (C/G)
O/L Warn Θ	Thermal overload protection: thermal warning stage (C/G)
O/L Pickup Θ	Thermal overload protection: pick−up of thermal trip stage (C/G)

Operational annunciations of motor restart lockout:

MSP off	Motor restart lockout is switched off (C/G)
MSP blocked	Motor restart lockout is blocked (C/G)
MSP Trip	Motor restart lockout has tripped (C/G)

Operational annunciations of overcurrent time protection:

O/C Ph off	Phase overcurrent time protection is switched off (C/G)
O/C Ph block	Phase overcurrent time protection is blocked (C/G)
O/C E off	Earth overcurrent time protection is switched off (C/G)
O/C E block	Earth overcurrent time protection is blocked (C/G)

Operational annunciations of directional overcurrent protection:

dir.O/C P off	Directional phase overcurrent time protection is switched off (C/G)
dir.O/C P blk	Directional phase overcurrent time protection is blocked (C/G)
dir.O/C E off	Directional earth overcurrent time protection is switched off (C/G)
dir.O/C E blk	Directional earth overcurrent time protection is blocked (C/G)

Operational annunciation of the internal auto−reclose function:

AR off	Auto−reclose function is switched off (C/G)

`AR inoperativ`	Auto−reclose function inoperative, i.e, cannot be initiated (C/G)
`CB not ready`	Auto−reclose function: Circuit breaker is not ready (C/G)

Operational annunciation of the undervoltage protection:

`u/v off`	Undervoltage protection is switched off (C/G)
`u/v blocked`	Undervoltage protection is blocked (C/G)

Operational annunciation of the overvoltage protection:

`o/v off`	Overvoltage protection is switched off (C/G)
`o/v blk`	Overvoltage protection is (C/G)

Operational annunciation of the unbalanced load protection (negative sequence current I_2)**:**

`I2 off`	Unbalanced load protection is switched off (C/G)
`I2 blocked`	Unbalanced load protection is blocked (C/G)

Operational annunciation of the motor start−up time supervision:

`STRT-SUP off`	Start−up time supervision is switched off (C/G)
`STRT-SUP blk`	Start−up time supervision is blocked (C/G)

Operational annunciation of trip circuit supervision:

`SUP off`	Trip circuit supervision is switched off (C/G)
`SUP MarshFail`	Trip circuit supervision is blocked because binary input is not marshalled (C/G)
`Failure TC`	Trip circuit is interrupted (C/G)

Operational annunciations of switching device control:

abort:sw.auth	Abortion of the control operation due to impermissible switching authority
abort:flt.det	Abortion of the control operation due to protection pick–up (C)
abort:cw	Abortion of the control operation due to codeword violation (C)
abort:entime	Abortion of the control operation due to expired entry time (C)
abort: set=is	Abortion of the control operation due to set state already being equal to actual state
abort:cmd ex.	Abortion of the control operation due to an already running command (C)
abort:BI dbl	Abortion of the control operation due to double selection of binary inputs (C)
abort:test	Abortion of the control operation due to running of a test sequence (C)
CR time exp	Permissible command running time for a switching command exceeded (C)
sw.auth.loc	Local control is possible C/G)
sw.auth.rem	Remote control is possible (C/G)

Further messages:

TABLE OVERFLOW	If more messages have been received the last valid message is TABLE OVERFLOW.
END OF TABLE	If not all memory places are used the last message is END OF TABLE.

6.4.3 Alarm state annunciations

In this menu the momentarily active alarms (states) are indicated. These alarms are an excerpt from the operations messages listed under 6.4.2 plus a few additional messages. The ALARM STATE is called up from the level OPERATION MENU 1 with numerical key **3** (see also Figure 6.10).

The messages are activated by entering the sub–menu ALARM STATE. The indication can be updated any time by operating the key E.

Beside an example (Figure 6.12) all available alarms are listed in the following. The short form text is described next to the box.

```
ALARMSTATE

O/C Ph active
O/C E active
o/v active
O/L active
Failure Isymm
IL2 exceeded
err:DC pos Q8
END OF TABLE
```

Figure 6.12 Example of alarm state annunciations

In the menu ”alarm state” only the momentarily active (after ”coming” until ”going”) operation messages are shown.

The display can be updated any time by the key **E**.

When no messages are available, the text ”TABLE EMPTY” appears.

The key **R** leads back to the level OPERATION MENU.

General alarm state annunciations:

LogMeasBlock	Messages and measured values via system interface blocked
Test mode	Messages and measured values via the system interface are marked with ”Test operation” (C/G)
Param. Set A	Parameter set A is active (C/G)
Param. Set B	Parameter set B is active (C/G)

Direct response from binary inputs:

>Buchh. Warn	Buchholz protection warning stage
>Buchh. Trip	Buchholz protection tripping stage

`>MCB trip`	Miniature circuit breaker has tripped
`>SF6 pres fd`	SF6 pressure alarm feeder side
`>SF6 pres bb`	SF6 pressure alarm bus−bar side
`>HV fuse bl`	High−voltage fuse blown
`>LV plug rem`	Low−voltage plug removed
`>tempalarm`	Temperature alarm
`>temptrip`	Temperature trip
`>vt fail feed`	Voltage transformer secondary circuit failure (m.c.b. tripped) on feeder side
`>vt fail bb`	Voltage transformer secondary circuit failure (m.c.b. tripped) on bus−bar side

Alarm state annunciations of monitoring functions:

`Oper.Ann.Inva`	Operational annunciations invalid
`Flt.Ann.Inval`	Fault annunciations invalid
`E/F Prot.Inva`	Earth fault report (for non−earthed systems) invalid
`Stat.Buff.Inv`	Buffer for operation statistics invalid
`LED Buff.Inva`	Buffer for stored LEDs invalid
`VDEW StateInv`	VDEW state invalid for protocol acc. IEC 870−5−103
`Wrong SW-vers`	Software version of the device is wrong
`Wrong dev. ID`	Device identification number is wrong
`Chs Error`	Check−sum error detected
`Chs A Error`	Check−sum error detected for parameter set A: no operation possible with this set
`Chs B Error`	Check−sum error detected for parameter set B: no operation possible with this set
`Failure 24V`	Failure in internal supply voltage 24 V
`Failure 15V`	Failure in internal supply voltage 15 V

`Failure 0V`	Failure in offset voltage 0 V
`Failure I/O 1`	Failure on first input/output module
`Fail. TripRel`	Failure on Trip relay
`LSA disrupted`	LSA−link disrupted (system interface)
`Failure ΣI`	Failure detected by current plausibility monitor ΣI
`Fail.ΣI (IEE)`	Failure detected by current plausibility monitor ΣI_{EE}
`Failure Isymm`	Failure detected by current symmetry monitor
`Failure ΣUp-p`	Failure detected by voltage plausibility monitor ΣU_{ph-ph}
`Failure Usymm`	Failure detected by voltage symmetry monitor
`Fail.PhSeq I`	Failure detected by phase sequence monitor of currents
`Fail.PhSeq V`	Failure detected by phase sequence monitor of voltages
`Fail.Battery`	Failure of internal back−up battery
`Blk fw failed`	Interlocking signal ”forward direction” disturbed
`Blk rw failed`	Interlocking signal ”reverse direction” disturbed
`IL1 exceeded`	Limit value of phase current monitor L1 exceeded
`IL2 exceeded`	Limit value of phase current monitor L2 exceeded
`IL3 exceeded`	Limit value of phase current monitor L3 exceeded
`IE exceeded`	Limit value of earth current monitor exceeded
`IL< alarm`	Limit value of undercurrent monitor fallen below
`cosφ alarm`	Limit value of power factor monitor cos φ< fallen below
`Pr exceeded`	Limit value reactive power P_r exceeded
`Pa exceeded`	Limit value active power P_a exceeded
`err:CB pos Q0`	Position feedback signal for the circuit breaker Q0 is undefined
`err:DC pos Q1`	Position feedback signal for the bus−bar disconnector Q1 is undefined

`err:DC pos Q2`	Position feedback signal for the bus–bar disconnector Q2 is undefined
`err:DC posQ01`	Position feedback signal for the disconnector Q01 is undefined
`err:DC pos Q5`	Position feedback signal for the operation earthing switch Q5 is undefined
`err:DC pos Q6`	Position feedback signal for the measuring earthing switch Q6 is undefined
`err:DC pos Q8`	Position feedback signal for the feeder earthing switch Q8 is undefined
`err:DC posQ10`	Position feedback signal for the coupling disconnector Q10 is undefined
`err:DC posQ15`	Position feedback signal for the bus–bar earthing switch Q15 is undefined
`err:DC posQ16`	Position feedback signal for the bus–bar earthing switch Q16 is undefined

Alarm state annunciations of overcurrent time protection:

`O/C Ph active`	Phase overcurrent time protection is active
`O/C E active`	Earth overcurrent time protection is active

Alarm state annunciations of directional overcurrent time protection:

`dir.O/C P act`	Directional phase overcurrent time protection is active
`dir.O/C E act`	Directional earth overcurrent time protection is active

Alarm state annunciations of the voltage protection functions:

`u/v active`	Undervoltage protection is active
`o/v active`	Overvoltage protection is active

Alarm state annunciation of the unbalanced load protection (negative sequence current)**:**

`I2 active`	Unbalanced load protection is active

Alarm state annunciation of the motor start–up time supervision:

`STRT-SUP act`	Start–up time supervision is active

Alarm state annunciations of thermal overload protection:

`O/L active`	Thermal overload protection is active
`O/L Warn I`	Thermal overload protection: current warning stage
`O/L Warn Θ`	Thermal overload protection: thermal warning stage

Alarm state annunciations of motor restart lockout:

`MSP active`	Motor restart lockout is active

Alarm state annunciations of highly sensitive earth fault detection:

`E/F Det.activ`	Earth fault detection is active

Alarm state annunciations of the internal auto−reclose function:

`AR off`	Auto−reclose function is switched off
`AR inoperativ`	Auto−reclose function inoperative, i.e, cannot be initiated
`CB not ready`	Auto−reclose function: Circuit breaker is not ready

Alarm state annunciations of trip circuit supervision:

`SUP off`	Trip circuit supervision is switched off
`SUP MarshFail`	Trip circuit supervision is blocked because binary input is not marshalled
`Failure TC`	Trip circuit is interrupted

Alarm state annunciation of breaker failure protection:

`B/F active`	Breaker failure protection is active

6.4.4 Fault annunciations

The annunciations which occurred during the last eight network faults can be read off on the front panel or via the operating interface. These annunciations are selected with the **MENU**−key → OPERATION−MENU 1 → option **5**: FAULT−PROTOCOLS. When no massages are present, the display shows ”`TABLE EMPTY`”.

Otherwise, the network faults are chronologically listed, starting with the most recent network fault (see example Figure 6.13). Within one fault report, the oldest annunciation is situated at the top of the list. Time information is shown in hours, minutes, and seconds (with 3 decimal digits) (refer to Figure 6.14).

```
FAULT ANNUNCIATIONS

1:22.08.95
  17:22:41,132
  System Flt 43
2:16.05.95
  01:45:01,947
  System Flt 42
3:16.05.95
  01:44:22,349
  System Flt 41
4:11.01.95
  10:11:45,293
 ⩔System Flt 40
```

```
FAULT ANNUNCIATIONS
⩓
5:31.08.94
  19:30:12,932
  System Flt 39
6:31.08.94
  19:29:55,143
  System Flt 38
7:31.08.94
  19:28:18,364
  System Flt 37
8:22.07.94
  05:28:25,245
  System Flt 36
```

Figure 6.13 Example for network faults, page 1 (left hand) and page 2 (right hand)

Paging between the display pages is possible with the paging keys ⩓ and ⩔. The individual annunciations of a fault can be obtained by entering one of the option numbers 1 to 8 (Figure 6.14).

```
001:22.09.94
    System Flt 43 :C
002:17:22:41,132
    Fault 43 :C
003:0 ms
    O?C Gen.Fault :C
004:0 ms
    Fault L13 :C
005:0 ms
    I>> Fault :C
006:9 ms
    T-I>> expired :C
007:9 ms
 ⩔  O?C Gen.Trip :C
```

Figure 6.14 Example of a fault report of system fault 1

For these purposes, the term ”system fault” means the period from short circuit inception up to final clearance. If auto−reclose occurs, then the ”system fault” is finished on expiry of the last reclaim or lock−out time, that is, after successful or unsuccessful AR. Thus the total fault clearance procedure inclusive AR−cycles occupies only one fault annunciation store. Within one system fault, several fault events can have occurred, i.e. from pick−up of any protection function until drop−off of the last pick−up of a protection function.

The fault protocol begins with the oldest event which represents the fault inception. The following events follow the fault inception. They are tagged with the relative time, starting with the fault detection. Each fault protocol can comprise up to 60 individual annunciations.

Page on with the paging keys ⩔ or back with ⩓ in case not all annunciations are displayed on one display page.

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 shown for a system fault, and explained.

Change−back to the overview is possible with the key **R**; with the **MENU**−key, the main menu is reached (OPERATION MENU).

Display	Explanation
▽ 001:22.08.95 System Flt 43 :K	under item 1, the date of the system fault is indicated, in the second line the consecutive number of the system fault
△▽ 002 17:22:41,132 Fault 43 :K	under item 2, the time of the beginning of the fault is displayed; time resolution is 1 ms
△▽ 003 0 ms Fault L13 :K	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.
△▽ 004 0 ms I>> Fault :K	
△▽ 005 101 ms I>> Trip :K	

etc.

General fault annunciations of the device:

Annunciation	Meaning
Flt.Buff.Over	Fault annunciations lost (buffer overflow)
Syst.Flt	System fault with consecutive number
Fault	Beginning of fault
Dev. Drop−off	Drop−off of the device, general
IL1/In=	Interrupted fault current of phase L1
IL2/In=	Interrupted fault current of phase L2
IL3/In=	Interrupted fault current of phase L3

Fault annunciations of overcurrent time protection:

Annunciation	Meaning
Fault L1	Overcurrent protection: fault detection phase L1
Fault L1E	Overcurrent protection: fault detection phase L1 − E

`Fault L2`	Overcurrent protection: fault detection phase L2
`Fault L2E`	Overcurrent protection: fault detection phase L2 – E
`Fault L12`	Overcurrent protection: fault detection phases L1 – L2
`Fault L12E`	Overcurrent protection: fault detection phases L1 – L2– E
`Fault L3`	Overcurrent protection: fault detection phase L3
`Fault L3E`	Overcurrent protection: fault detection phase L3 – E
`Fault L13`	Overcurrent protection: fault detection phases L1 – L3
`Fault L13E`	Overcurrent protection: fault detection phases L1 – L3– E
`Fault L23`	Overcurrent protection: fault detection phases L2 – L3
`Fault L23E`	Overcurrent protection: fault detection phases L2 – L3– E
`Fault L123`	Overcurrent protection: fault detection phases L1 – L2 – L3
`Fault L123E`	Overcurrent protection: fault detection phases L1 – L2 – L3 – E
`Fault E`	Overcurrent protection: earth fault detection
`I>> Fault`	Fault detection overcurrent protection on high phase current stage I>>
`I>> Trip`	Phase overcurrent time protection trip by high phase current stage I>>
`I> Fault`	Fault detection overcurrent protection on stage I> (definite time)
`I> Trip`	Phase overcurrent time protection trip by I> stage
`Ip Fault`	Fault detection overcurrent protection on stage I_p (inverse time)
`Ip Trip`	Phase overcurrent time protection trip by I_p stage
`IE>> Fault`	Fault detection overcurrent protection on high phase current stage I_E>>
`IE>> Trip`	Earth overcurrent time protection trip by I_E>>
`IE> Fault`	Fault detection overcurrent protection on stage I_E>
`IE> Trip`	Earth overcurrent time protection trip by I_E> stage
`IEp Fault`	Fault detection overcurrent protection on stage I_{Ep}
`IEp Trip`	Earth overcurrent time protection trip by I_{Ep} stage

Fault annunciations of directional overcurrent time protection:

`I>> dir.Fault`	Fault detection directional overcurrent protection on high phase current stage I>>
`I>> dir. Trip`	Directional overcurrent time protection trip by high phase current stage I>>
`I> dir.Fault`	Fault detection directional overcurrent protection on stage I> (definite time)
`I> dir. Trip`	Directional phase overcurrent time protection trip by I> stage
`Ip dir.Fault`	Fault detection directional overcurrent protection on stage I_p (inverse time)
`Ip dir. Trip`	Directional phase overcurrent time protection trip by I_p stage
`IE>>dir.Fault`	Fault detection directional overcurrent protection on high phase current stage I_E>>
`IE>>dir. Trip`	Directional earth overcurrent time protection trip by I_E>> stage
`IE> dir.Fault`	Fault detection directional overcurrent protection on stage I_E>
`IE> dir. Trip`	Directional earth overcurrent time protection trip by I_E> stage
`IEp dir.Fault`	Fault detection directional overcurrent protection on stage I_{Ep}
`IEp dir. Trip`	Directional earth overcurrent time protection trip by I_{Ep} stage

Fault annunciations of voltage protection:

`U< Fault`	Undervoltage protection: fault detection U< stage
`U< cc Fault`	Undervoltage protection: fault detection U< stage with current criterion
`U< sc Fault`	Undervoltage protection: fault detection U< stage with start−up criterion
`U< cc sc Flt`	Undervoltage protection: fault detection U< stage with current criterion and start−up criterion
`U<< Fault`	Undervoltage protection: fault detection U<< stage
`U<< cc Fault`	Undervoltage protection: fault detection U<< stage with current criterion
`U< Trip`	Undervoltage protection: trip by U< stage
`U<< Trip`	Undervoltage protection: trip by U<< stage
`U> Fault`	Overvoltage protection: fault detection U> stage
`U> cc Flt`	Overvoltage protection: fault detection U> stage with current criterion
`U> Trip`	Overvoltage protection: trip by U> stage

Fault annunciations of unbalanced load protection (negative sequence current)**:**

`I2>> Fault`	Negative sequence protection fault detection I_2>> stage
`I2> Fault`	Negative sequence protection fault detection I_2> stage
`I2> Trip`	Trip by negative sequence protection

Fault annunciations of start−up time supervision:

`Rotor locked`	Rotor is locked
`STRT-SUP trip`	Trip by supervision of start−up time

Fault annunciation of thermal overload protection:

`O/L Trip`	Trip by thermal overload protection

Fault annunciation of highly sensitive earth fault detection:

Note: The following annunciation can only be displayed in the fault annunciations if the earth fault protection is parameterized to trip on earth faults detected by this function (address 3001 EARTH FAULT = *ON*, refer also to Section 6.3.15). Otherwise, earth fault annunciations of the earth fault protection are stored in the earth fault report (refer to Section 6.4.5).

`E/F Detec. L1`	Earth fault in phase L1 detected
`E/F Detec. L2`	Earth fault in phase L2 detected
`E/F Detec. L3`	Earth fault in phase L3 detected
`E/F forwards`	Earth fault in forward direction detected
`E/F reverse`	Earth fault in reverse direction detected
`E/F undefined`	Earth fault direction undefined (not detectable)
`UE Fault`	Earth fault detection by displacement voltage
`UE Trip`	Trip by displacement voltage detection
`IEE>> Fault`	Earth fault detected by highly sensitive protection stage I_{EE}>>
`IEE>> Trip`	Trip by highly sensitive earth stage I_{EE}>>

`IEE> Fault`	Earth fault detected by highly sensitive protection stage I_{EE}>
`IEE> Trip`	Trip by highly sensitive earth stage I_{EE}>
`IEEp Fault`	Earth fault detected by highly sensitive protection stage I_{EEp} (inverse time)
`IEEp Trip`	Trip by highly sensitive earth stage I_{EEp} (inverse time)
`IEE=`	Magnitude of earth fault current (only when set non−directional)
`IEEa=`	Active component of the earth fault current (only when set directional)
`IEEr=`	Reactive component of the earth fault current (only when set directional)
`E/F Det.block`	Earth fault detection is blocked (if during fault)

Fault annunciation of internal auto−reclose function:

`AR Close Cmd.`	Reclose command from auto−reclose function issued

Fault annunciations of fault location:

`FLTLOCTYPE`	Fault location data, the line loop is indicated from which fault data have been calculated
`Xsek= Ω`	Calculated secondary fault resistance in ohms
`d = km`	Calculated fault distance in kilometers or miles, (dependent on setting of address 7103, Section 5.3.2), based on the parameterized rated values (addresses 1103 to 1105, refer to Section 6.3.3.1) and the line data as parameterized under addresses 1122 or 1123 (refer to Section 6.3.18)

Annunciations of circuit breaker failure protection:

`B/F(int)flt`	Initiation of breaker failure protection by internal protection function
`B/F(ext)flt`	Initiation of breaker failure protection by external protection function
`B/F(int)trip`	Trip by breaker failure protection after internal command
`B/F(ext)trip`	Trip by breaker failure protection after external command

Further messages:

`Table empty`	means that no fault event has been recorded
`Table overflow`	means that other fault data have occurred, however, memory is full
`Table superceded`	a new fault event has occurred during read−out: page on with △ or ▽; the display shows the first annunciation in the actualized order
`End of table`	If not all memory places are used the last message is `End of table`

6.4.5 Earth fault reports

For earth faults in isolated or compensated systems detected by the earth fault protection a special earth fault data store is provided. This is available only when this function is not parameterized to give trip command (address 3001 EARTH FAULT = *ALARM ONLY*, refer also Section 6.3.15). Up to 15 messages can be stored for each of the three last earth faults. Input of the codeword is not required.

The survey of the earth fault reports is obtained from with the **MENU**−key → OPERATION MENU → option **6**: EARTH FAULTS (see also Figure 6.10). When no data are available, the display shows ”`Table empty`”.

Otherwise the last three earth faults are presented (Figure 6.15). Each of the earth faults can be selected by the option numbers **1** to **3**. The individual messages are the displayed (refer to Figure 6.16). In the following, all the available earth fault annunciations are indicated. In the case of a specific fault, of course, only the associated annunciations appear in the display.

```
EARTH FAULT-
  PROTOCOLS
1:22.06.95
  15:22:41,132
  E/F Det. 3
2:16.01.95
  01:45:01,943
  E/F Det. 2
3:14.10.94
  09:15:47,923
  E/F Det. 1
```

Figure 6.15 Example of an earth fault survey

```
001:14.10.94
    E/F Det. 1
002:09:15:47,923
    E/F Detection :C
003:0 ms
    E/F Detec. L3 :C
004:34 ms
    E/F Detec. L3 :G
005:09:15:47,957
    E/F Detection :G
006:14.10.94
    E/F Det. 1
```

Figure 6.16 Example: Report of earth fault no.1

`001:14.10.94` `    E/F Det. 1`	under item No. 1, the date and the sequence number of the earth fault are displayed
`002:09:15:47,923` `    E/F Detection :C`	Item No. 2 shows the time of commencement of the earth fault
`003:0 ms` `    E/F Detec. L3 :C`	The following items indicate all earth fault annunciations in chronological sequence. They are tagged with the relative time, starting with the earth fault detection.
	The following items show the earth fault data
`E/F Detec. L1`	Earth fault detected in phase L1
`E/F Detec. L2`	Earth fault detected in phase L2
`E/F Detec. L3`	Earth fault detected in phase L3
`E/F forwards`	Earth fault in forward direction (if set directional)

`E / F   r e v e r s e`	Earth fault in reverse direction (if set directional)
`E / F   u n d e f i n e d`	Earth fault direction undefined (not detectable, if set directional)
`I E E a   =`	Active component of the earth fault current during earth fault
`I E E r   =`	Reactive component of the earth fault current during earth fault
`I E E     =`	Magnitude of earth fault current (if set non−directional) during earth fault
`E / F   B u f f . O v e r`	Earth fault report buffer overflow

6.4.6 Circuit breaker operation statistics − address block 56

The number of trip commands initiated by 7SJ531 is counted, including the manual and test trip commands. Also, the number of auto−reclose attempts is counted, separately for RAR and DAR. Additionally, the interrupted currents are stated for each individual pole following each trip command. The operating hours of the protected object under load (load current higher than the minimum current under address 1160) are accumulated. Additionally, the date of the last setting of the counters is displayed. Counter status and stores are secured against auxiliary voltage failure and can be read off in the breaker operation statistics.

These data can be obtained with **MENU** → OPERATION MENU → option **7**: CB OPER. STATISTICS. Paging in the display is possible with ⩔ and ⩓. Codeword input is not necessary.

Change back to main menu is performed with the **MENU**−key or the **R**−key.

The counters can be reset to 0 or to a required value in address block 82 (see Section 6.5.2).

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

```
CB OPER. STATISTICS

5602 RAR 3P =
     0
5603 DAR 3P =
     0
5604 TRIP No=
     2
5605 date:
     25.07.95
5610 LAST IL1/In
     0
5611 LAST IL2/In
 ⩔   0
```

Number of auto−reclose attempts after three−pole trip RAR cycles

Number of auto−reclose attempts after three−pole trip DAR cycles

Number of trip commands

Date of last (re)setting of the counters

Last interrupted current for CB pole L1

Last interrupted current for CB pole L2

The counters can be (re)set in menu item SETTINGS (see Section 6.5.2).

Figure 6.17 Example breaker operation statistics (page 1)

6.4.7 Read−out of operational measured values

The steady state r.m.s. operating values can be read out at any time via the **MENU**−key → OPERATION MENU → option **4**: MEASURED VALUES. At least three pages are provided: for the currents (page 1), voltages (page 2), power/energy/frequency (page 3). Further pages depend on the available and configured scope of functions: Thermal overload protection and/or restart lockout for motors (if *EXIST*, addresses 7827 and/or 7828) on page 4, highly sensitive earth fault detection (if *EXIST*, address 7830) on the last page. Paging is possible with the keys ⇓ and ⇑. Entry of the codeword is not necessary. The values will be updated after every few seconds. During a system fault, the operational measured values are not calculated and, therefore, not updated.

The currents are displayed in percent of the rated device values and in absolute primary values, the voltages, powers, and energy in primary 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.

The voltages which are calculated from the connected voltages (e.g. displacement voltage are marked with an ⋆.

In the following example, some typical values have been inserted. In practice the actual values appear. Values which cannot be determined (e.g. frequency without applied voltage) are indicated with ⋆⋆⋆⋆.

```
MEASURED VALUES

IL1 [%]  = 106.0 %
IL2 [%]  = 108.5 %
IL3 [%]  = 107.3 %
IE [%]   = 0.3 %
IL1      = 1060 A
IL2      = 1085 A
IL3      = 1073 A
IE       = 3 A


 ⇓
```

Page 1: Measured currents

```
MEASURED VALUES
 ⇑
UL1E   = 63.2 kV
UL2E   = 63.5 kV
UL3E   = 62.5 kV
UL12   = 109.5 kV ⋆
UL23   = 110.0 kV ⋆
UL31   = 108.3 kV ⋆
UE     = 0.8 kV ⋆



 ⇓
```

Page 2: Measured voltages

Figure 6.18 Examples for measured values, displayed on max. five pages: Pages 1 and 2 (continued in Figure 6.19)

The powers are assigned with sign, if applicable; separate counters are available for positive and negative energy. Also, the last date the energy meters have been set can be read out.

The calculated temperature rise on which the thermal overload protection and the motor restart lockout protection are based, will be displayed on page 4 when at least one of these functions had been configured as *EXIST*. The percentage is referred to the trip temperature rise in case of thermal overload protection, to the maximum permissible rotor temperature rise in case of the motor restart lockout function.

The earth currents are displayed on the last page provided the highly sensitive earth fault detection is configured as *EXIST*. When this function is parameterized to give trip command, each earth fault is a fault event which is announced in the fault annunciations. The earth currents are here only displayed when earth fault detection is parameterized *ALARM ONLY* (address 3001), i.e. normally in non−earthed systems.

The components of the earth current are displayed in primary and secondary values. The secondary values correspond to the current at the relay input for highly sensitive earth current. The primary value assume that the rated values and the matching factor are parameterized correctly in address block 11 (Section 6.3.3.1).

You may page back to the menu with the backspace key **R** or with the **MENU** key.

```
MEASURED VALUES
 ⇑
Pa        = 98.3 MW
Pr        = 67.1 MVAR
f  Hz     = 51.4 Hz
COS PHI   = 0.87
Wp pos    = 8123.4 MWh
Wq pos    = 1002.9 MVARh
Wp neg    = 0.0 MWh
Wq neg    = 0.0 MVARh
Set.date: 25.07.95

 ⇓
```

Page 3: Powers, energy, frequency

```
MEASURED VALUES
 ⇑
Θ/Θ trip L1 = 85 %
Θ/Θ trip L2 = 88 %
Θ/Θ trip L3 = 87 %
Θ/Θ trip    = 86 %
ΘL/ΘLtrip   = 86 %
```

Page 4: Thermal data

```
MEASURED VALUES
 ⇑
IEEa s   = 0.2 mA
IEEr s   = 1.5 mA
IEEa p   = 1.3 A
IEEr p   = 9.2 A
```

Page 5: Earth currents

Figure 6.19 Examples for measured values, displayed on max. five pages:
Pages 3 to 5 (if applicable)

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. 7SJ531 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, to change over preselected sets of function parameters, or to operate the circuit breaker.

The functions can be controlled from the operating panel on the front of the device, via the operating interface in the front and the system interface (if fitted) 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 setting facilities are obtained with the **MENU**−key: the main menu OPERATION−MENU 1 appears (see Figure 6.15). The menu option is selected by pressing the option number. The options of operational control are the items **1** and **8**. If one selects, for example, option 8, the SETTINGS menu appears (Figure 6.21).

The backspace key **R** is used to return to the upper menu. If the **R**−key is pressed in the main menu OPERATION MENU, the basic diagram is displayed again.

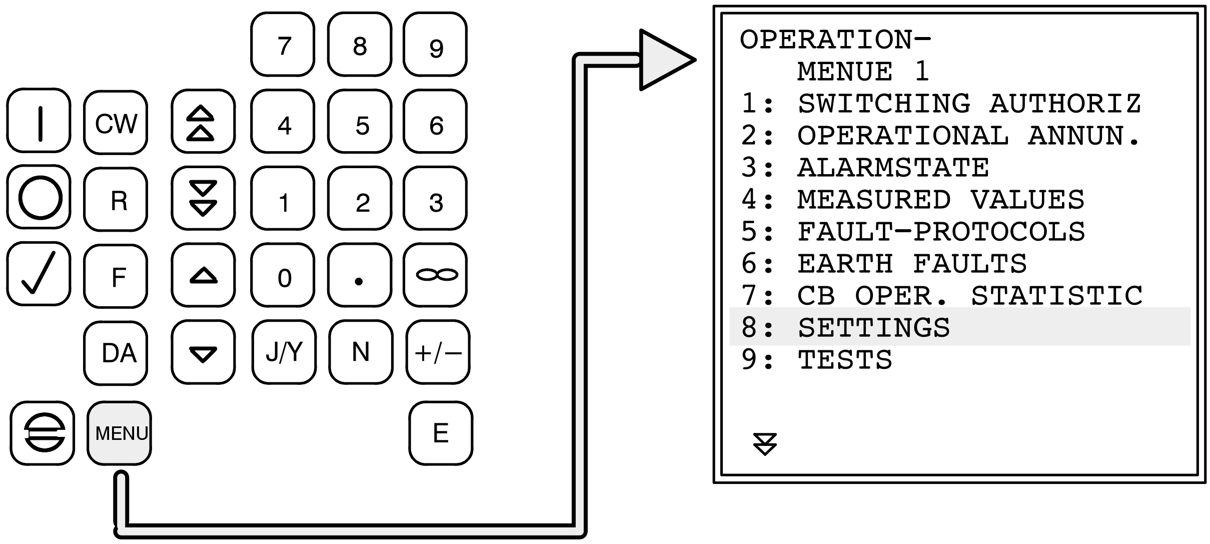


Figure 6.20 Operation menu for selection of operational facilities

```
SETTINGS

1: 8100 SETTING
   REAL TIME CLOCK
2: 8200
   RESET
3: 8300 SYS-VDEW
   ANNUNC.-MEAS.VAL
4: 8500 PARAMETER
  CHANGE-OVER
```

Sub−menu SETTINGS

Adjusting and synchonizing the real time clock

Reset of stored LEDs, counters, operational and fault annunciations

Influencing annunciations via the system inteface during tests

Parameter set change−over

Figure 6.21 Sub−menu SETTINGS

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. This is reached with the **MENU**−key → OPERATION MENU → option **8**: SETTINGS → option **1**: SETTING REAL TIME CLOCK. Input of the codeword of code level 1 is required to change the data.

Selection of the individual addresses is by further scrolling using ∇ and Δ. Each modification must be confirmed with the enter key **E**.

The backspace key **R** is used to return to the upper menu level. the **MENU**−key leads to the main menu (OPERATION MENU)

```
R  8100 SETTING
        REAL TIME CLOCK
∇  8101 ■18.04.1995
        12:17:42
```

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

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

```
Δ  8102 DATE
∇
```

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

```
Δ  8103 TIME
∇
```

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

```
Δ  8104 DIFF. TIME
```

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

Note: When the setting menu is left by pressing the **MENU**−key or twice the **R**−key after entering a new item (e.g. time), the relay does <u>not</u> ask for confirmation by the question ”SAVE NEW SETTINGS ?”.

6.5.2 Erasing stored annunciations and counters − address block 82

The statistical indications (Section 6.4.6, address block 56) are stored in EEPROMs in the device. They are not therefore erased if the auxiliary power supply fails. Additionally, annunciations and the status of the LED memories are stored in NV−RAMs and thus saved provided the back−up battery is operational. These stores can be cleared in block 82. This is reached with the **MENU**−key → OPERATION MENU → option **8**: SETTINGS → option **2**: RESET (refer to Figure 6.21). With the exception of resetting the LED indications (address 8201), codeword entry of code level 1 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 with the cursor keys ▽ or △. Erasure requires confirmation with the "Yes"−key **J/Y**. The display then confirms the erasure. If erasure is not required, press key **N** or simply page on. During erasure of the stores (which may take some time) the display shows TASK IN PROGRESS. After erasure the relay acknowledges erasure with "SUCCESSFUL"

The addresses 8204, and 8208 to 8212 (counters) allow to set a new starting magnitude. This is done by writing the desired starting value with the numerical keys. The number **0** is entered in order to reset the counters to 0. Confirm the new starting value with the enter key **E**. The relay acknowledges with "SUCCESSFUL".

The energy metering values overflow after exceeding their maximum value: 999999 → 000000. Different counters are available for positive and negative energy components.

R	8200 RESET	Beginning of block "Reset"
▽	8201 ■RESET LED ?	Request whether the LED memories should be reset
△ ▽	8202 RESET OPERAT.ANNUNC. ?	Request whether the operational annunciation buffer store should be erased
△ ▽	8203 RESET FAULT ANNUNC. ?	Request whether the fault annunciation buffer store should be erased
△ ▽	8204 TRIP No =	Setting the trip counter; maximum number: 4 digits
△ ▽	8206 RESET E/F ANNUNC. ?	Request whether the earth fault report buffer store should be erased
△ ▽	8207 RESET AR−COUNTERS ?	Request whether the AR−counters should be reset

△ ▽	8208 Set WP pos = MWh	Setting a new starting value for the positive active energy meter, i.e. energy output into the feeder (dimension varies according to the rated values of current and voltage)
△ ▽	8209 Set WQ pos = MWh	Setting a new starting value for the positive reactive energy meter, i.e. inductive energy into the feeder (dimension varies according to the rated values of current and voltage)
△ ▽	8210 Set WP neg = MWh	Setting a new starting value for the negative active energy meter, i.e. intake from the feeder (dimension varies according to the rated values of current and voltage)
△ ▽	8211 Set WQ neg = MVARh	Setting a new starting value for the negative reactive energy meter, i.e. inductive energy from the feeder (dimension varies according to the rated values of current and voltage)
△	8212 HOUR METER [1]) = h	Setting a new starting value for the operating hour meter [1])

Note: When the rated primary values are changed, so that the measurement range changes, the energy metering values are automatically reset to 0.

Note: When the setting menu is left by pressing the **MENU**−key or twice the **R**−key after any change, the relay does not ask for confirmation.

---

[1]) only for model 7SJ531★−★★★★2−★★★★

6.5.3 Off/On control of part functions of the device

During operation of the relay it may be desired to control the relay manually or from system criteria, temporarily to switch off partial functions of the relay or to switch them on only under specific conditions. Examples may be the switching on or off of the auto−reclose system when a transfer bus is being used, dependent upon whether a transformer or line branch is switched to the transfer.

7SJ531 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(CW−level 2). The control functions are found at the beginning of the parameter block of each protection or supplementary function. The switch condition shown in the display can be changed over using the ”No”−key **N**. The opposite switch condition then appears in the display. Each change of condition must be confirmed with the **E**−key. The change−over is first recorded in the relay when codeword operation has been terminated. This is done by the key combination **F E**, i.e. depressing the function key **F** followed by the entry key **E**. The display shows the question ”SAVE NEW SETTINGS?”. Confirm with the ”Yes”−key **J/Y** that the new settings shall become valid now. The switched conditions are then permanently stored in EEPROMs and protected against auxiliary voltage failure; the display confirms ”NEW SETTINGS SAVED”. If you press the ”No”−key **N** instead, codeword operation will be aborted, i.e. all alterations which have been changed since the last codeword entry are lost. Thus, erroneous alterations can be made ineffective.

A function is switched *ON* when the on−command has been given by both the binary input AND also from the operator panel or interface. The function is then shown in the alarm status annunciations as ”`active`”.

A function is switched *OFF* when the off−command is given by EITHER the binary input OR from the operator panel or the operating interface. Thus it is ensured that a partial function can only be switched on from that place where it was previously switched off.

Control inputs which are not marshalled to a binary input are regarded, from that location, as switched on, so that change of the condition is possible from the operator panel or the operating interface.

Since most of the part functions are switched *OFF* when the relay is delivered, they must have been switched *ON* in order to allow switching via binary inputs.

The completion of a switching command is, independent of its cause, output as an operational annunciation:

– ”(function) `off`” **C**omes at the instant of switch−off,

– ”(function) `off`” **G**oes at the instant that it is switched on.

These annunciations are listed in block 51 under OPERATIONAL ANNUNCIATIONS and can also be transmitted via the system (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 F) and in the survey of the binary output functions (Table 5.3, Section 5.5) these annunciations are identified with a leading '>' 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.

Parameter	Binary input confirmation	Completion indication ('comes' and 'goes')
1201■O/C PHASES	Overcurrent protection phases	
ON	1701 >O/C Ph on	
N OFF	1702 >O/C Ph off	1751 O/C Ph off
1301■O/C EARTH	Overcurrent protection earth	
ON	1711 >O/C E on	
N OFF	1712 >O/C E off	1756 O/C E off
1401■O/C DIR.PH	Directional overcurrent protection phases	
ON	2601 >dirO/C P on	
N OFF	2602 >dirO/C P off	2651 dir.O/C P off
1501■DIREC. IE>	Directional overcurrent protection earth	
ON	2611 >dirO/C E on	
N OFF	2612 >dirO/C E off	2656 dir.O/C E off
1601■UNDERVOLTG	Undervoltage protection	
ON	6501 >u/v on	
N OFF	6502 >u/v off	6530 u/v off
1701■OVERVOLTG	Overvoltage protection	
ON	6511 >o/v on	
N OFF	6512 >o/v off	6565 o/v off
1801■NEG. SEQ.	Unbalanced load protection (negative sequence current	
ON	5140 >I2 on	
N OFF	5141 >I2 off	5151 I2 off

Parameter	Binary input confirmation	Completion indication ('comes' and 'goes')
2101■START SUPV	Start–up time supervision for motors	
ON	6803 >STRT–SUP on	
N OFF	6804 >STRT–SUP off	6811 STRT–SUP off
2701■THERMAL OL	Thermal overload protection	
ON	1501 >O/L on	
N OFF	1502 >O/L off	1511 O/L Prot. off
2801■MOT. START	Motor restart lockout	
ON	4820 >MSP on	
N OFF	4821 >MSP off	4824MSP off
3001■E/F PROTEC	Highly sensitive earth fault detection	
ON	1205 >E/F Det. on	
N OFF	1206 >E/F Det. off	1211 E/F Det. off
3401■AR FUNCT	Internal auto–reclose function	
ON	2701 >AR on	
N OFF	2702 >AR off	2781 AR off
3901■B/F PROT.	Circuit breaker failure protection	
ON	1401 >B/F on	
N OFF	1402 >B/F off	1451 B/F off

6.5.4 Information to LSA during test operation − address block 83

When the relay is connected to a central storage device or localized substation automation system and the protocol according VDEW/ZVEI and IEC 870−5−103 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. Additionally, it is possible to block all annunciations, messages and measured values to LSA during test operation.

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

In order to accomplish switch−over via binary inputs, the respective inputs must have been assigned during marshalling (refer to Section 5.5.2). The following input functions are suitable:

FNo 15 `>Sys-Test` for tagging the messages and measured values with the origin "Test operation",

FNo 16 `>Sys-MM-block` for blocking all messages and measured values.

In order to achieve switch−over by the operator, entry of the codeword (code level 1) is necessary (refer to Section 5.3.1). For this purpose, address block 83 is available. The block is called up with the **MENU**−key → OPERATION MENU → option **8**: SETTINGS → option **3**: SYS−VDEW ANNUNC.−MEAS. VAL. (refer to Figure 6.21). Use keys ∇ or Δ to scroll through the addresses. By pressing the "No"−key **N** the positions of this switches 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.

	Display	Explanation
R	8300 SYS-VDEW ANNUNC.-MEAS.VAL	Beginning of the block "Annunciations and measured values for the system interface with VDEW/ZVEI compatible protocol acc. IEC 870−5−103"
∇	8301■SYS-TEST OFF	in *ON* position, the VDEW/ZVEI−compatible annunciations acc. IEC 870−5−103 are assigned with the origin "test operation"
N	ON	
Δ	8302 SYS-BLOCK OFF	in *ON* position, no annunciations and measured values are transmitted to the system interface
N	ON	

Do not forget to switch the addresses back to *OFF* after having finished test operations!

6.5.5 Selection of parameter sets – address block 85

Up to 2 different sets of parameters can be selected for the functional parameters, i.e. the addresses above 1000 and below 4000. These parameter sets can be switched over during operation, locally using the operator panel or via the operating interface using a personal computer, or also remotely using binary inputs or the system interface.

The first parameter set is identified as set A, the second as set B. 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), with the **MENU**–key → paging with key⩔ to page 2 of the OPERATION MENU → option **1**: PARAMETER SETTING. 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**. After confirmation with the enter key **E** all displayed parameters now refer to parameter set B.

The parameter set is indicated in the display by a leading character (A or B) before the address number indicating the parameter 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**

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 (code level 2).

The address block for parameter change–over is reached with the **MENU**–key → OPERATION MENU → option **8**: SETTINGS → option 4 PARAMETER CHANGE–OVER. The heading of the block will appear:

```
8500 PARAMETER
     CHANGE-OVER
```

Beginning of the block ”Parameter change–over”: processing of parameter sets

It is possible to scroll through the individual addresses using the ▽ key or to scroll backwards with △.

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

In order to switch–over to a different parameter set scroll on with ▽ to address 8503. Using the ”No”–key **N** you can change to any desired parameter set; alternatively, you can decide that the parameter sets are to be switched over from binary inputs, or via the system interface. 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.

R ▽	8501■ACTIV PARAM SET A	Address 8501 shows the actually active parameter set
△ ▽	8503■ACTIVATING SET A	Use the ”No”−key **N** to page through the alternative possibilities. The desired possibility is selected by pressing the enter key **E**.
	SET B	
N	SET BY BIN.INPUT	If you select *SET BY BIN.INPUT*, then the parameter set can be changed−over via binary inputs (see Section 6.5.5.3)
	SET BY LSA CONTR	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), ACTIVATING must be switched to *SET BY BIN.INPUT* (refer to Section 6.5.5.2).

− One logical binary input is available for control of the 2 parameter sets. This binary input is designated ”`>ParamSelec.1`” (FNo `7`).

− The logical binary input is allocated to a physical input module (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.

− If the binary input ”`>ParamSelec.1`” (FNo `7`) is set in normally open mode (df. Section 5.5.2) the following results for parameter set change−over:

not energized:	parameter set A is valid
energized:	parameter set B is valid

− The control input signal must be continuously present as long as the selected parameter set shall be active.

6.5.6 Control of switching devices

A control function is incorporated in SIPROTEC 7SJ531, which permits the closing and tripping of circuit breakers by separate operating elements in the relay. The momentary switching state of all switching devices of the feeder is shown in a feeder mimic diagram at the integrated graphical display in the relay's front−plate. Out of a large number of feeder mimic diagrams (see annex E) the suitable one for the switchgear was selected during the configuration (refer Section 5.4.3).

All breaker and disconnector state feedback signals are monitored for plausibility. If neither the check−back signal ON nor OFF is received from a switching device Qnn, a failure indication e.g. "`err:CB pos Qnn`" is sent after a parameterized time. The switching device has to be in one of the two positions, except for the instant when switching is performed. In parallel to the individual failure indication a collective alarm "`err:CB/DC pos`" is created with the first indication which is given. This signal disappears when all switching devices have again resumed a defined state.

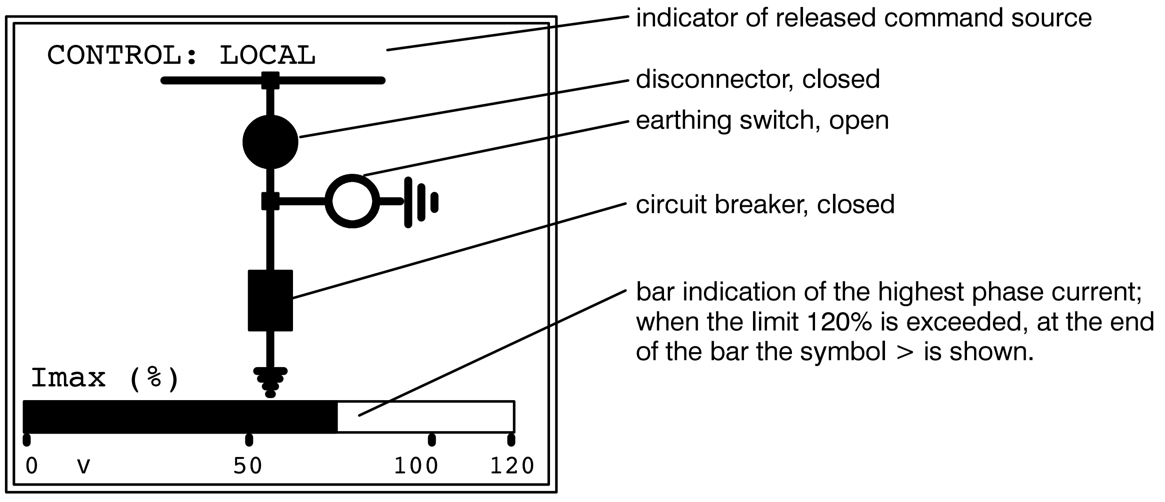
Pick−up of the monitoring of the feedback signal does not create an alarm, as long as the switching command is under execution.

The presentation of the feeder mimic diagram in the graphical display is based on the so−called basic diagram 1, see example in Figure 6.23, in which the momentary switching device states are depicted.

From the utilized symbols the type of switching device (disconnector or circuit breaker) and the switching state (closed, open, faulty) can be recognized.

The control of the switching devices can be effected in the 7SJ531 from four command sources:

− local operation via the integrated keypad,
− binary inputs manual close / manual trip,
− remote control via the system interface,
− operation via the PC interface and program DIGSI®.



type of switching device	symbol for the switching device and state closed	open interm.	state	set flashl.
isolator switch				selected final state flashing
circuit breaker				

Fig 6.18 Example for a basic diagram 1 and explanation of the symbols for switches

6.5.6.1 Switching authority

The switching authority defines which one of the command sources is authorized. The released command source is indicated in the headline of fundamental diagram 1 (Figure 6.23).

The switching authority can be addressed directly out of the operation menu selection (see Figure 6.20): After operating the **MENU** – key, option **1** leads directly to the menu SWITCHING AUTHORITY.

Dependent on the configuration of the switching device control (see also Section 5.4.5, address 7501) either address 7598 or 7599 appears in the display. The options for the switching authority can be changed by (eventually repeated) operation of the "No"–key **N**.

It was also defined during the configuration whether codeword entry is required for changing the switching authority (Section 5.4.5, address 7512). If codeword entry is required, code level 1 applies.

Key	Display	Explanation
R	SWITCHING AUTHORITY	Switch over, from which input source switching commands can be given
	7598■SWITCH AUTH LOCAL	*LOCAL* allows only local control
N	LOCAL/REMOTE	Permits *LOCAL* or *REMOTE* control
	VIA BI	Permits the selection of the switching authority *VIA* *B*inary *I*nput
	LOCKED	Any control is *LOCKED*

Key	Display	Explanation
R	SWITCHING AUTHORITY	Switch over, from which input source switching commands can be given
	7599■SWITCH AUTH LOCAL	*LOCAL* allows only local control
N	REMOTE	Permits exclusively *REMOTE* control
	VIA BI	Permits the selection of the switching authority *VIA* *B*inary *I*nput
	LOCKED	Any control is *LOCKED*

6.5.6.2 Local control

For local control three individual keys of different colour are located at the left side of the keypad. The control keys can only be operated when the feeder mimic diagram is shown in the display. Coming from other operating modes it is necessary to return to the basic diagram 1 for control. First the switching direction is defined by operating the ON or OFF key (see Figure 4.15).

The symbol for the circuit breaker starts flashing.

The switching itself is carried out only after pushing the command release key (see Figure 6.24). If no command release is given within a parameterized waiting time, then the flashing changes into the corresponding original state. An interruption is always possible before the command release or during the selection of the switching device by means of the keys *R* or *MENU*. When a switching direction is selected which corresponds to the switching device's momentary state, the input causes no reaction and no interruption alarm is given.

During the configuration of the switching device control (see also Section 5.4.5, address 7510) it was defined whether breaker control depends of a codeword entry (code level 1).

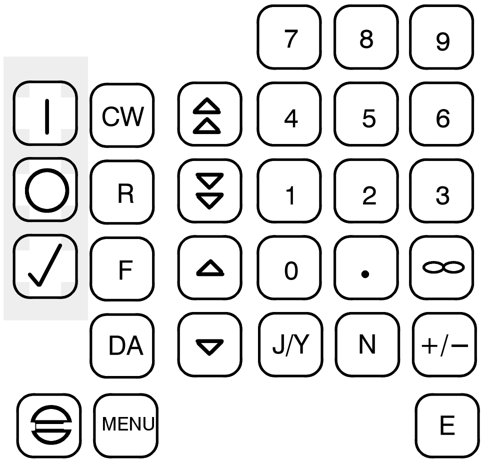


Figure 6.24 Membrane keyboard on the front of the relay

The command execution is initiated by pushing the command release key. Corresponding annunciations are created inside the relay, containing the breaker designation, the control source, the type (command or feedback), the result (positive or negative) and the switching direction. When all conditions are fulfilled and the command relay is marshalled accordingly, the command is given. The annunciations are shown below the feeder mimic diagram instead of the bar indication of the highest phase current.

Together with the command output a monitoring time is started (command running time monitoring) to check whether the circuit breaker reaches the desired final state within this time. Upon receiving the "breaker state feedback signal" the command relay drops out and the monitoring time is stopped. In case of a missing feedback, the alarm "command response time expired (`CR time exp`)" is given.

When the command response time is expired, the intermediate state monitor for the corresponding switching device is reactivated.

Any switching command can always be interrupted by a protection trip command.

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 5.2.6).

It is recommended that the actual settings for the relay be used for the testing procedure. If these values are not (yet) available, test the relay with the factory settings. In the following description of the test sequence the preset settings are assumed unless otherwise noted; for different setting values formulae are given, where necessary.

For the functional test a three−phase symmetrical voltage source with individually adjustable voltage outputs, together with 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. The phase rotation must be clockwise; otherwise two phases must be interchanged in current as well as in voltage. Alternatively the binary input ”`>negative seq`” must be allocated and energized which reverts the internal phase rotation processing.

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

NOTE! The accuracy which can be achieved during testing depends on the accuracy of the testing equipment. The accuracy values specified in the Technical data can only be reproduced under the reference conditions set down in IEC 255 resp. VDE 0435/part 303 and with the use of precision measuring instruments. The tests are therefore to be looked upon purely as functional tests.

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

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

Note:
Part of the protection functions is switched off resp. configured non existing upon delivery of the relay. The advantage is that first the main function (overcurrent time protection) can be tested without interference by other functions. For further tests and for commissioning the required functions then have to be activated.

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 1301 O/C EARTH = *ON* (as delivered). Addresses 1223 and 1323 must be switched to *I>> ALWAYS* (as delivered) in order to allow the I>> stages to operate independent of the auto–reclose function.

Testing can be performed with single–phase, two–phase or three–phase test current without difficulties.

Caution!

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

For testing the I>> stages, therefore, measurement shall be performed dynamically. It should be stated that the relay picks up at 1.1 times setting value and does not pick up at 0.9 times setting value.

When the test current is injected via one phase and the earth path and the set value for IE>> (address 1302, 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 (when delivered the general fault detection signal is allocated to LED 1 and the earth fault detection to LED2). Signal relay 1 closes its make contact (when delivered).

After expiry of the time delay (address 1303 T–IE>> for the earth current path, address 1203 T–I>> for the phase path), trip signal is given (LED 3 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 (as before). Furthermore, the *DEFINITE TIME* mode must be configured in addresses 7812 and/or address 7813 (as delivered, refer also Section 5.4.2).

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

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

Caution!

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

For test currents above 4 x I_N measurement shall be performed dynamically. It should be stated that the relay picks up at 1.1 times setting value and does not pick up at 0.9 times setting value.

When the test current is injected via one phase and the earth path and the set value for IE> (address 1312, factory setting 0.2 x I_N) is exceeded the pick−up indication for I_E> appears (LED 2 at factory setting), with further increase above the pick−up value of the phase current stage (address 1212 I>, factory setting 1 x I_N) pick−up indication appears for the tested phase (when delivered the general fault detection signal is allocated to LED 1 and the earth fault detection to LED2). Check that the assigned signal relay contacts close.

After expiry of the time delay (address 1313 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 3 at delivery). Check that the assigned signal relay and trip relay contacts close.

Reset occurs at approx. 95 % of the pick−up value. It must be noted that the set times are pure delay times; operating times of the measurement functions are not included.

6.6.4 Testing the inverse time overcurrent time protection stages I_p, I_{Ep}

For these tests the related functions must be switched on (as before), furthermore, the *INVERSE TIME* modes must be configured in addresses 7812 and/or address 7813 (contrary to delivered setting).

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

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

Caution!

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

For test currents above 4 x I_N measurement shall be performed dynamically. It should be stated that the relay picks up at 1.2 times setting value and does not pick up at 1 times setting value.

When the test current is injected via one phase and the earth path and the set value for IEp (address 1314, factory setting 0.2 x I_N) is exceeded by more than 10 % the pick−up indication for I_{Ep} appears (LED 2 at factory setting), with further increase above 1.1 times the pick−up value of the phase current stage (address 1214 Ip, factory setting 1 x I_N) pick−up indication appears for the tested phase (when delivered the general fault detection signal is allocated to LED 1 and the earth fault detection to LED2). Check that the assigned signal relay contacts close.

With current less than 1.05 times setting value, no pick−up must occur.

The time delay depends on which characteristic has been set in addresses 1218/1219 and/or 1318/1319 and the set time multiplier in addresses 1214/1215 and/or 1314/1315. The expected time delays can be calculated from the formula given in the technical data (Section 3.3) or read from the characteristic curves in Figures 3.1 to 3.4 (Section 3.3).

It is suggested that one point of the trip time characteristic is checked with 2 x setting value. Check that the assigned signal relay and trip relay contacts close.

6.6.5 Testing the directional overcurrent time protection (if available)

If the relay is fitted with the directional determination supplement (model 7SJ531⋆−⋆⋆⋆⋆**2**−⋆⋆⋆**1**), this can be tested with an additional symmetrical three−phase voltage source. The related function must be switched on, i.e. address 1401 O/C DIR.PH = *ON* and/or address 1501 DIREC. IE> = *ON* (contrary to delivered setting). Addresses 1423 and 1523 must be switched to *I>> DIR. ALWAYS* (as delivered) in order to allow the I>> stages to operate independent of the auto−reclose function.

The stages of the directional phase overcurrent time protection are tested in the same way as described in Section 6.6.3 (for definite time overcurrent protection) or 6.6.4 (for inverse time overcurrent protection), but this time with the applied three−phase voltage (approximately rated voltage). When the polarity of the voltages related to the currents is correct, trip will now occur not corresponding to the non−directional time delays (addresses 1203, 1213 or 1215) but corresponding to

− T−I>> DIR. (address 1403, 0.1 s at delivery),

− T−I> DIR. (address 1413, 0.5 s at delivery) in definite time overcurrent mode,

− T−Ip DIR. (address 1415, time multiplier 0.5 at delivery) in INV. TIME IEC overcurrent mode; observe the set characteristic according address 1418, it may be different from that for the non−directional stage.

− D−Ip DIR. (address 1416, time multiplier 5.0 at delivery) in INV. TIME ANSI overcurrent mode; observe the set characteristic according address 1419, it may be different from that for the non−directional stage.

Testing with earth fault is performed with a single−phase current via one phase and the earth path, and the measured voltage of the same phase is switched off from the relay terminal. The time delay now must be

− T−IE>> DIR. (address 1503, 0.1 s at delivery),

− T−IE> DIR. (address 15213 0.5 s at delivery) in definite time overcurrent mode,

− T−IEp DIR. (address 1515, time multiplier 0.5 at delivery) in INV. TIME IEC overcurrent mode; observe the set characteristic according address 1518, it may be different from that for the non−directional stage.

− D−IEp DIR. (address 1516, time multiplier 5.0 at delivery) in INV. TIME ANSI overcurrent mode; observe the set characteristic according address 1519, it may be different from that for the non−directional stage.

Should the directional characteristic be verified then note:

− Directional determination can be performed with quadrature voltages (fault−free voltages) and memorized voltages. That is why always all three voltages must be applied before commencement of the test.

− The actual directional characteristic with two−phase tests may deviate against the theoretical directional characteristic by ±30°. This deviation is caused by the use of quadrature voltages.

6.6.6 Testing the voltage protection functions

The functions undervoltage and overvoltage protection can be tested only when they are switched active, what is not the case upon delivery (address 1601 UNDERVOLTG = *ON* resp. address 1701 OVERVOLTG = *ON*) , and when the voltage protection is configured *EXIST* (address 7816, see Section 5.4.2).

For the undervoltage protection the smallest of the three measured voltages is used, for the overvoltage protection the largest. Therefore a single−phase test is sufficient for the overvoltage protection. In the undervoltage protection the pick−up value can only be measured, when at first all three phase voltages are above the pick−up threshold. Therefore a three−phase measurement is recommended. It is, however, also possible to feed all three voltage inputs in parallel with a single−phase voltage.

It has to be noted that the connected voltages are not necessarily identical with those that are taken for the evaluation. There is an option to evaluate the connected phase−to−earth voltages or to calculate and evaluate the corresponding phase−to−phase voltages in the relay (address 7911). In latter case, the selected pick−up values refer to phase−to−phase voltages. For a test of the pick−up values with three−phase connection, the phase−to−phase voltage must be measured, therefore.

Caution!

Test voltages larger than 140 V may overload and damage the relay if applied continuously (refer to Section 3.1.1 for overload capability).

Undervoltage as well as overvoltage protection can be combined with a current criteria. When the current criterion is switched on, then the release condition of the current criterion must be fulfilled in addition to the voltage criterion for protection pick−up.

The time delays are tested for overvoltage with approximately 1.2 time pick−up value, for undervoltage by switching the voltage to zero. It is recalled that the set times are pure delay times; operating times of the measurement functions are not included.

Switch voltage to 1.2 times pick−up value U> (address 1702 resp. 1703).
- annunciation ”`U> Fault`” or ”`U> cc Fault`”, if the current criterion is switched on and fulfilled (upon delivery LED 1, relay pick−up).
- after T−U> (0.5 s; address 1704) annunciation ”`U> Trip`” (LED 3 and signal relay 2).
- command relay 1.

<u>*Note:*</u> When the undervoltage protection is activated (address 1601 = *ON*), which is not the case upon delivery, and no measuring voltage is present, then the undervoltage criterion is immediately fulfilled and the protection picks up. As no operation is possible during a pick−up condition, a measuring voltage above the reset threshold of the undervoltage protection would have to be applied to allow access to the operation functions. If this is not feasible from the switchgear side or too complicated, the undervoltage protection may be blocked by energizing binary input 11 (pre−set: block undervoltage protection) so that the pick−up resets.

When the current criterion is active (address 1620 = *ON*), the pick−up may reset in case of missing measuring voltage even without blocking. This happens if the current drops below a settable minimum current limit (address 1621) after the voltage has been disconnected.

Reduce voltage to a value below the setting U< (address 1602 resp. 1603).
- annunciation ”`U< Fault`” or ”`U< cc Fault`”, if the current criterion is switched on and fulfilled (upon delivery LED 1, relay pick−up).
- after T−U< (1.5 s; address 1606) annunciation ”`U< Trip`” (LED 3 and signal relay 2).
- command relay 1.

Disconnect voltage.
- annunciation ”`U<< Fault`” or ”`U<< cc Fault`”, if the current criterion is switched on and fulfilled.
- after T−U<< (0.5 s; address 1612) annunciation ”`U<< Trip`”.

Check the U< stage with additional start−up threshold. The start−up criterion has to be activated, which is not the case upon delivery (address 1607).

Disconnect currents, so that the threshold of the current criterion (address 1608) is reached and thus the start−up threshold becomes effective instead of the normal pick−up threshold:
start−up threshold = pick−up threshold x r/1.05

pick−up threshold U< (address 1602 resp. 1603)
reset ratio r (address 1604 resp. 1605).

Decrease voltage; check pick−up value of the start−up threshold with the must value as per above formula. When falling below this limit:
- annunciation ”U< sc Fault”, resp. ”U< cc sc Flt” if the current criterion is also activated and fulfilled.
- after T−U< (1.5 s; address 1606) annunciation ”U< Trip” (LED 3 and signal relay 2).
- command relay 1.

Set voltage to approximately rated voltage. Energize binary input ”>U< block” (not allocated upon delivery). Decrease voltage below set value U< (address 1602 resp. 1603)
- annunciation ”u/v blocked” (not allocated upon delivery).
- no further annunciation referring to undervoltage protection.

Disconnect voltage. Annunciations of the U<< stage appear, because only the U< stage is blocked:
- annunciation ”U<< Fault” or ” U<< cc Fault”, if the current criterion is switched on and fulfilled.
- after T−U<< (0.5 s; address 1612) annunciation ”U<< Trip” (LED 3 and signal relay 2).
- command relay 1.

Set voltage to approximately rated voltage.
De−energize binary input ”>U< block”.

Energize binary input ”>U<< block” (not allocated upon delivery).
- annunciation ”>U<< block” (not allocated upon delivery).

Disconnect voltage.
Annunciations of the U< stage appear, because only the U<< stage is blocked:
- annunciation ”U< Fault” or ”U< cc Fault”, if the current criterion is switched on and fulfilled.
- after T−U< (1.5 s; address 1606) annunciation ”U< Trip” (LED 3 and signal relay 2).
- command relay 1.

Set voltage to approximately rated voltage. Energize binary input 11 ”>u/v block”. Switch off voltage.
- annunciation ”u/v blocked” (not allocated upon delivery).
- no further annunciation referring to undervoltage protection.

Disconnect voltage, disconnect current.

Attention! If setting values have been changed for these tests, make sure that the original settings are restored (addresses 1602 to 1704)!

Further checks are carried out during commissioning with primary values (Section 6.7.1).

6.6.7 Testing the unbalanced load protection (if available)

The unbalanced protection can only be tested if this function has been configured in address 7818 as NEG. SEQ. = *EXIST* and parameterized as operative (NEG. SEQ. = *ON*, address 1801).

The unbalanced load protection has two definite time delay stages (I2>, TI2> and I2>>, TI2>>).

Testing can be performed with single–phase, two–phase or three–phase test current. In the following, testing with a three–phase current with swopped phases described (e.g. L2 with L3). In this case the unbalanced load amounts to the test current which is referred to the unit current.

Caution!

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

When the pick–up value is exceeded (test current > setting values), the associated annunciations "`I2> Fault`" and "`I2>> Fault`", LED 1 (device fault detection) and signal relay 1 (at delivery) must be indicated. After the associated time delay has expired (T–I2> 5 s at delivery, T–I2>> 1 s at delivery), trip annunciation "`I2 Trip`" is issued (LED 3 and signal relay 2 at delivery). Check that the trip contacts close.

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

6.6.8 Testing the start–up time supervision (if available)

The start–up time supervision can only be tested if it has been configured as START SUPV = *EXIST* (address 7821, refer to Section 5.4.2) and parameterized as operative, under address 2101.

Testing can be performed with single–phase, two–phase or three–phase test current. Tests should be carried out dynamically, because of the high start–up currents.

Caution!

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

For test currents above 4 x I_N measurement shall be performed dynamically. It should be stated that the relay picks up at 1.1 times setting value I–STRT–MAX and does not pick up at 0.9 times setting value I–STRT–MAX.

The tripping time depends on the set start–up time T–STRT–SUP, the set start–up current I–STRT–MAX, and the test current I_{rms}. It can be calculated from the formula:

$$t = \left(\frac{I_{STRT-MAX}}{I_{rms}}\right)^2 \cdot T_{STRT-SUP} \qquad \text{for } I_{rms} > I_{STRT-DET}$$

It is suggested that one point of the trip time characteristic is checked. For example, the preset values ($I_{STRT-MAX}$ = 4 x I_N, $T_{STRT-SUP}$ = 10 s and the pick–up threshold $I_{STRT-DET}$ = 2.5 x I_N, address 1165) result in a tripping time of 2.5 s when the test current amounts to 2 x set value = 10 time I_N. Trip is annunciated with "`STRT–SUP trip`".

Note: The start–up supervision operates independent on the thermal overload protection and the motor start protection. Thus, it is possible that the overload protection and/or the motor start protection may trip before the start–up time supervision does, dependent on the set parameters. If necessary, the overload protection and motor start protection may be switched off or blocked before testing the start–up time supervision. But do not forget to switch in on again after the tests, when it is to be used.

6.6.9 Testing the thermal overload protection

The overload function can only be tested if it has been configured as THERMAL OL = *EXIST* (address 7827, refer to Section 5.4.2) and parameterized as operative, under address 2701.

The basis current for the detection of overload is the rated current of the device. Overload data are calculated for each individual phase.

When applying the rated current (factory settings) tripping must not occur. After an appropriate time (approximately 5 x τ) a steady−state temperature rise according to the following relationship is established:

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

This value can be read out in the operational measured values for each phase. For different setting values k, test current should be lower than k x I_N (e.g. 90%).

To check the time constant, the current input is simply subjected to 1.6 x the pick−up value, i. e. 1.6 x k x I_N. Tripping will then be initiated after a time interval which corresponds to half the time constant.

It is also possible to check the trip characteristic (Figure 3.5). It must be noted, that before each measurement, the temperature rise must be reduced to zero. This can be achieved either by de−activating and re−activating the overload function (address 2701) or by blocking it 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.

6.6.10 Testing the motor restart lockout

The motor restart lockout (only available in model 7SJ531★−★★★★**2**) can only be tested if it has been configured as MOTOR START = *EXIST* (address 7828, refer to Section 5.4.2) and parameterized as operative, under address 2801.

The tests can be carried out with single−phase fault.

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 motor restart lockout presupposes that the thermal limit of the rotor is reached when the motor has been started just for the permissible number of times. With the preset parameters 2806 (n_W = 2) and 2807 ($n_c - n_W$ = 1) the motor may be started three times (n_c = 3) successively.

Considering the presettings of addresses 2805 (I_B/I_N = 1), 2802 (I_A/I_B = 4,5) and 2803 (T STRT MAX = 10 s), three motor starts must be simulated one after the other, each with 10 s duration and with a test current of 4,5 times rated current of the relay. Then the thermal limit value must be nearly reached: the operational measured value Θ_L/Θ_{Ltrip} shows nearly 100 %.

When the test current is switched off, the protection will issue a lockout signal, i.e. annunciation "`MSP Trip`" and LED 3 (as delivered) and signal relay 2 (as delivered). The lockout signal disappears as soon as another restart would be permissible. It can be aborted also by switching of the lockout function or via a binary blocking input (not allocated when delivered), since the thermal replica is then erased.

Note: The motor restart lockout operates independent on the thermal overload protection and the start−up supervision. Thus, it is possible that the overload protection and/or the start−up supervision may trip before the motor start protection does, dependent on the set parameters. If necessary, the overload protection and the start−up supervision may be switched off or blocked before testing the start−up time supervision. But do not forget to switch in on again after the tests, when it is to be used.

6.6.11 Testing the earth fault detection

The displacement voltage detection can be tested when the earth fault detection is activated (address 3001). Conditions are that the earth fault detection is configured *EXIST* (address 7830, see Section 5.4.2) and that the relay gets the information under address 7911 that its voltage inputs are connected with phase−to−earth voltages of the switchgear.

I the relay is connected to *three* phase−to−earth voltages, the relay calculates the displacement voltage by forming the sum of the vectors of the phase−to−earth voltages according to the following formula

$$\underline{U}_E = 1/\sqrt{3}\,|(\underline{U}_1 + \underline{U}_2 + \underline{U}_3)|$$

Thus the protection function can be tested using a three−phase voltage source with individually controlled phase voltages. One of the three voltages is decreased, starting with rated voltage, until the voltage triangle is so deformed that the protection picks up. This happens according to above formula when decreasing the voltage by $\sqrt{3}$ of the parameterized pick−up threshold Ue> cal. (address 3010). Eventually the threshold has to be set lower for the test.

If two phase−to−earth voltages are connected, the displacement voltage U_{en} must be connected, additionally. The relay must be informed of the connection mode during configuration (address 7911). In this case, the displacement voltage is directly processed as it is available at the terminals for U_E.

Slowly increase the test voltage until the protection picks up.

- after the measuring time and the delay time T−E/F (1 s) parameterized under address 3011, annunciation ”`UE Fault`” (upon delivery LED 1 and signal relay 1: relay pick−up).
- after T−UE (10 s; address 3012) annunciation ”`UE Trip`” (LED 3 and signal relay 2, if trip by earth fault protection is released under address 7930, E FLT DET = WITH UE OR IEE).
- command relay 1.

Disconnect voltage.

Attention! If setting values have been changed for these tests, make sure that the original settings are restored (addresses 3001 to 3012)!

Models 7SJ531⋆−⋆⋆⋆⋆**2−0** or **−1** provide the highly sensitive earth current detection stages which can be test as follows:
The current stages IEE>>/T−IEE>> (addresses 3013 and 3014), furthermore IEE>/T−IEE> (address 3017 and 3018 if definite time mode is selected under address 7830), IEEp/T−IEEp (addresses 3019 and 3020 if inverse time mode is selected under address 7830), are tested in a similar way as the earth overcurrent time protection (Sections 6.6.2 to 6.6.4). But the following must be observed:

The test current is injected on the measured value input for the high−sensitivity earth fault protection. Otherwise this function cannot operate.

This measured current input is specially designed for highly sensitive measurement. Thus, restricted threshold values are available only, and its input rating is independent of the rated current of the relay.

Caution!

The thermal capability of the measured current input for highly sensitive earth fault protection is 15 A continuous. Test currents larger than 15 A may overload and damage the measured input circuits if applied continuously (refer to Section 3.1.1 for overload capability). Observe a cooling down period!

If one or more stages are set to operate directional, the voltage U_E must be available, which is needed for directional determination. When the displacement voltage is directly connected to the relay and the relay is correctly informed during configuration (address 7911 *P−E, UE, PROT P−E*), the direction can be easily determined.

For directional determination, the current component (IEE>/pDIR., address 3023) in the direction which is determined by the setting under addresses 3024 PHI CORR and 3025 E/F MEAS. must also be exceeded. Measurement is, for example, not possible when test current and test voltage are in phase and E/F MEAS. is set *SIN PHI* and PHI CORR is set to 0° as the current vector then lies exactly between the directional characteristics for forward and reverse direction.

If the relay is connected to three phase−to−earth voltage transformers and it is informed during configuration (address 7911 PH−E CALC PH−E), the relay calculates the displacement voltage from the phase−to−earth voltage. In this case testing of the earth fault protection for non−earthed networks is not completely possible with conventional test sets, since the simulation of an earth fault requires a complete displacement of the voltage triangle. The correct relationship and polarity of the measuring transformer connections, essential for proper earth fault detection, can only be tested when primary load current is available during commissioning (see Section 6.7.3).

6.6.12 Testing the auto−reclose functions (if available)

The internal AR function can be tested provided it is configured under address 7834 as INTERNAL AR = *EXIST* (refer to Section 5.4.2) and switched to AR FUNCT = *ON* (Address 3401).

The binary input ”circuit breaker ready” must be simulated unless an open circuit contact has been programmed for this purpose (FNo `2730 ">CB ready`”, refer also to Section 5.5.2).

Depending of the selected AR program short circuit should be simulated for each of the desired auto−reclose shots, each time once with successful and once with unsuccessful AR. Check the proper reaction of the relay according to the set AR programs.

Note that each new test can begin only after the reclaim time for the previous test has expired; otherwise an auto−reclose cannot result: Annunciation ”`AR not ready`” (FNo `2784`, not allocated at delivery) must not be present or must be annunciated ”**G**oing”.

If the circuit breaker is not ready a reclose attempt must not result; clearance of short circuits is delayed by the stage which is set for tripping without auto−reclosure. However, a normal AR cycle must occur when the signal ”circuit breaker ready” first disappears after the inception of the fault.

6.6.13 Testing the trip circuit supervision (if available)

The trip circuit supervision function − if available − can only be tested if it has been configured under address 7837 (contrary to the state of delivery) *with 2 BI* (with 2 binary inputs) or *BYPASS−RESISTOR* (with one binary input, the second is by−passed by a resistor). Furthermore, it must be switched *ON* in address 3701 (TRIP SUP = *ON*), and the associated binary input(s) must be marshalled for this purpose (refer to Section 5.5.2).

6.6.13.1 Trip circuit supervision with two binary inputs

In accordance with the task of this operation mode of the trip circuit supervision, the trip circuit is assumed to be disturbed when none of the two binary inputs is energized. (refer also to Section 4.11.1). This condition cannot occur steadily, i.e. over a certain time, as long as the trip circuit is operating correctly. It can only occur for a short time during the operation of the circuit breaker. Therefore, alarm is given, if this condition lasts for a time which corresponds to three measurement repetitions.

Energize the binary inputs one after the other: the fault indication disappears as long as one binary input is energized and reappears a short time after both inputs are de−energized.

When both control voltages are switched off, the annunciation ”`Failure TC`” (i.e. trip circuit interrupted, not allocated at delivery) appears after 400 ms to 700 ms.

6.6.13.2 Trip circuit supervision with one binary input

In accordance with the task of this operation mode of the trip circuit supervision, the trip circuit is assumed to be disturbed when the binary input is not energized. (refer also to Section 4.11.2). This condition cannot occur steadily, i.e. over a certain time, as long as the trip circuit is operating correctly. It can only occur for a short time during which the trip relay of the protection device is closed. Therefore, alarm is given, if this condition lasts for a time which should be longer than the duration of a trip command of the device.

Energize the binary input: the fault indication disappears.

When the control voltage is switched off, the annunciation ”`Failure TC`” (not allocated at delivery) appears after approximately 1 to 1.5 times the setting value T FAIL TC, address 3702, i.e. after 2 to 3 s with the presetting.

6.6.14 Testing the circuit breaker failure protection

Testing the function breaker failure protection is possible when it is configured *EXIST* (address 7839) and when one of the alarm or command relays was assigned to the corresponding logical function ”`B/F(...) trip`” under address block 62 resp. 64. This is not the case upon delivery of the relay.

For testing the function based on an internal protection trip, the latter must be switched *ON* as a source (as delivered, address 3902). Furthermore the switching off of the test current through the trip command given by the 7SJ531 must be prevented. The current which continues to flow, then has to operate the corresponding signal or command relay after the time T−B/F (pre−set 0.25 s), settable under address 3907, if the current is above the set value BRK CLOSED under address 1160 (pre−set 0.04 times I_N).

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 7SJ531 can also be made to trip through the voltage protection as an example, provided that the circuit breaker's auxiliary contact is used as a criterion for pick−up under address 3905. Although the current criterion is not fulfilled, a trip command must be given by the breaker failure protection, when the auxiliary contact indicates a closed circuit breaker.

If the breaker failure protection shall also be started by a binary input, this function is to be tested, too. The binary input has to be configured as an external source under address 3903 (as it is upon delivery). A test current is injected whose magnitude is above the pick−up value of BRK CLOSED (address 1160). This current must be selected such that none of the integrated protection functions picks up. This means the test current for the circuit breaker failure protection must be smaller than the setting of any other current protection function.

The circuit breaker failure protection is started via the corresponding binary input ”`>B/F Start`”. After the time T−B/F (address 3907) the corresponding alarm or command relay shall be operated.

The option to start the circuit breaker failure protection by control via the keypad can be tested as well. Then this control facility has to be configured as a source under address 3904. A test current is injected whose magnitude is above the pick−up value BRK CLOSED (address 1160). This current must be selected such that none of the integrated protection functions picks up. This means the test current for the circuit breaker failure protection must be smaller than the setting of any other current protection function.

The circuit breaker failure protection is started by the control. After the time T−B/F (address 3907) the corresponding signal or command relay shall be operated.

Switch off test current.

6.6.15 Testing the switching device control

Depending of the selected feeder mimic diagram, four to ten binary inputs are assigned for the switching device position feedback signals. Each switching device requires two binary inputs. The correlation between switching devices and binary inputs can be taken from the feeder mimic diagrams in Appendix E.

In accordance with the definition for the faulty−position monitoring a switching device error is assumed, when neither the position feed−back signal ON nor OFF is indicated. Under normal operating conditions, this state can only occur temporarily during switching operation and not under steady−state conditions. Otherwise an alarm is given after approximately the time parameterized under address 7525:

Energize each two binary inputs assigned to one switching device separately by connection of a d.c. voltage $\geq$ 16 V (respectively $\geq$ 80 V or $\geq$ 160 V when an increased pick−up threshold is provided as per Section 5.2.2.3) one after the other. As long as only one of the two inputs is energized, no error indication is given.

Switch on or off d.c. voltage simultaneously at each two paired inputs.

- Alarm ”`err:CB/DC pos Qn`” and in parallel together with the first alarm also collective alarm ”`err:CB/DC pos`” is created. This alarm (upon delivery configured at LED 6 and signal relay 4) will be registered as ”**G**oing”, after all switching devices have again resumed their defined positions.

6.7 Commissioning using primary tests

All secondary testing sets and equipment must be removed. Reconnect current and voltage transformers. For testing with primary values the line or protected object must be energized.

Warning

Primary tests shall be performed only by qualified personnel which is trained in commissioning of protection systems and familiar with the operation of the protected object as well as the rules and regulations (switching, earthing, etc.)

6.7.1 Current, voltage and phase sequence checks

The connections to the current and voltage transformers are checked with primary currents and voltages. A minimum load of 10 % rated current is required. Provided that no failure is indicated by the switch position feedback signals, none of the measured value monitors in the relay operates, i.e. LED 5 is dark and alarm relay 4 not energized. In case of a failure indication, the operations messages or alarm state can be consulted for the reason for this failure. The alarm state, which show only the active alarms, can be called up from the level OPERATIONS MENU with key **3**.

In case of a current summation error the matching factor (address 1110, 1112 and 1114, Section 6.3.3) has to be checked.

If unbalanced phase values are indicated, the reason may be a real unbalance in the switchgear. If this must be considered a normal operation condition, then the corresponding monitor is set less sensitive (see Section 6.3.14).

The relay determines the phase sequence from the connected voltages and flowing currents. Both systems must have positive sequence, otherwise ”`Fail.PhSeq V`” resp. ”`Fail.PhSeq I`” is indicated. If this is the case, then the connections of the measuring quantities have to be checked for their phase sequence and, if necessary, corrected. When the network system has an inverse sequence, then two phases have to be interchanged, what has to be considered for the configuration of phase−selective pick−up indications (Section 5.5.3 and 5.5.4). If the phase rotation can be altered during operation, a binary input can be allocated to the input function ”`>negative seq`”; energization of this inputs informs the relay that the phase sequence is counter−clockwise.

Currents and voltages can be read in the front−side display or via operation interface on a personal computer under operations measured values and compared with the actual measured values. Currents and voltages are indicated as primary quantities. A prerequisite for the conformity of the read out and the actual measured quantities is the correct input of the current and voltage transformer ratios (addresses 1103, 1104, 1105, 1112 and 1114). Additionally the currents are indicated in percent of the rated current.

Switch off voltage transformer miniature circuit breakers of the feeder. Provided that the relay 7SJ531 is connected to voltage transformers at the feeder side, values close to zero are indicated for the voltages under the operation measuring values (small measured voltage values are insignificant).

Check in the operation messages that the miniature circuit breaker trip was recognized (annunciation ”`>vt fail feed C`”).

If the voltage transformer is on the bus−bar, the corresponding miniature circuit breaker is also switched off. The alarm in the operation messages has to be ”`>vt fail bb C`”.

Close miniature circuit breaker: the above mentioned alarms appear under operations messages as ”going”, ie. with the suffix ”G” (e.g. ”`>vt fail feed G`”).

If an alarm is missing, then the connection and configuration of these signals (Section 5.5.2) have to be checked.

When the ”C” and ”G” suffix are inverted, then the type of contact (NO or NC) have to be checked (Section 5.5.2).

6.7.2 Direction check with load current

Correct connections of current and voltage transformers are checked using load current over the protected line. The line must be energized and must carry a load current of at least 10 % of the rated current; this shall be ohmic or ohmic−inductive. The direction of the load current must be known. In cases of doubt, interconnected or ring networks must be isolated.

Direction annunciations should be generated by the directional overcurrent time protection. To achieve this, the pick−up values of the directional overcurrent time protection (e.g. addresses 1412 and 1414) must be reduced so that this protection can pick up on load current and determine the direction. The direction is output by the annunciations ”`FltI>/IpL*    fw`” for forward load or ”`FltI>/IpL*  rw`” for reverse load (`*` represents any concerned phase). Note that the forward direction is defined as the direction to the protected object which must not necessarily be equal to the load direction during normal operation.

The correct direction annunciations corresponding to the load flow must appear for all three phases. If all directions are wrong, the polarity of the measuring transformers and the programmed polarity (address 1101, Section 6.3.3.1) do not agree with each other. Check the polarity and program correctly. If the directions given in the display differ from each other, the individual phases in the current or voltage transformer connections are interchanged, or the phase relationship is not correct. Check the connections.

If the load is capacitive, caused for example by underexcited generators or charging currents, borderline cases can occur with respect to the directional characteristics which will lead to undefined or inconsistent directional information. By means of the load power display in address block 57 the position of the load power vector can be determined (see Figure 6.25).

Attention! If setting values have been changed for these tests, make sure that the original settings are restored!

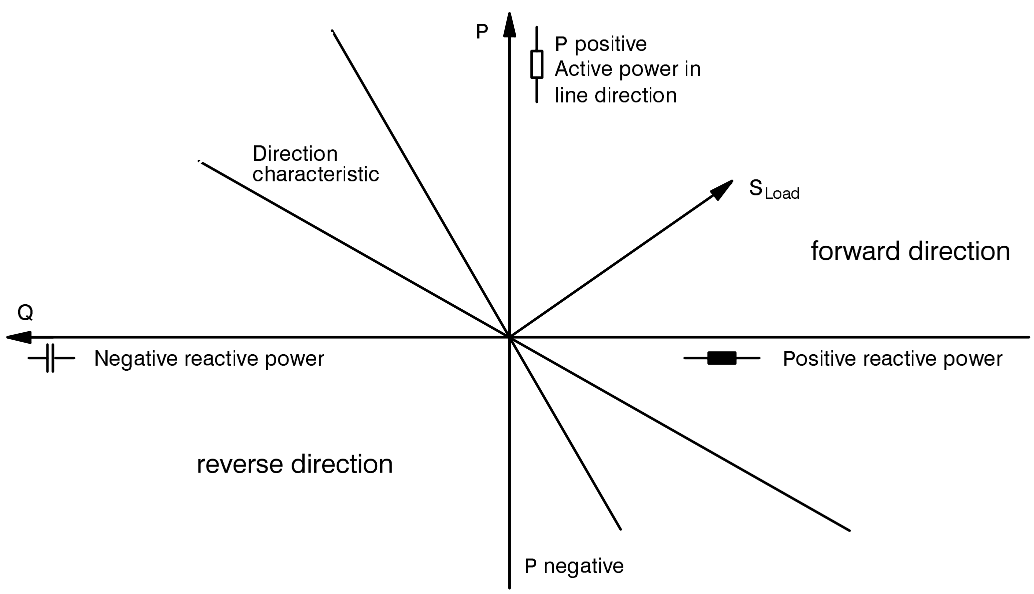


Figure 6.25 Load power vector

6.7.3 Direction check for directional earth fault protection (if available)

6.7.3.1 Earth fault checks for non−earthed systems

The primary current test allows determination of the correct polarity of transformer connections for the earth fault direction determination.

DANGER!

Operations in primary area must only be performed with plant sections voltage−free and earthed!

The most reliable test is to apply a primary earth fault. The procedure is as follows:

− Disconnect the line and earth at both ends; the line must remain disconnected at the remote end throughout the whole test.

− Apply a bolted single−phase earth bridge to the line. On overhead lines, this can be done at any convenient point, but in any case behind the current transformers (looked at from the direction of the bus−bar of the circuit under test). For cables, the earth should be applied at the remote end (termination).

− Open the line earthing switches.

− Close the circuit breaker at the line end to be tested.

− Check the directional indication given (appropriately allocated LED).

− In the earth fault report on the operator terminal (see also Section 6.4.5) the earth faulted phase (”`E/F Detec. L*`”) and the line direction, i.e. ”`E/F forwards`” will be indicated. Active and reactive current are equally indicated: for isolated networks the reactive current, for resonant earthed networks the active current is critical. If the display indicates ”`E/F reverse`” then there is a crossed connection in the earth circuit of voltage or current transformers. If the display shows ”`E/F undefined`” the earth fault current is probably too small.

− Disconnect the line and earth it; remove the bolted earth connection.

− The test is thus completed.

If a test with a real primary earth fault is not possible, at least a fault should be simulated on the secondary side with the line energized. It must be noted, however, that during all such simulations which do not represent exactly the practical conditions, asymmetry of the measured values cause the measured value monitors to operate. This annunciation should then be ignored.

DANGER!

All precautionary measures must be observed when working on the instrument transformers! Secondary connections of the current transformers must be short−circuited before any current leads to the relay are interrupted!

If the Holmgreen connection is used for the current transformers, the displacement voltage will be derived by bypassing a voltage transformer phase (e.g. L1, see Figure 6.27). If earth detection windings of the voltage transformers are not available, the corresponding phase should be interrupted on the secondary side. In the current circuit, only the current from the current transformer corresponding to the phase in which the voltage is missing, will be used. If the line is carrying real power, practically the same relationships apply for the relay as with an earth fault in the line direction in a resonantly earthed (compensated) network. With an isolated network it must be noted that a load with inductive component flowing in the line direction appears to the relay as an earth fault in the reverse direction. Check the directional indication. In the earth fault report (Address 5500, see also Section 6.4.4) the ”earth faulted” phase and the corresponding direction will be indicated. Active and reactive component of the ”earth current” are equally indicated: for isolated networks the reactive and for resonantly earthed networks the active current is critical.

If the display indicates the wrong direction then a crossed connection is present in either the current or voltage transformer connections. If the display shows ”`E/F undefined`” the measured components of the earth fault current are probably too low or the phase relationship of the test circuit is not correct. If there is no indication whatsoever, it is possible that the threshold value of the displacement voltage (Addresses 3009 or 3010) has not been reached, or the relay does not recognize increase in the healthy voltages (address 3007).

If the residual current is derived from a window type summation c.t., the displacement voltage will be derived by bypassing a voltage transformer phase (e.g. L1, see Figure 6.26). If earth detection windings of the voltage transformers are not available, then the corresponding phase should be interrupted on the secondary side. From this interrupted phase a test current is fed into the window type summation c.t. via a series connected impedance Z, which limits the current. Here, direction and connection of the current flow through the window type summation c.t. must be correct as shown. If the current is too small to operate the directional detection, its effect can be increased by making additional turns of the conductor through the window of the summation c.t. In resonantly earthed networks, the value of Z should be an ohmic resistance (60 Ohms/100 W to 600 Ohms/10 W), in isolated networks, a capacitor (5 µF to 100 µF; $\geq$ 250 V) connected in series with a resistance of approximately 30 to 60 Ohms ($\geq$ 10 W) to limit the closing current. The connection illustrated in Figure 6.8 will simulate an earth fault in the line direction. In the earth fault report (address 5500, see also Section 6.4.5), the display should indicate the "earth faulted" phase and line direction, i.e. "`E/F forwards`" Active and reactive current components are equally indicated; for isolated networks the reactive current component, for compensated systems the active current component is critical.

If the directional indication is wrong, it may be due to a crossed connection of the voltage connections in the earth fault detection winding of the voltage transformers or in the earth current path. If the indication "`E/F undefined`" appears, the earth current is probably too small, it can be increased by winding the conductor repeatedly through the window of the summation c.t. or by reduction of Z (smaller R or larger C). If there is no indication whatsoever, it is probable that the threshold value of the displacement voltage (addresses 3009 or 3010) has not been reached, or the relay does not recognize increase in the healthy voltages (address 3007).

Finally, **properly reconnect all the transformer connections** and correct parameters which may have be changed during the test.

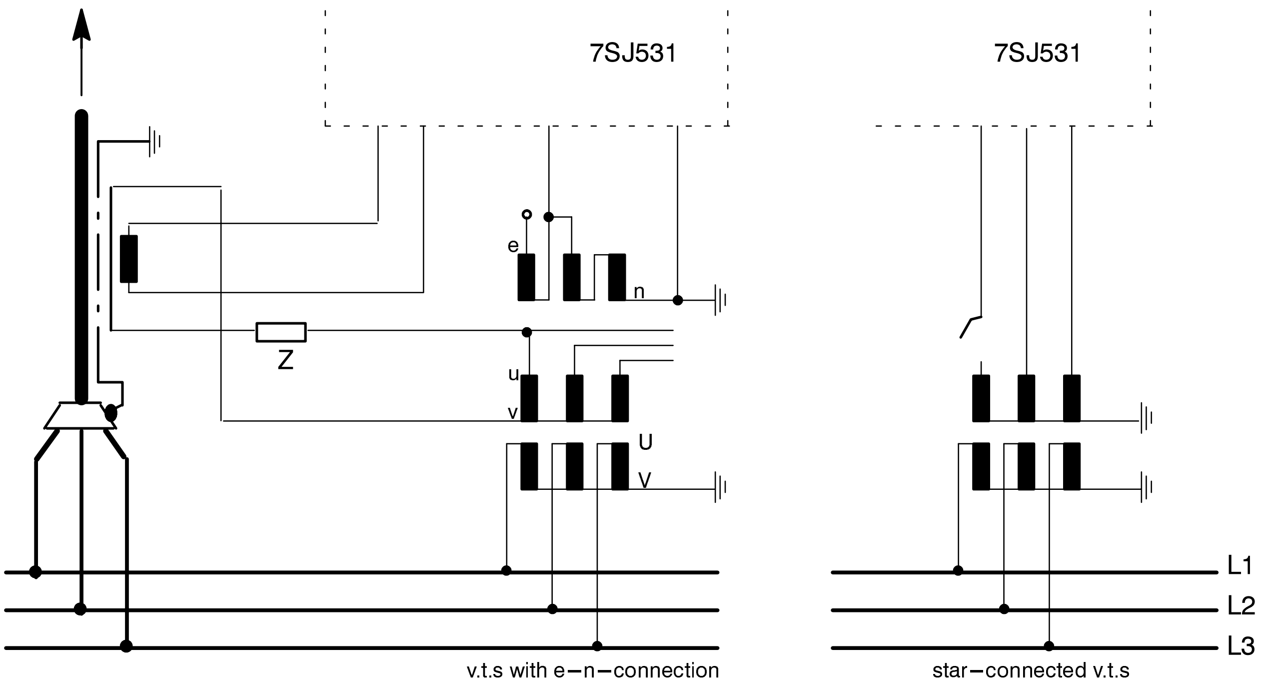


Figure 6.26 Earth fault direction test with window–type summation current transformer

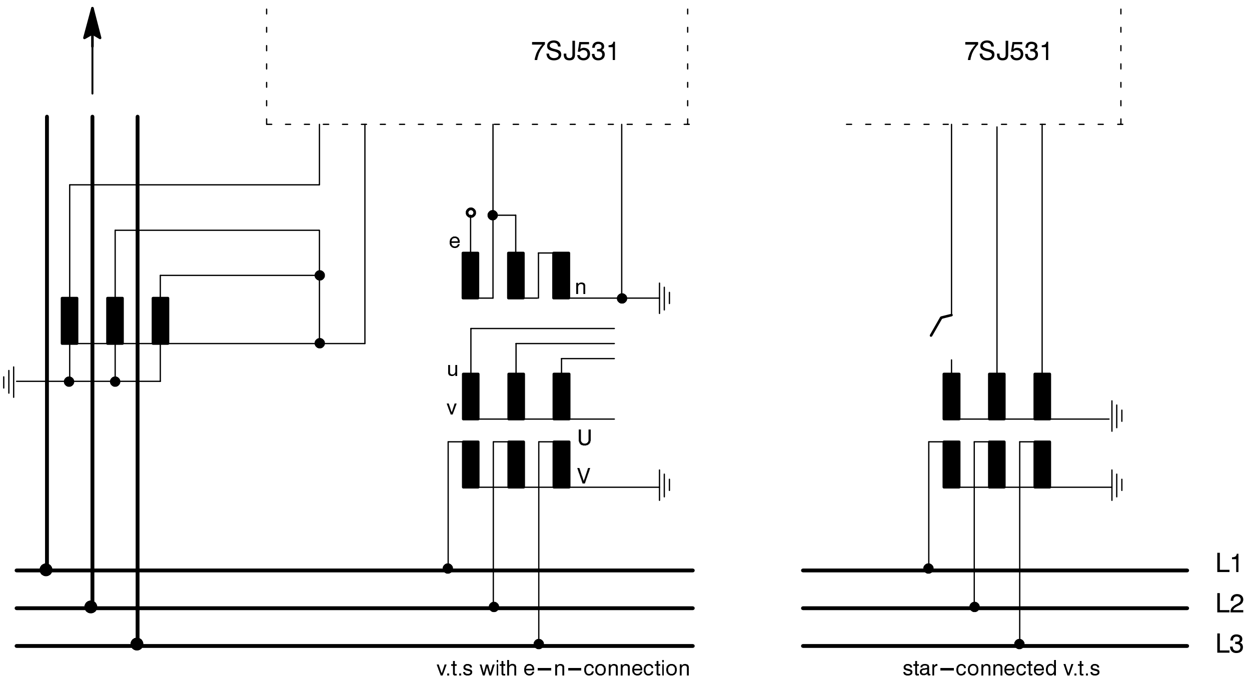


Figure 6.27 Earth fault direction test with Holmgreen connection

6.7.3.2 Direction check for earthed systems

The primary current test allows determination of the correct polarity of transformer connections for the earth fault direction protection.

The trip circuits should be made inoperative as the relay will issue a trip command during this test. Furthermore, it must be noted, that during all such simulations which do not represent exactly the practical conditions, asymmetry of the measured values can cause the measured value monitors to operate. These annunciations should then be ignored.

DANGER!

All precautionary measures must be observed when working on the instrument transformers! Secondary connections of the current transformers must be short−circuited before any current leads to the relay are interrupted!

The displacement voltage will be derived by bypassing a voltage transformer phase (e.g. L1, see Figure 6.27). If earth detection windings of the voltage transformers are not available, the corresponding phase should be interrupted on the secondary side. In the current circuit, only the current from the current transformer corresponding to the phase in which the voltage is missing, will be used. If the line is carrying active and inductive power in line direction, practically the same relationships apply for the relay as with an earth fault in the line direction.

Check the directional indication. In the fault event report on the display panel (see also section 6.4.4) at least the following fault annunciations must be indicated: ”`E/F forwards`”, and trip annunciation ”`E/F Trip`”. If the directional indication is wrong ”`E/F reverse`”, it may be due to a crossed connection of the voltage connections in the earth fault detection winding of the voltage transformers or in the earth current path. If the indication ”`E/F undefined`” appears, the earth current is probably too small. If no pick−up annunciation occurs the current is probably too low or the phase relationship of the test circuit is not correct. If there is no indication whatsoever, it is possible that the threshold value of the displacement voltage (address 3009 $Ue>_{meas.}$ or address 3010 $Ue>_{cal.}$) has not been reached.

Finally, **properly reconnect all the transformer connections**.

6.7.4 Checking the reverse interlock scheme (if used)

For use and tests of the reverse interlock scheme it is necessary that at least one of the binary inputs has been assigned to the function ”`>I>> block`” and/ or further blocking inputs. Tests can be performed with phase currents or earth current. With earth current the corresponding earth current parameters are valid.

Reverse interlocking can be used in ”normally open mode”, i.e. the I>> stages are blocked when the binary input ”`>I>> block`” is energized, or ”normally closed” mode, i.e. the I>> stages are blocked when the binary input ”`>I>> block`” is de−energized. The following procedure is valid for ”normally open mode”.

The protection relay on the incoming feeder and those on all outgoing circuits must be in operation. At first the auxiliary voltage for reverse interlocking should not be switched on.

Apply a test current which makes pick−up the I>> stage as well as the I> or I_p stage. Because of the absence of the blocking signal the relay trips after the (short) delay time T−I>>.

Caution!

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

Now switch on the d.c. voltage for the reverse interlocking. The test as described above is repeated, with the same result.

Simulate a pick−up on each protective device on all outgoing feeders. Simultaneously, a short circuit is simulated on the incoming feeder (as described before). Tripping now occurs after the delayed time T−I> (for definite time protection) or corresponding to T−Ip (for inverse time protection).

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

6.7.5 Checking the circuit breaker failure protection

The protection function itself has already been tested according to Section 6.6.14.

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 can feed 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.

6.7.6 Tripping test including circuit breaker

SIPROTEC 7SJ531 allows simple checking of the tripping circuit and the circuit breaker. If the internal auto−reclose system is activated, a trip−close test cycle is also possible.

```
OPERATION-
   MENUE 1
1: SWITCHING AUTHORIZ
2: OPERATIONAL ANNUN.
3: ALARMSTATE
4: MEASURED VALUES
5: FAULT-PROTOCOLS
6: EARTH FAULTS
7: CB OPER. STATISTIC
8: SETTINGS
9: TESTS
```

6.7.6.1 TRIP−CLOSE test cycle − address block 43 (only for 7SJ531⋆−⋆⋆⋆⋆⋆−0 and −2)

Prerequisite for the start of a trip−close test cycle is that the integrated auto−reclose function programmed as *EXIST* (address 7834) and it is switched on (Address 3401).

A TRIP−CLOSE test cycle is also possible with an external auto−reclose system. Since in this case, however, 7SJ531 only gives the tripping command, the procedure shall be followed as described in Section 6.7.6.2.

If the circuit breaker auxiliary contact advises the relay, through a binary input, of the circuit breaker position, the test cycle can only be started when the circuit breaker is closed. This additional security feature should not be omitted.

```
TESTS

1: 4300 CB TEST
   TRIP-CLOSE CYCLE
2: 4400 CB TEST
   LIVE TRIP
3: 4900 TEST
   FAULT RECORDING
```

DANGER!

A successfully started test cycle will lead to closing of the circuit breaker!

Initiation of the test cycle can be given from the operator keyboard or via the front operator interface. Input of the code word of code level 1 is necessary. The procedure is started with address 4300. This is reached with the **MENU**−key → option **9**: TESTS → option **1**: 4300 CB TEST TRIP−CLOSE CYCLE. The cursor will automatically move to address 4304 (see below).

Further prerequisites for the start of test are that no protective function fault detector has picked up, that no control sequence is in progress, and that the conditions for reclose (circuit breaker ready, AR not blocked) are fulfilled.

```
4300 CB TEST
     TRIP-CLOSE CYCLE
```

Beginning of the block ”Circuit breaker test: Trip−close−cycle

```
4304■CB TEST
     L123 WITH AR ?

     CB CLOSED ?
```

Carry out three−pole test cycle of circuit breaker? Confirm with ”**J/Y**”−key or abort with page−on key ▽

Confirm with ”**J/Y**”−key that circuit breaker is closed or abort with page−on key ▽

After confirmation by the operator that the circuit breaker is closed, the test cycle proceeds. However, the relay rejects the test cycle as long as the auxiliary contact indicates that the circuit breaker is not closed, even if the operator has confirmed that it is.

The relay displays the test sequence in the second display line and, when the test cycle is interrupted or rejected, a corresponding message is displayed.

Display	Meaning
4304 CB TEST STARTED	Circuit breaker test: test cycle started
ABORTED	test cycle aborted
SUCCESSFUL	test cycle successfully executed
FLT. IN PROGRESS	test cycle is already in progress
FAULT RUNNING	protection has picked up on fault; no test possible
CB NOT CLOSED !	CB is not closed; no test possible
AR NOT READY	AR is not ready for reclosure; no test possible
CB NOT OPEN	CB has not opened
CON. IN PROGRESS	Control sequence is in progress

6.7.6.2 Live tripping of the circuit breaker − address block 44

To check the tripping circuits, the circuit breaker can be tripped by 7SJ531 independently on whether an auto−reclosure will occur or not. However, this test can also be made with an external auto−reclose relay.

If the circuit breaker auxiliary contact advises 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.

DANGER!

If an external auto−reclosure device is used, then a successfully started test cycle may lead to closing of the circuit breaker!

Initiation of the test can be given from the operator keyboard or via the front operator interface. Input of the codeword of code level 1 is necessary. The procedure is started with address 4400. This is reached with the **MENU**−key → option **9**: TESTS → option **2**: 4400 CB TEST LIVE TRIP. The cursor will then automatically move to address 4404 (see below).

Further prerequisites for the start of test are that no protective function fault detector has picked up and that no control sequence is in progress.

```
4400 CB TEST
     LIVE TRIP
```

Beginning of the block ”Circuit breaker test: Live trip”

```
4404■CB TRIP
     CB THREE-POLE ?
```

Carry out three−pole trip test of circuit breaker? Confirm with ”**J**/**Y**”−key or abort with page−on key ▽

```
     CB CLOSED ?
```

Confirm with ”**J**/**Y**”−key that circuit breaker is closed or abort with page−on key ▽

After confirmation by the operator that the circuit breaker is closed, the test cycle proceeds. However, the relay rejects the test cycle as long as the auxiliary contact indicates that the circuit breaker is not closed, even if the operator has confirmed that it is.

The relay displays the test sequence in the next display line and, when the test cycle is interrupted or rejected, a corresponding message is displayed. The annunciations are the same as under Section 6.7.6.1.

6.7.7 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 5.3.5): address 7431 concerns triggering via binary input, address 7432 triggering via the operating keyboard or via the operating interface. The pre−trigger time was set under address 7411.

Test fault records started externally (i.e. without protection pick−up) are treated like regular fault records, which means they are registered under a number of their own to have a clear record statistic. Such test fault records, however, are not shown in the system fault overview in the display, because they do not represent a system fault.

```
4900 TEST
     FAULT RECORDING
```

Beginning of the block ”Test fault recording”

After codeword input (code level 1) a test fault record can be started

```
4901■FAULT REC.
     START ?
```

Start a fault record? Confirm with ”Yes”−key **J**/**Y** or abort by erasing codeword operation (key combination **F** followed by **E**)

```
      SUCCESSFUL
```

The relay acknowledges successful completion of the test recording

6.8 Putting the relay into operation

All setting values should be checked again, in case they were altered during the tests. Particularly check that all desired protection functions have been programmed in the configuration parameters (address blocks 78 and 79, refer to Section 5.4). Ensure that the trip times are not set to ∞ for those functions or stages which should trip and that 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). The counter values for active and reactive energy are, if necessary, read out, written down and set to zero.

The indications on the front−plate can be reset by the RESET−key, so that they furthermore indicate only real faults. While pushing the RESET key, the marshallable LEDs on the front−plate are illuminated, providing a lamp test. At the same time, spontaneous fault messages in the display, if any, are cancelled.

Push the key **R** (if necessary several times repeated) to return to the basic diagram. The display shows the feeder mimic diagram. The headline indicates the command source which is activated for control and the bottom line shows the bar diagram for indication of the largest phase current (basic diagram 1) resp. an overview of the actual operation measured values (basic diagram 2). Scrolling between the two pictures is possible with ⇑ ⇓.

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 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.

The display must not be touched nor treated with sharp articles. It must not be cleaned with aggressive detergents nor with alcohol.

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 10 years of operation, at the latest when the operational annunciation ”`Fail.Battery`” has appeared (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 (**MENU** → OPERATION MENU 1 → option 2: OPERATIONAL MEASURED VALUES) and comparison with the actual values for checking the analog interfaces.

– Simulation of an internal short–circuit with 4 x I_N for checking the analog input at high currents.

⚠ Warning

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

⚠ Caution!

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

– Circuit–breaker trip circuits are tested by actual live tripping. Respective notes are given in Section 6.7.5.

7.2 Replacing the back−up battery

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

The back−up battery should be replaced at the latest after 10 years of operation, at the latest when the operational annunciation "`Fail.Battery`" has appeared.

Recommended battery:

Lithium battery 3 V/1 Ah, type CR 1/2 AA, e.g.
− VARTA Order No. 6127 501 501
− SONNENSCHEIN Order No. 1110 150 301

The battery is located at the front edge of the processor board. The front plate must be unscrewed and opened in order to replace the battery.

The procedure when replacing the battery is described below.

− Prepare area of work: provide a surface suited to electrically endangered components (EEC).

− Read out device annunciations, i.e. all addresses which commence with 5 (5000 onwards). This is carried out most convenient using the front operating interface and a personal computer with the DIGSI® protection data processing program; the information is thus stored in the PC.

Note: All configuration data and settings of the device are stored in EEPROMs protected against switching off of the power supply. They are stored independent of the back−up battery. They are, therefore, neither lost when the battery is replaced nor when the device is operated without a battery.

− Prepare the battery as in Figure 7.1:

Caution!

Do not short−circuit battery! Do not reverse battery polarities! Do not charge battery! Do not place the battery on the conductive surface!

Shorten the legs to 15 mm (6/10 inch) each and bend over at a length of 40 mm (16/10 inch). Ensure that the polarity is visible.

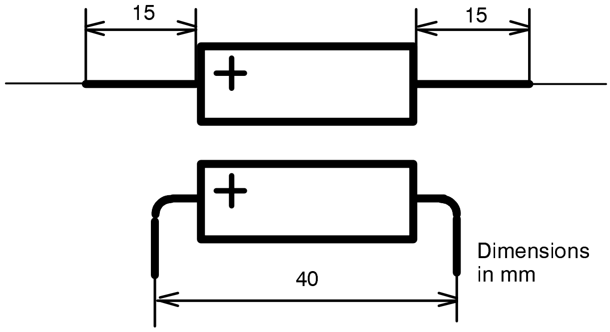


Figure 7.1 Bending the back−up battery

Warning

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

− Loosen the captive screws of the housing and remove the front plate.

− Remove both multi−pin plugs that connect the graphic display and the membrane keyboard to the processor module (right hand card). Loosen the ribbon cables that link the modules with each other so that the desired module can be drawn out.

− Loosen the locking aids at the top and bottom of the module, i.e. compress them in the direction of the impressed arrows and turn them out.

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 processor card and place it on the surface which is suited to electrostatically endangered components (EEC).

– Unscrew used battery from the terminals according to Figure 7.2; **do not place on the EEC–surface!**
– Insert the prepared battery into the terminals as in Figure 7.2 and tighten the screws.

– Re–insert the processor card into the housing; ensure that the locking aids are turned out of the front.

– Compress the locking aids in the direction of the impressed arrows.

– Push the locking aid while the module is being inserted; press the module in until the locking aid clicks into place.

– Re–connect the multi–pin plugs that connect the graphic display and the membrane keyboard to the module.

– Re–connect the ribbon cables to all concerned modules; observe the mark (top!). Ensure that the connection pins do not bend! Do not use force!

– Fix the front plate with the four fixing screws.

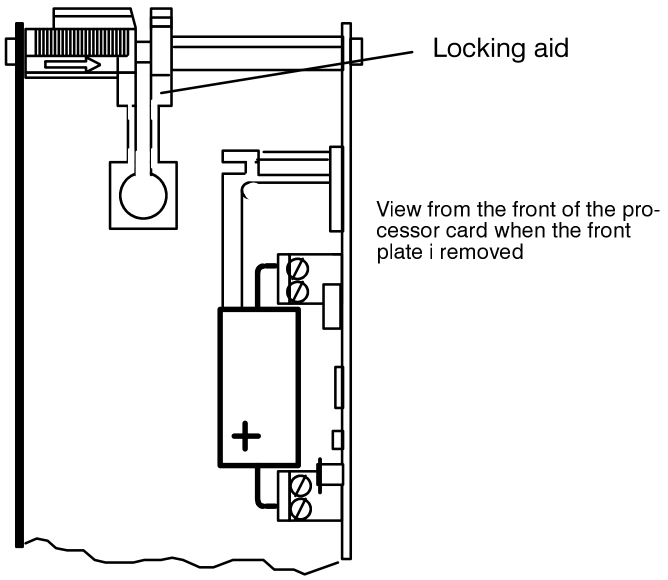
Warning

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

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



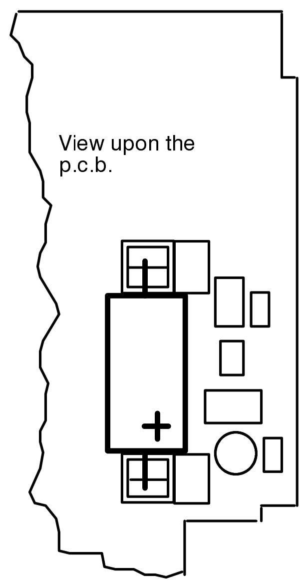


Figure 7.2 Installation of the back–up battery

7.3 Fault tracing

If the protective device indicates a defect, the following procedure is suggested:

If none of the LEDs on the front plate of the module is on, then check:

– Have the modules been properly pushed–in and locked?

– Is the ON/OFF switch on the front plate in the ON position ⊙ ?

– Is the auxiliary voltage available with the correct polarity and of adequate magnitude, connected to the correct terminals (General diagrams in Appendix A)?

– Has the mini–fuse in the power supply section blown (see Figure 7.3)? If appropriate, replace the fuse according to Section 7.3.1.

If the red fault indicator "Blocked" on the front is on and the green ready LED remains dark, the device has recognized an internal fault. Re–initialization of the protection system could be tried by switching the d.c. auxiliary voltage off and on again. This, however, results in loss of fault data and messages if the relay is not equipped with a buffer battery, and, if a parameterizing process has not yet been completed, the last parameters are not stored.

7.3.1 Replacing the mini–fuse

– Select a replacement fuse 5 × 20 mm. Ensure that the rated value, time lag (medium slow) and code letters are correct. (Figure 7.3).

– Prepare area of work: provide a surface that is suited to electrically endangered components (EEC).

Warning

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

– Loosen the captive screws of the housing and remove the front plate.

– Loosen the ribbon cables that link the modules with each other so that the centre module (power supply) can be drawn out.

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 power supply card and place it on the surface which is suited to electrostatically endangered components (EEC).

– Remove blown fuse from the holder (Figure 7.3).

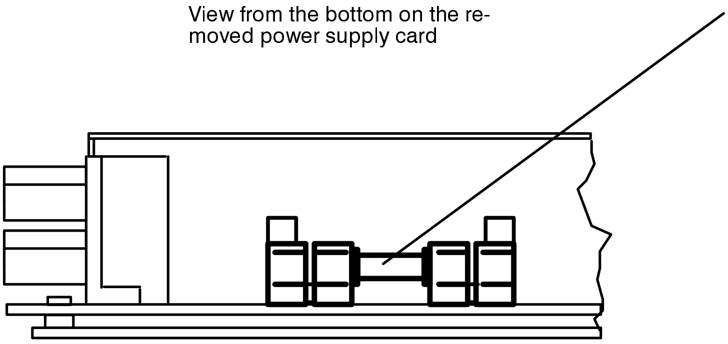
– Fit new fuse into the holder (Figure 7.3).

– Insert power supply card into the housing.

– Re–connect the ribbon cables to all concerned modules; observe the mark (top!). Ensure that the connection pins do not bend! Do not use force!

– Fix the front plate with the four fixing screws.

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	4 A/E
60/110/125	2 A/E
220/250	1.6 A/G

Figure 7.3 Mini–fuse of the power supply

8 Repairs

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

Therefore, if a defect cannot be corrected by operator procedures such as described in Chapter 7, it is recommended that the complete relay should be returned to the manufacturer. Use the original transport packaging for return. If alternative packing is used, this must provide the degree of protection against mechanical shock, as laid down in IEC 255−21−1 class 2 and IEC 255−21−2 class 1.

If it is unavoidable to replace individual modules, it is imperative that the standards related to the handling of **E**lectrostatically **E**ndangered **C**omponents are observed.

Warning

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

Caution!

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

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

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

9 Storage

Solid state protective relays shall be stored in dry and clean rooms. The limit temperature range for storage of the relays or associated spare parts is −25 °C to +55 °C (refer Section 3.1.4 under the Technical data), corresponding to −12 °F to 130 °F.

The relative humidity must be within limits such that neither condensation nor ice forms.

It is recommended to reduce the storage temperature to the range +10 °C to +35 °C (50 °F to 95 °F); this prevents from early ageing of the electrolytic capacitors which are contained in the power supply.

For very long storage periods, it is recommended that the relay should be connected to the auxiliary voltage source for one or two days every other year, in order to regenerate the electrolytic capacitors. The same is valid before the relay is finally installed. In extreme climatic conditions (tropics) pre−warming would thus be achieved and condensation avoided.

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

Appendix

A General diagrams

B Connection diagrams

C Calculation examples

D Operation structure

E Feeder mimic diagrams

F Tables

A General diagrams

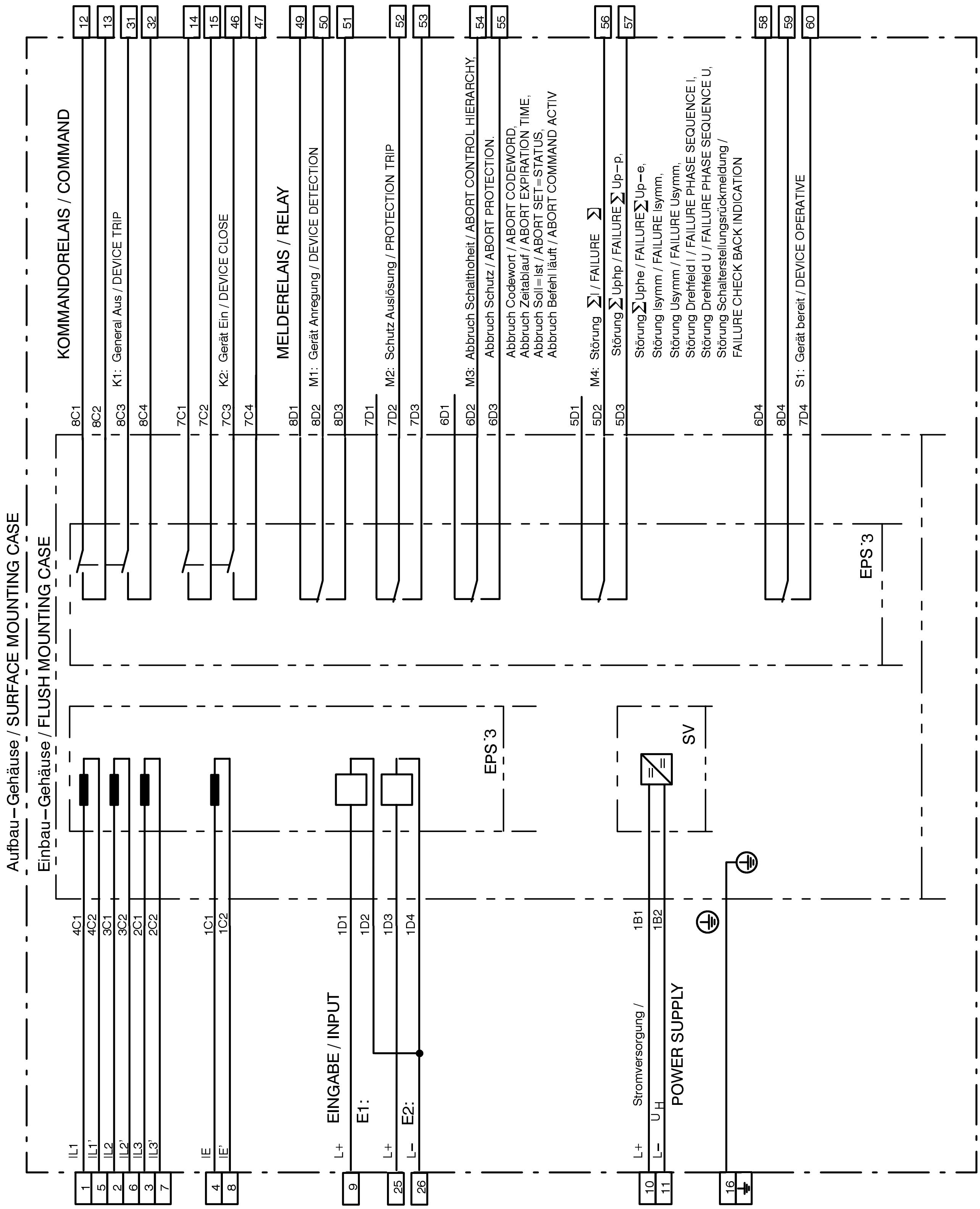


Figure A.1 General diagram 7SJ531★−★★★★★−★★★★/EE (sheet 1 of 3)

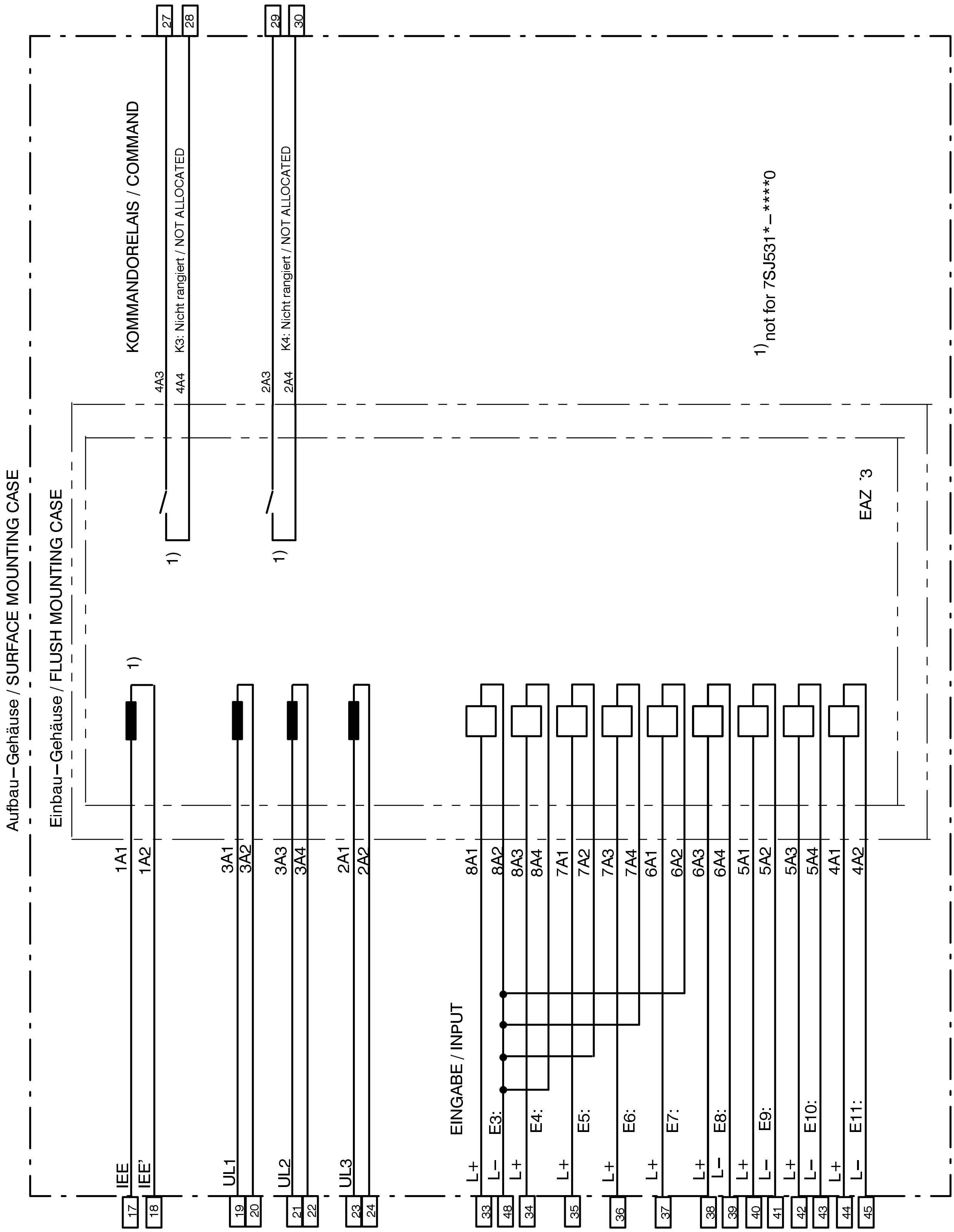


Figure A.2 General diagram 7SJ531⋆−⋆⋆⋆⋆⋆−⋆⋆⋆⋆/EE (sheet 2 of 3)

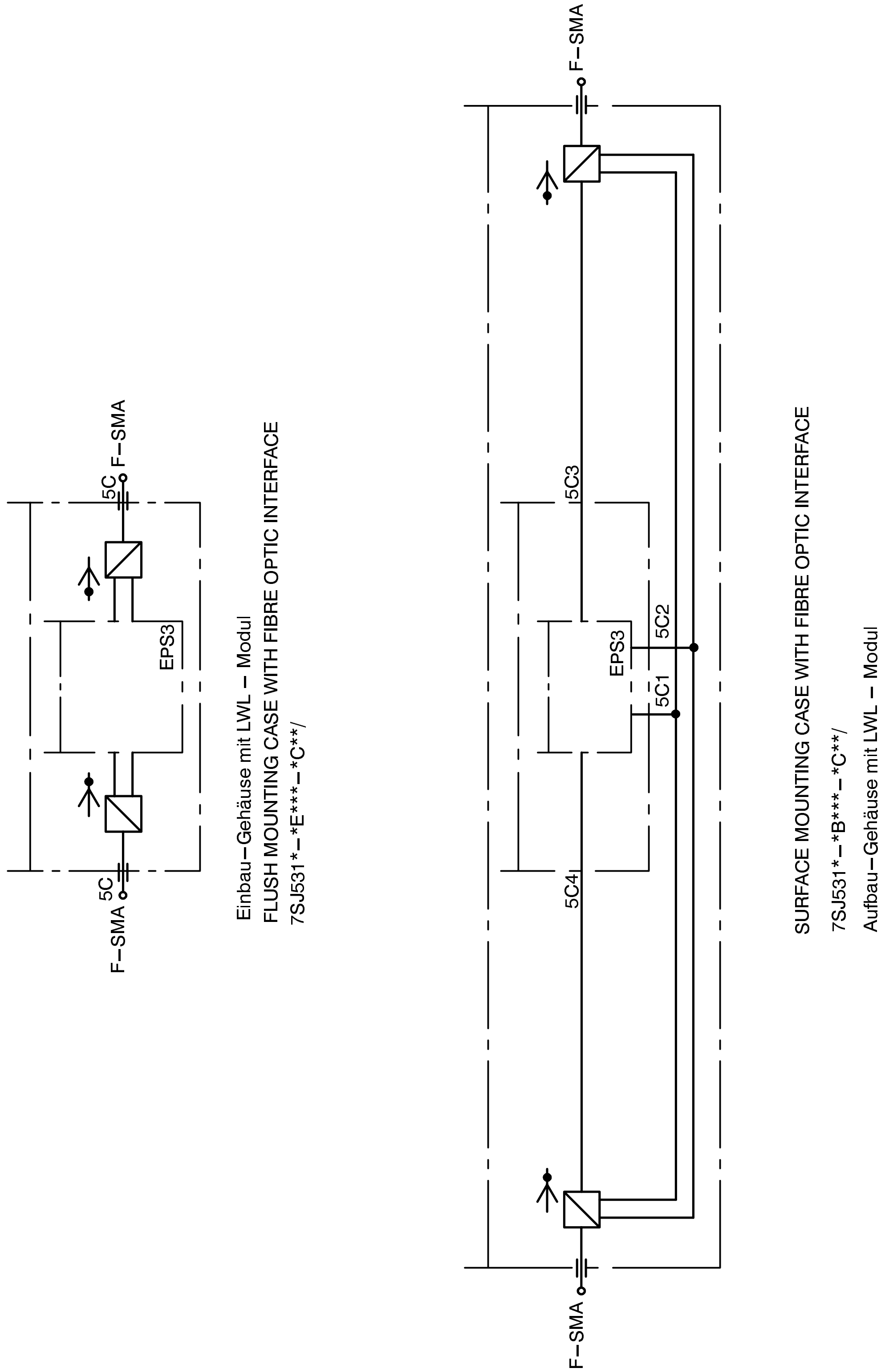


Figure A.3 General diagram 7SJ531★−★★★★★−★★★★/EE (sheet 3 of 3)

B Connection diagrams

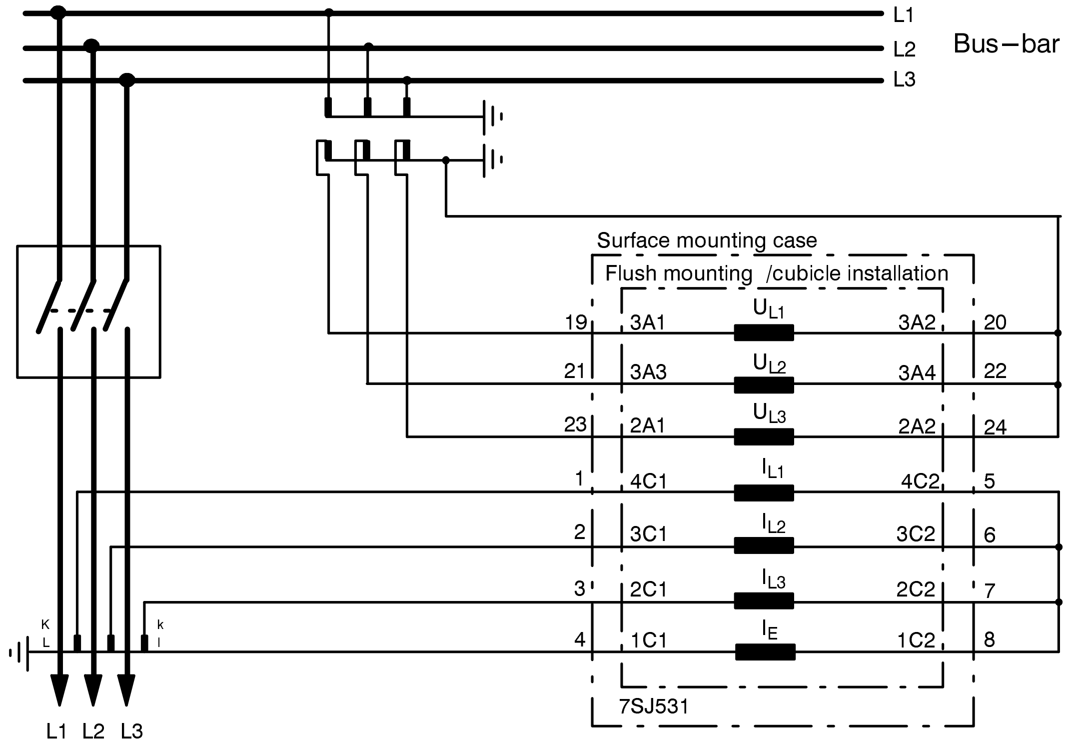


Figure B.1 Connection to three current transformers and three voltage transformers; v.t.s line−earth at bus−bar side − standard connection, suitable for all systems

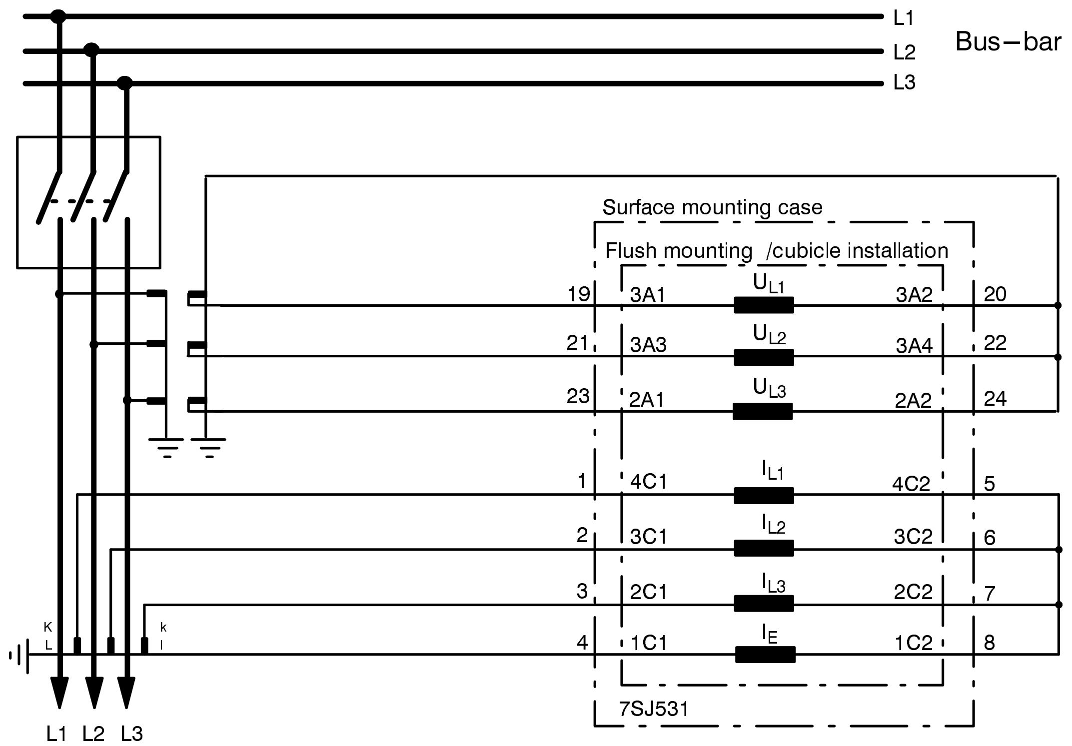


Figure B.2 Connection to three current transformers and three voltage transformers; v.t.s line−earth at feeder side − standard connection, suitable for all systems

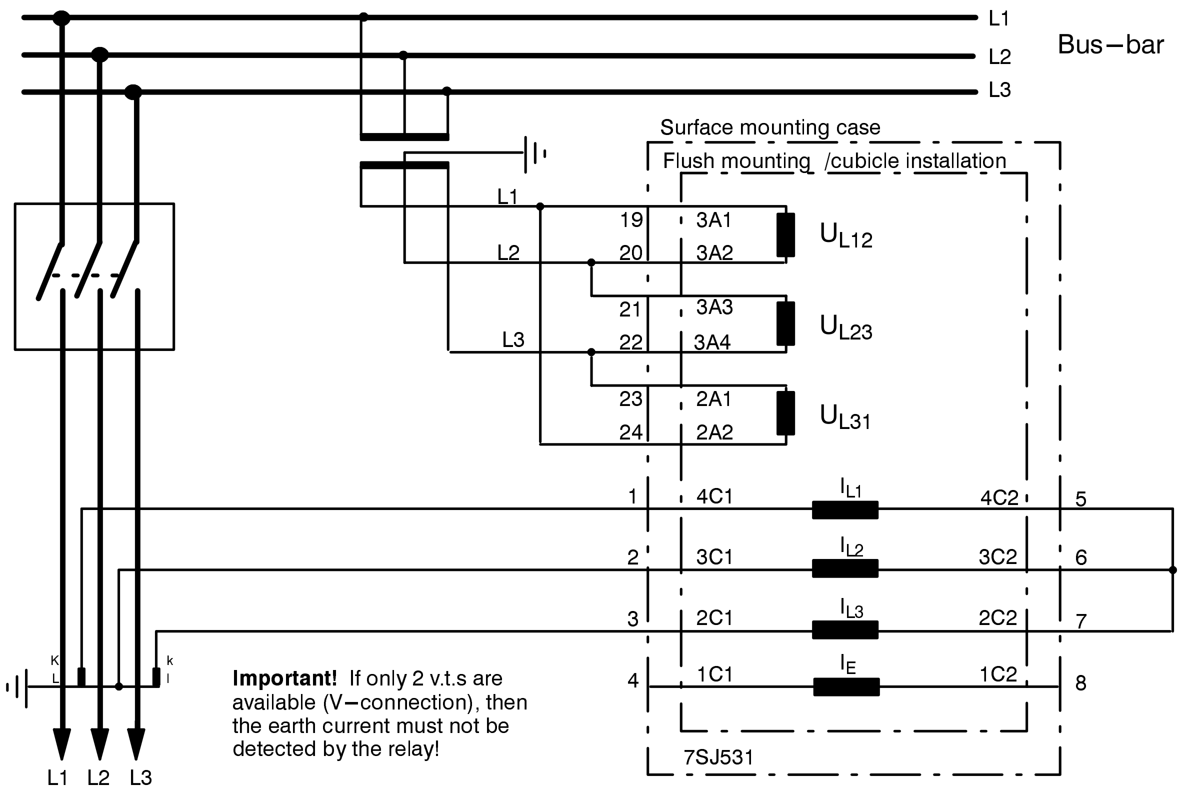


Figure B.3 Connection to two current transformers and two voltage transformers; v.t.s line−line at bus−bar side − only for all isolated or arc compensated systems (but no earth fault detection

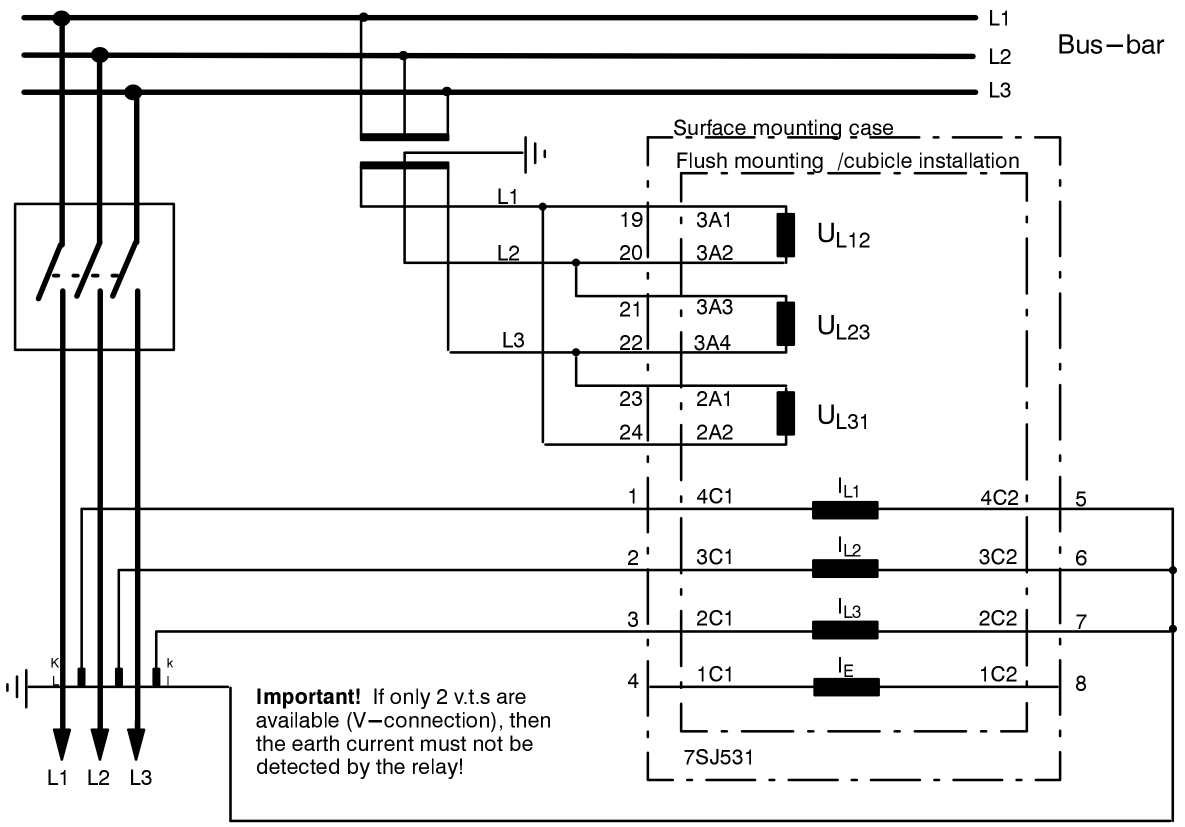


Figure B.4 Connections to three current transformers and two voltage transformers, only for isolated or compensated systems

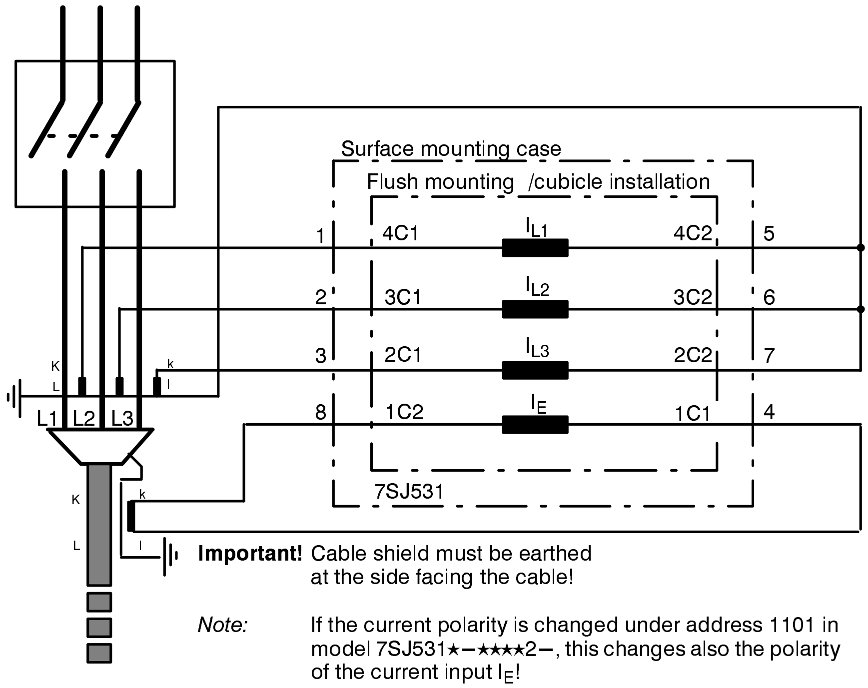


Figure B.5 CT connections with three current transformers, earth current from additional summation CT, preferably for solidly or low−resistance earthed systems

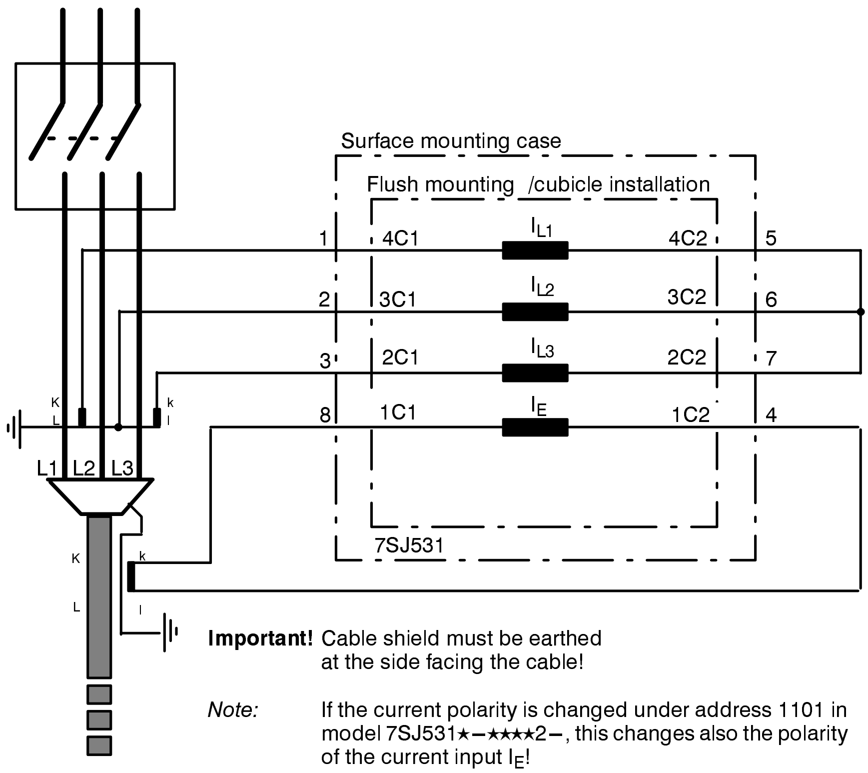


Figure B.6 Connections to two current transformers, preferably for isolated or compensated systems

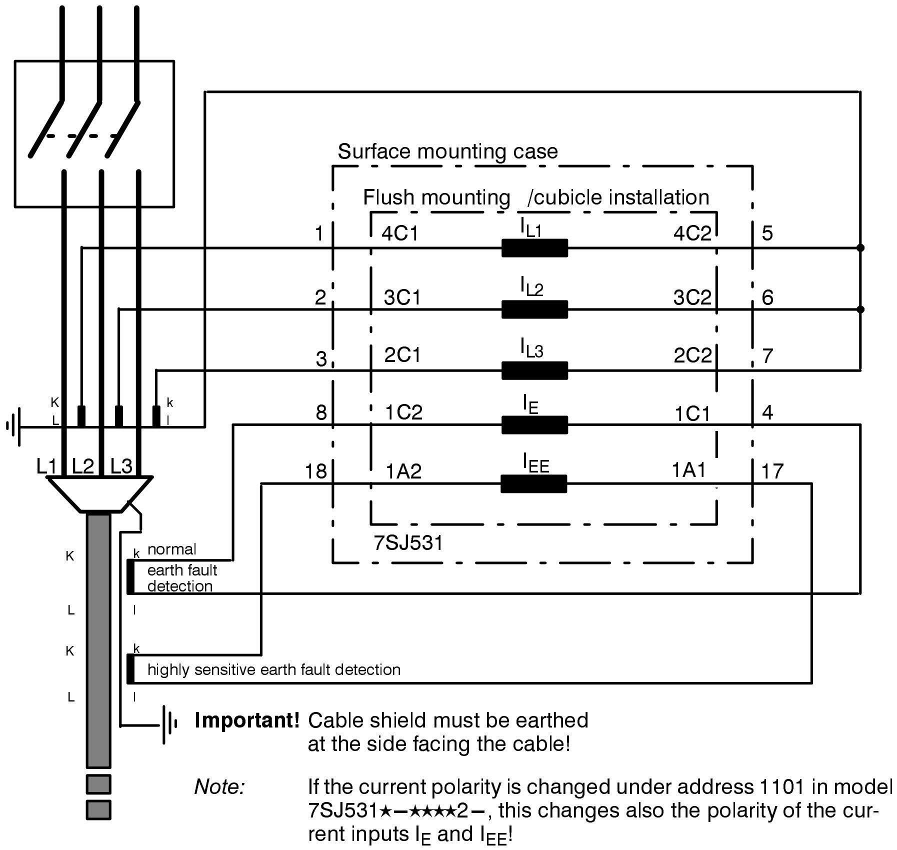


Figure B.7 Example for connections to two different summation c.t.s, suitable for all systems

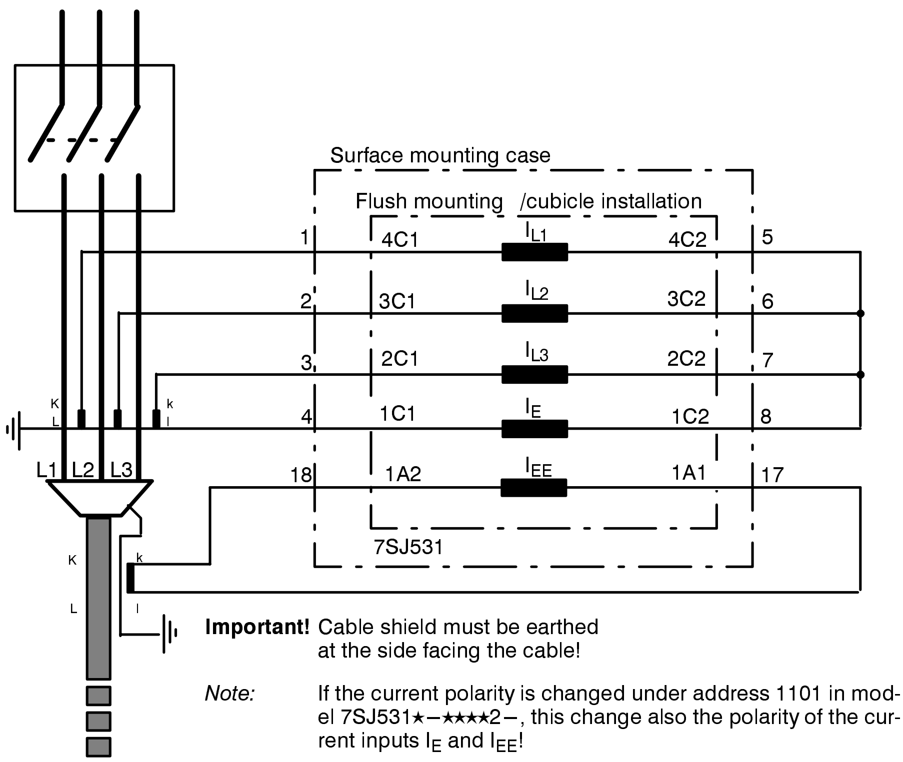
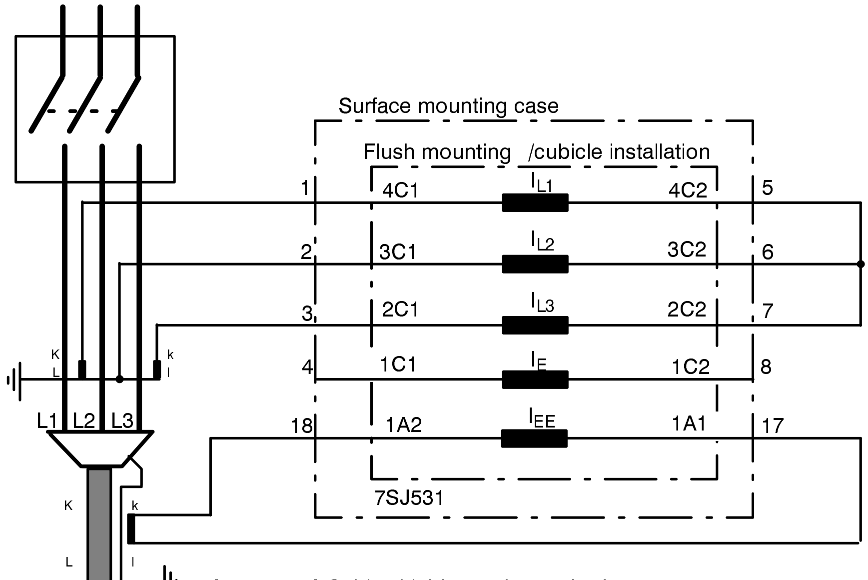


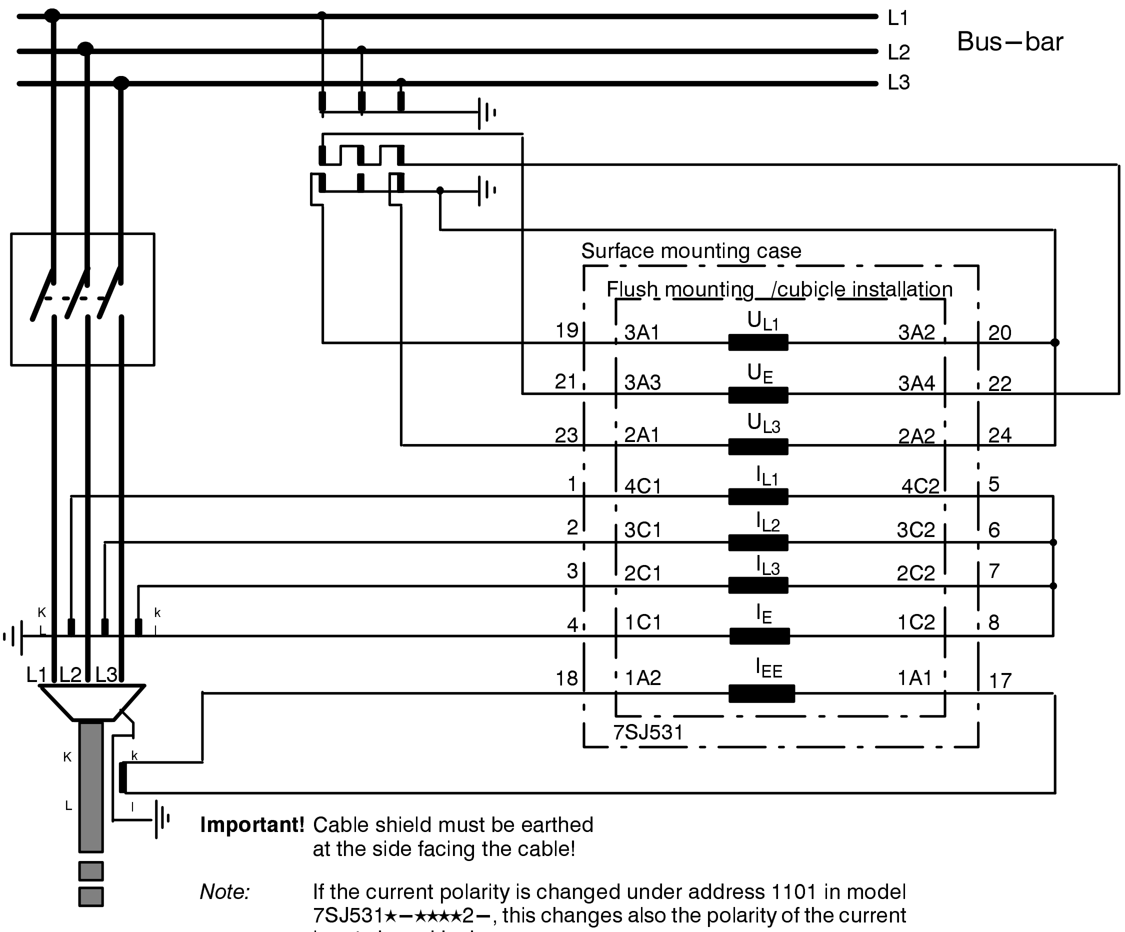
Figure B.8 Connections to three current transformers with star–point (residual current) – additional summation c.t. for highly sensitive earth fault detection, suitable for all systems



Important! Cable shield must be earthed at the side facing the cable!

Note: If the current polarity is changed under address 1101 in model 7SJ531★–★★★★2–, this changes also the polarity of the current input I_{EE}!

Figure B.9 Connections to two current transformers – additional summation c.t. for highly sensitive earth fault detection, only for isolated or compensated systems



Important! Cable shield must be earthed at the side facing the cable!

Note: If the current polarity is changed under address 1101 in model 7SJ531★–★★★★2–, this changes also the polarity of the current inputs I_E and I_{EE}!

Figure B.10 Connections to three current transformers with star–point (residual current) and two voltage transformers – additional summation c.t. and open–delta v.t. for highly sensitive earth fault detection, preferably for compensated systems

C Calculation Examples

C.1 Cable: Thermal overload protection

1st example:

Given: permissible continuous current: .... I_{max} = 500 A at 40 °C ambient temperature
maximum permissible current for 1 s: ..... $I_{1s} = 45 \cdot I_{max}$ = 22.5 kA
current transformers: .... 600 A/1 A

This results in:

$$k = \frac{I_{max}}{I_N} = \frac{500\,A}{600\,A} = 0.833 \quad \text{; selected setting value } k = 0.83$$

$$\tau_{min} = \frac{1}{60} \cdot \left(\frac{I_{1s}}{i_{max}}\right)^2 = \frac{1}{60} \cdot 45^2 = 33.75 \text{ minutes ; selected setting value 33.7 minutes}$$

The cable wires should be thermally independent from one another. The mode of measured value formation is set in address 2706: O/L−CALCUL = Θ *MAX*.

The expected tripping time can be derived from the temperature equation for a constant current jump:

$$\Theta(t) = \left(\Theta - \Theta_{pre}\right) \cdot \left(1 - e^{-t/\tau}\right) + \Theta_{pre} \qquad \text{with} \quad \Theta = \left(\frac{I}{k\,I_N}\right)^2$$

The resulting tripping time T_{trip}:

$$T_{trip} = \tau \cdot \ln \frac{\left(I/I_{max}\right)^2 - \left(I_{pre}/I_{max}\right)^2}{\left(I/I_{max}\right)^2 - 1}$$

If, for example, the preload is I_{pre} = 410 A and the current jumps to I = 850 A, the tripping time T_{trip} would be:

$$T_{trip} = 33.75 \text{ minutes} \cdot \ln \frac{\left(850/500\right)^2 - \left(410/500\right)^2}{\left(850/500\right)^2 - 1} = 5.39 \text{ minutes}$$

$$T_{trip} = 5 \text{ minutes, } 24 \text{ s}$$

2nd example:

Given: Permissible continuous current: .... I_{max} = 500 A at 40 °C ambient temperature
The cable should be capable to carry twice the permissible continuous current for 10 minutes; i.e.

T_{Trip} = 10 min at $I = 2 \cdot I_{max}$ = 1000 A.
Preload not considered, i.e. I_{pre} = 0.

The following time constant τ results:

$$\tau = \frac{T_{Trip}}{\ln \frac{\left(I/I_{max}\right)^2 - \left(I_{pre}/I_{max}\right)^2}{\left(I/I_{max}\right)^2 - 1}} = \frac{10 \text{ min}}{\ln \frac{\left(1000/500\right)^2 - 0}{\left(1000/500\right)^2 - 1}}$$

$$\tau = 34.8 \text{ minutes}$$

3rd example: If the actual ambient temperature differs from the specified nominal temperature, this can be considered by a matched k−factor.

Given:

permissible continuous current: . . . . . I_{max} = 500 A at θ_N = 40 °C ambient temperature
max. current for 1 s: . . . . $I_{1s} = 45 \cdot I_{max}$ = 22.5 kA
max permissible cable temperature . . θ_{max} = 90° C
actual ambient temperature . . . . θ_{amb} = −5° C
current transformers: . . . . 600 A/1 A

This results in a normalized ambient temperature Θ_a which gives a new k−factor:

$$\text{with } \Theta_u = \frac{\theta_{amb} - \theta_N}{\theta_{max} - \theta_N} = \frac{-5^\circ C - 40^\circ C}{85^\circ C - 40^\circ C} = -1$$

$$k_{new} = k_{old} \cdot \sqrt{1 - \Theta_u} = \frac{500\,A}{600\,A} \cdot \sqrt{1+1} = 0.83 \cdot \sqrt{2} = 1.17$$

$I_{max} = k_{new} \cdot I_N = 1.17 \cdot 600$ A = 707 A at the actual ambient temperature −5 °C.

If, for example, the preload is I_{pre} = 410 A and the current jumps to I = 850 A, the tripping time T_{trip} would be with the above values:

$$T_{trip} = \tau \cdot \ln\frac{(I/I_{max})^2 - (I_{pre}/I_{max})^2}{(I/I_{max})^2 - 1} = 33.75 \text{ minutes} \cdot \ln\frac{(850/707)^2 - (410/707)^2}{(850/707)^2 - 1} = 30.8\text{minutes}$$

$$T_{trip} = 30 \text{ minutes and } 48 \text{ secs}$$

C.2 Motor: Thermal overload protection, start−up time supervision, motor restart lockout

4th example:

Given:

rated voltage . . . . U_N = 6600 V
rated current . . . . I_N = 126 A
noload current . . . . I_0 = 24,6 A
start−up current . . . . I_{STRT} = 624 A
start−up time . . . . $T_{STRT\,max}$ = 8,5 s at I_{STRT} = 624 A
continuous permissible stator current . . . . I_{max} = 135 A
heating−up time constant . . . . τ_h = 55 minutes
cooling−down time constant at stand still . τ_c = 220 minutes
current transformers: . . . . 200 A/1 A, 5P20, 30 VA

This results for the **thermal overload protection** in:

k−factor: $k = \frac{I_{max}}{I_N} = \frac{135\,A}{200\,A} = 0.675$; selected setting value k = 0,67

k_τ−factor $k_\tau = \frac{\tau_c}{\tau_h} = \frac{220 \text{ minutes}}{55 \text{ minutes}} = 4$

In case the permissible overload is stated for a certain duration, instead of the time constant, then the time constant can be calculated as shown in the 2nd example for a cable.

The results for the **start−up time supervision**:

Start−up current: $$\frac{I_{STRT}}{I_N} = \frac{\text{start−up current}}{\text{rated c.t. current}} = \frac{624\,A}{200\,A} = 3.12 \cdot I_N$$

With reduced voltage, the start−up current is equally reduced. The start−up current at 80 % rated voltage will be in this example: $0.8 \cdot I_{STRT} = 2.5 \cdot I_N$

The threshold for start−up detection must lie above the maximum load current and below the minimum start−up current. If no further influences are considered, the threshold (address 1165) can be set to a mean value between the mentioned limits:

The continuous permissible current: $$\frac{135\,A}{200\,A} = 0.68 \cdot I_N$$

$$I_{STRT-DET} = \frac{2.5\,I_N + 0.68\,I_N}{2} \approx 1.6 \cdot I_N$$

With other conditions than the rated conditions,the tripping time of the start−up protection will change:

$$T_{trip} = \left(\frac{I_{ANL}}{I}\right)^2 \cdot T_{STRT\ max}$$

With 80 % rated voltage and 80 % rated start−up current, the tripping time would be:

$$T_{trip} = \left(\frac{624\ A}{0.8 \cdot 624\ A}\right)^2 \cdot 8.5\ s = 13.3\ s$$

For **motor restart lockout**, the following additional data should be stated:v

Permissible number of startups
− with cold motor: .... $n_C = 3$
− with hot motor: .... $n_W = 2$
Between two startups, a pause duration of 1 minute is necessary.

This results in the following settings for restart lockout:

$I_A/I_B = \frac{624\ A}{126\ A} = 4.95$; selected setting value $I_A/I_B = 4.9$

$I_B/I_N = \frac{126\ A}{200\ A} = 0.63$; selected setting value $I_B/I_N = 0.6$

$n_W = 2$

$n_C - n_W = 1$

The thermal replica of the rotor calculates the rotor temperature rise Θ_{rotor}. The following is valid:

$$k_{rotor}^2 = \frac{n_c}{n_c - n_w} = 3 \qquad k_{rotor} = \sqrt{3}$$

$$\tau_{rotor} = \frac{(n_c - n_w)\,T_{STRT}}{\ln\frac{1}{1-(I_B/I_A)^2}} = \frac{8.5\ s}{\ln\frac{1}{1-(126\ A/625\ A)^2}} = 204\ s$$

The theoretical relative end temperature rise caused by the start–up current is:

$$\Theta_E = \left(\frac{I_A}{k_L/I_B}\right)^2 = \left(\frac{624\ A}{\sqrt{3}\cdot 126\ A}\right)^2 = 817\ \%$$

The relative temperature rise during normal operation under rated conditions is:

$$\Theta_{rotor\ N} = \frac{1}{k_L^{\ 2}} = 33\ \%$$

In order to ensure the last start–up when (n_C – 1) start–ups have already occurred, the thermal rotor replica has a small negative tolerance (operational measured value Θ_L/Θ_{LTrip}).

If the cooling–down time constant is different from the heating–up time constant (for the stator and/or for the rotor), the relay must recognize whether the motor is running or at stand–still. The criterion is the current flow, the limit of which is set in address 1160 BRK CLOSED (additional plant data, Section 6.3.3.3). Above this current the breaker is assumed to be closed, i.e. the motor is assumed to be running. This parameter is processed by several protection functions. The thermal overload protection and the restart lockout operate with the cooling–down time constant $k_\tau \cdot \tau$, when the measured current is smaller than the above mentioned limit.

In order to distinguish correctly between running motor and stand–still, the limit BRK CLOSED must be higher than the smallest load current (e.g. idle current).

In secondary values, the following results:

$$I_{noload\ sec}/I_N = 24.6\ A/200\ A = 0.123$$

When considering a tolerance of 3 % I_N, the setting value of BRK CLOSED is chosen: 0.09 · I/I_N.

For **short–circuit protection**, the following should be assumed:

Short–circuit currents of the feeder:
– three–phase .... I_{sc3ph} = 21 kA
– two–phase .... I_{sc2ph} = 7.5 kA

Assumed the maximum start–up current is not higher than 1.6 times the rated start–up current I_{STRT}. The setting value I>> of the overcurrent time protection results:

$$1.6 \cdot I_{STRT} < I{>>} < I_{sc2pol}$$

$$998\ A < I{>>} < 7.5\ kA$$

Setting must be above the maximum start–up current. Selected value: 1000 A. In secondary value:

$$I{>>}/I_N = \frac{1000\ A}{200\ A} = 5$$

The factor 1.6 considers higher start–up currents by increased voltage. The stage can be set instantaneous or with only a small delay (50 ms).

For the **current transformer requirements**, the following should be considered:
The secondary c.t. current must deliver at least as much fundamental wave that the stage I>> can pick up.

The following applies:

$$n' = n \cdot \frac{P_N + P_i}{P_b + P_i}$$

where

– n' .... effective overcurrent factor
– n .... nominal overcurrent factor
– P_N .... rated burden of the c.t.s
– P_b .... actually connected burden (< 0,2 VA with 7SJ531, plus wiring)
– P_i .... internal burden of the c.t.s ($\overline{P_i} = I_{Nsek}{}^2 \cdot R_i$)

The saturation current I_S which can be transmitted by the c.t.s without saturation, under steady–state conditions, is:

$I_S = n' \cdot I_N$

With the given current transformer data, an assumed internal burden of 20 %, i.e. $P_i \approx 0{,}2 \cdot P_N = 0{,}2 \cdot 30$ VA = 6 VA, the following results:

$$I_s = 20 \cdot \frac{(30 + 6)\ \text{VA}}{(0.2 + 6)\ \text{VA}} \cdot 200\ \text{A} = 23.2\ \text{A}$$

This calculated saturation current is higher than the maximum short–circuit current, so that the c.t. requirement are fulfilled.

C.3 Transformer:

A bus–bar of a distribution network is fed from a power transformer with the following data>

rated apparent power .... S_{NT} = 16 MVA
per unit impedance .... u_k = 10 %
primary (higher) voltage .... U_N = 110 kV
secondary (lower) voltage .... U_N = 20 kV
vector group Dy5
star–point .... earthed
short–circuit power at the 110 kV end .... 1 GVA

The following short–circuit values result:

– three–phase higher voltage side .... $I''_{sc3,1,110}$ = 5250 A at higher voltage side
– three–phase, lower voltage side .... $I''_{sc3,2,20}$ = 3928 A at lower voltage side
corresponds to .... $I''_{K3,2,110}$ = 714 A at higher voltage side

Rated current of the transformer .... $I_{NT,110}$ = 84 A at higher voltage side

Assumed the current transformers at the higher voltage side should be 100 A/1 A, and at the lower voltage side 500A/1A. The following settings result:

The **high−set I>> stage** requires that it must not pick up on a short−circuit on the lower voltage side. This is ensured when it is set higher than $^1/u_k$ times rated current, i.e. 10 · 84 A = 840 A. With a safety margin, we select 1000 A. On the secondary side: $I>>/I_N$ = 10.

The **overcurrent stage $I>/I_p$** represents the back−up stage for the downstream protective relays and must be graded with these. The pick−up value should lie approximately 20 % to 30 % above the maximum presumed load current (including permissible overload). We select as setting value, for example, $I>/I_N$ = 1,3 (i.e. I> = 130 A).

The **unbalanced load protection** can also be used on transformers, in order to detect low−current single−phase or two−phase faults. This allows, for example, to detect single−phase short−circuit on the lower voltage side of the transformer even when there is no zero sequence current on the higher voltage side (connection group Dy).

The power transformer transforms symmetrical current according to its transformation ratio

$$I_p = \frac{1}{N_{tr}} \cdot I_s$$

(N_{tr} = transformation ratio)

This is also valid for the negative sequence currents I_2

$$I_{2p} = \frac{1}{N_{tr}} \cdot I_{2s}$$

In case of single−phase fault, $I_{a0} = I_{a1} = I_{a2} = 1/3 \cdot I_a$, and thus

$$I_{a2} = \frac{1}{3\,N_{tr}} \cdot I_a$$

In case of two−phase fault, $I_b = -\,I_a$; $I_{a0} = 0$; $I_{a1} = I_{a2} = 1/\sqrt{3} \cdot I_a$, and thus

$$I_{a2} = \frac{1}{\sqrt{3}\;N_{tr}} \cdot I_a$$

The assumed data of this example result in:

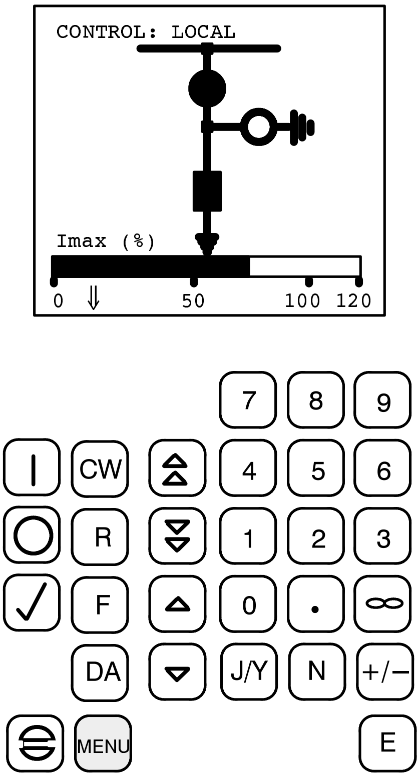
$$N_{tr} = \frac{110\text{ kV}}{20\text{ kv}} = 5,5$$

If we set $I_2 \geq 0.1 \cdot I_N$ at the relay on the higher voltage side, the minimum detectable fault current on the lower voltage side is $I_a = 3 \cdot N_{tr} \cdot I_2> = 3 \cdot 5.5 \cdot 0.1 \cdot 100$ A = 165 A with single−phase fault, and $\sqrt{3} \cdot N_{tr} \cdot 0{,}1 \cdot 100$ A = 95 A with two−phase fault. This corresponds to 36 % or 20 % of the rated transformer current.

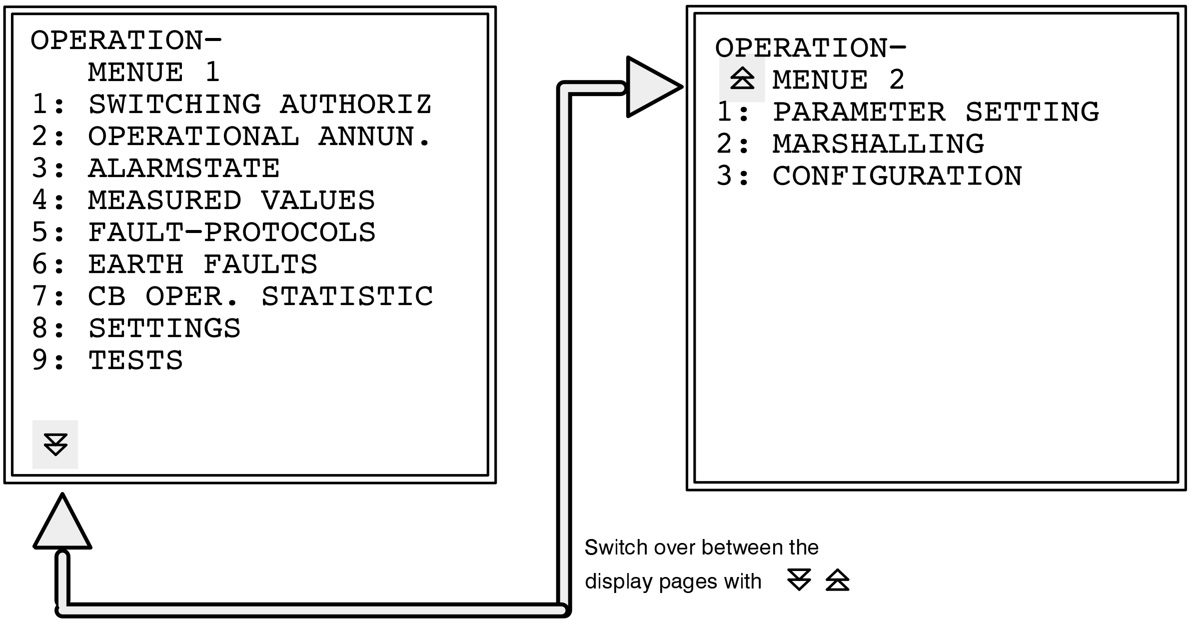
The unbalanced load protection cannot distinguish between fault on the higher voltage side and on the lower voltage side. Therefore, the time delay $TI_2>$ must be coordinated with the time grading of the downstream protection relays.

D Operation structure

Basic image 1:



MENU−key offers the OPERATION MENU (2 display pages); back with **R**



Option **1** of OPERATION MENU 1

```
SWITCHING AUTHORIZ.

7598 SWITCH AUTH
     LOCAL
     LOCAL/REMOTE
     VIA BI
     LOCKED
```

← alternative →

```
SWITCHING AUTHORIZ.

7599 SWITCH AUTH
     LOCAL
     REMOTE
     VIA BI
     LOCKED
```

Option **2** of OPERATION MENU 1
(examples)

```
OPERATIONAL ANNUN.
 ⇑
04.10.94 16:08:38,263
   B/F off     :C
04.10.94 16:08:49,422
   LED reset   :C
04.10.94 16:09:17,106
   CB in Test :C
04.10.94 16:16:33,337
   Failure 5V :C
04.10.94 16:17:27,282
   Failure 5V :G
04.10.94 16:21:15,974
 ⇓ System Flt 11:C
```

further annunciations

Option **3** of OPERATION MENU 1
(examples)

```
ALARMSTATE

O/C Ph active
O/C E active
o/v active
O/L active
Failure Isymm
E/F.Prot Inva
err:DC pos Q8
END OF TABLE
```

Option **4** of OPERATION MENU 1 (on 4 or 5 display pages, continued next page)

```
MEASURED VALUES

IL1      = 1060 A
IL2      = 1085 A
IL3      = 1073 A
IE       = 3 A
IL1 [%]  = 106.0 %
IL2 [%]  = 108.5 %
IL3 [%]  = 107.3 %
IE [%]   = 0.3 %


 ⇓
```

```
MEASURED VALUES
 ⇑
UL1E     = 63.2 kV
UL2E     = 63.5 kV
UL3E     = 62.5 kV
UL12     = 109.5 kV ★
UL23     = 110.0 kV ★
UL31     = 108.3 kV ★
UE       = 0.8 kV ★

                  ★...calculated values

                  UL*E only
 ⇓                if available
```

Option **4** of OPERATION MENU 1 (on 4 or 5 display pages, continuation)

```
MEASURED VALUES

P       = 98.3 MW
Q       = 67.1 MVAR
FREQ.  = 51.4 Hz
COS PHI= 0.87
Wp pos = 8123.4 MWh
Wp neg = 0 MWh
Wq pos = 1002.9 MVARh
Wq neg = 0 MVARh
Set.date: 25.07.96
```

```
MEASURED VALUES

Θ/Θtrip L1= 85 %
Θ/Θtrip L2= 88 %
Θ/Θtrip L3= 87 %
Θ/Θtrip    = 86 %
ΘL/ΘLtrip = 22 %
```

```
MEASURED VALUES

IEEa s = 0.2 mA
IEEr s = 1.5 mA
IEEa p = 1.3 A
IEEr p = 9.2 A
```

Option **5** of OPERATION MENU 1 (examples)

```
FAULT ANNUNCIATIONS

1:22.09.94
  17:22:41,132
  System Flt 43
2:16.09.94
  01:45:01,947
  System Flt 42
3:16.09.94
  01:44:22,349
  System Flt 41
4:11.09.94
  10:11:45,293
  System Flt 40
```

→ detailed info →

```
001:22.09.94
    System Flt 43 :C
002:17:22:41,132
    Fault 43 :C
003:0 ms
    O/C Gen.Fault :C
004:0 ms
    Fault L13 :C
005:0 ms
    I>> Fault :C
006:234 ms
    T-I>> expired :C
007:236 ms
    O?C Gen.Trip :C
```

Option **6** of OPERATION MENU 1 (examples)

```
EARTH FAULT-
  PROTOCOLS
1:22.06.95
  15:22:41.132
  E/F Det. 3
2:16.01.95
  01:45:01,943
  E/F Det. 2
3:14.10.94
  09:15:47,923
  E/F Det. 1
```

→ detailed info →

```
001:14.10.94
    E/F Det. 1
002:09:15:47,923
    E/F Detection :C
003:0 ms
    E/F Detec. L3 :C
004:34 ms
    E/F Detec. L3 :G
005:09:15:47,957
    E/F Detection :G
006:14.10.94
    E/F Det. 1
```

Option **7** of OPERATION MENU 1 (on 2 display pages)

```
CB OPER. STATISTICS

5602 RAR 3P =
     0
5603 DAR 3P =
     0
5604 TRIP No=
     2
5605 Set.date:
     25.07.95
5610 LAST IL1/In
     0
5611 LAST IL2/In
 ⩔   0
```

```
CB OPER. STATISTICS
 ⩓
5611 LAST IL3/In
     0
```

Option **8** of OPERATION MENU 1 (examples)

```
SETTINGS

1: 8100 SETTING
        REAL TIME CLOCK
2: 8200
        RESET
3: 8300 SYS-VDEW
        ANNUNC.-MEAS.VAL
4: 8500 PARAMETER
        CHANGE-OVER
```

```
8100 SETTING
     REAL TIME CLOCK
18.04.1995
12:17:42
8102 DATE

8103 TIME

8104 DIFF. TIME
```

```
8200
     RESET
8201 RESET
     LED ?
8202 RESET
     OPERAT.ANNUNC. ?
8203 RESET
     FAULT ANNUNC. ?
8204 TRIP No =

8206 RESET
     E/F ANNUNC. ?
8207 RESET
     AR-COUNTERS ?
```

```
8200
     RESET
8208 Set WP pos=
               MWh
8209 Set WQ pos=
               MVARh
8210 Set WP neg=
               MWh
8211 Set WQ neg=
               MVARh
8212 HOUR METER=
               h
```

(2nd display page)

```
8300 SYS-VDEW
     ANNUNC.-MEAS.VAL
8301 SYS-TEST
     OFF
8302 SYS-BLOCK
     OFF
```

```
8500 PARAMETER
     CHANGE-OVER
8501 ACTIV PARAM
     SET A
8503 ACTIVATING
     SET A
```

Option **9** of OPERATION MENU 1

```
TESTS

1: 4300 CB TEST
   TRIP-CLOSE CYCLE
2: 4400 CB TEST
   LIVE TRIP
3: 4900 TEST
   FAULT RECORDING
```

```
4300 CB TEST
     TRIP-CLOSE CYCLE
4304 CB TEST
     L123 WITH AR ?
```

```
4400 CB TEST
     LIVE TRIP
4404 CB TEST
     CB THREE-POLE ?
```

```
4900 TEST
     FAULT RECORDING
4901 FAULT REC.
     START ?
```

Option **1** of OPERATION MENU 2 (on 3 display pages)

```
PARAMETER SETTING

1: 1100
   POWERSYSTEM DATA
2: 1200 O/C PROT.
   PHASES
3: 1300 O/C PROT.
   EARTH
4: 1400 OVERCURR.-
   DIRECTIONAL PH
5: 1500 OVERCURR.-
   DIRECTIONAL E
6: 1600 UNDER
 ⩔ VOLTAGE
```

```
PARAMETER SETTING
 ⩓
1: 1700 OVER
   VOLTAGE
2: 1800 NEGATIVE
   SEQUENCE PROT.
3: 2100 START-TIME
   SUPERVISION
4: 2700 THERMAL
   OVERLOAD PROT.
5: 2800 MOT. START
   PROTECTION
6: 2900 MEAS.VALUE
 ⩔ SUPERVISION
```

```
PARAMETER SETTING
 ⩓
1: 3000 EARTHFAULT
   DETECTION
2: 3400 AUTO-
   RECLOSE FUNCTION
3: 3700 TRIP CIR'T
   SUPERVISION
4: 3800
   FAULT LOCATION
5: 3900 BREAKER
   FAILURE PROTEC.
```

Option **2** of OPERATION MENU 2

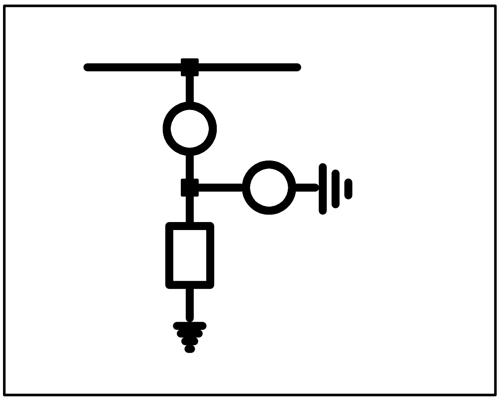
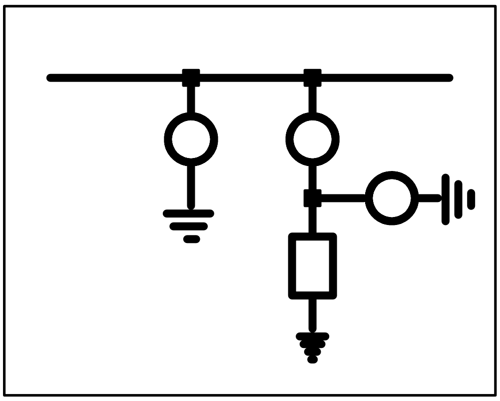
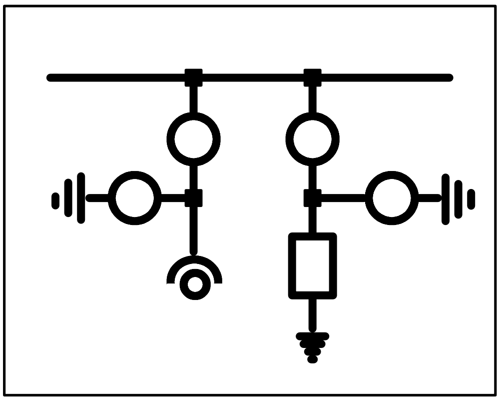
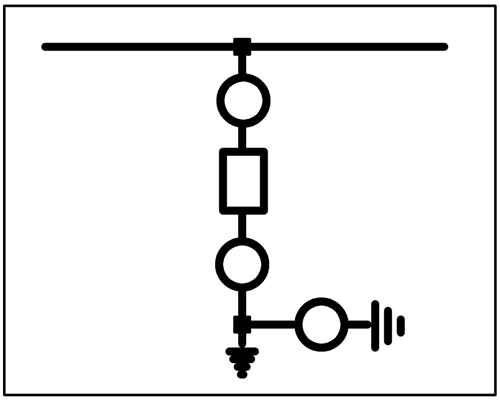
```
MARSHALLING

1: 6100 MARSHALLING
   BINARY INPUTS
2: 6200 MARSHALLING
   SIGNAL RELAYS
3: 6300 MARSHALLING
   LED INDICATORS
4: 6400 MARSHALLING
   COMMAND RELAYS
5: 6700 MARSHALLING
   LCD-ANNOUNCEMENT
```

Option **3** of OPERATION MENU 2

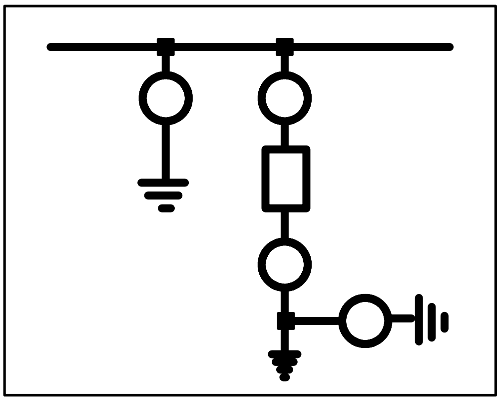
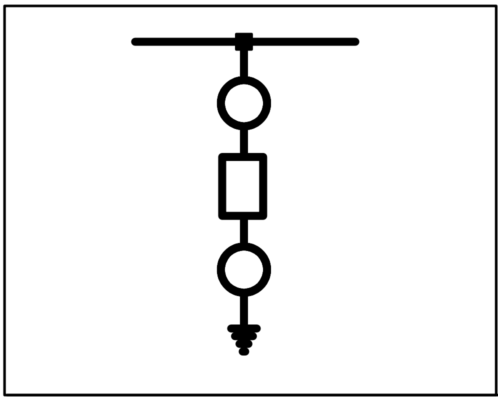
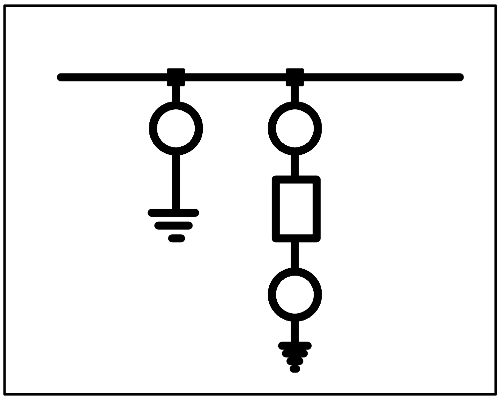
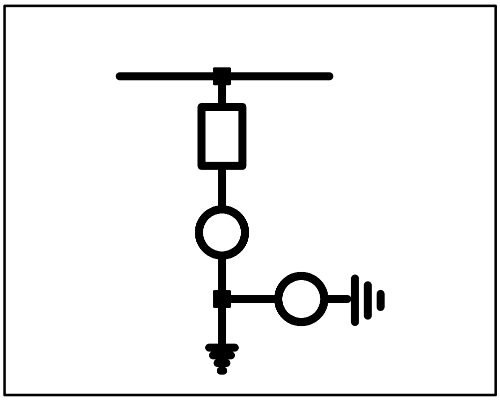
```
CONFIGURATION

1  7100 INTEGRATED
   OPERATION
2: 7200 PC/SYSTEM
   INTERFACES
3: 7400 FAULT
   RECORDINGS
4: 7500 BREAKER
   CONTROL
5: 7800 SCOPE OF
   FUNCTIONS
6: 7900 DEVICE
   CONFIGURATION
```

E Feeder mimic diagrams

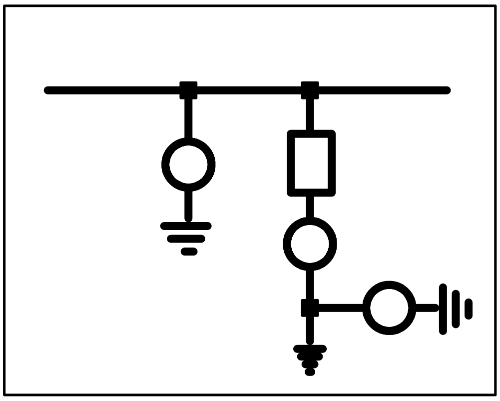
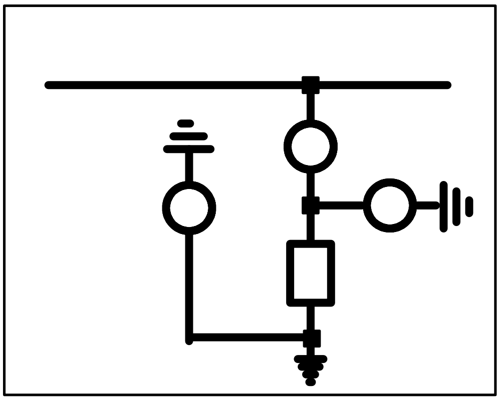
Diagrams E.1 Circuit breaker bays: single bus–bar (address 7875: ”CB BAY”)

Graphical display	Designation	Binary inputs OFF ON	 OFF ON	Parameter text of address 7876
	Circuit breaker bay (without addition) Q1 Q8 Q0	 3, 4 5, 6 1, 2		CB BAY 1
	Circuit breaker bay with bus–bar earthing Q15 Q1 Q8 Q0	 7, 8	 3, 4 5, 6 1, 2	CB BAY 2
	Circuit breaker bay with bus–bar voltage transformer Q6 Q1 Q5 Q8 Q0	 9, 10 7, 8	 3, 4 5, 6 1, 2	CB BAY 3
	Circuit breaker bay, drawer Q1 Q0 Q1 Q8	 3, 4 1, 2 3, 4 5, 6		CB BAY 4

Diagrams E.1 Circuit breaker bays: single bus−bar (address 7875: ”CB BAY”)

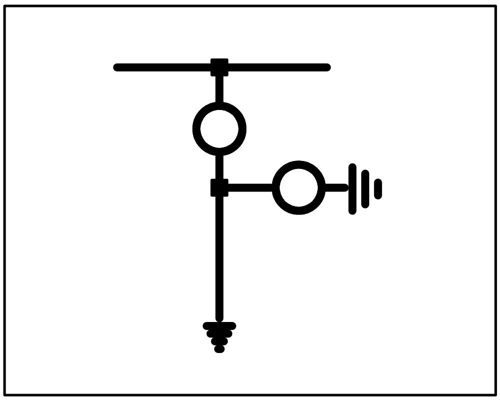
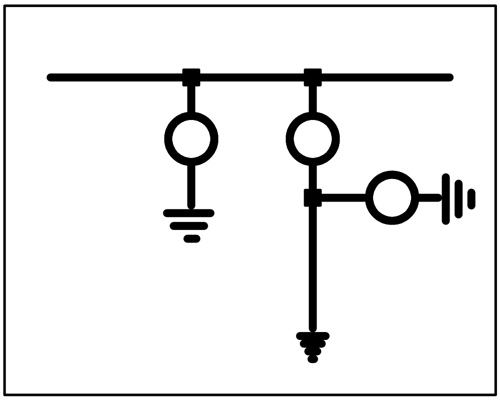
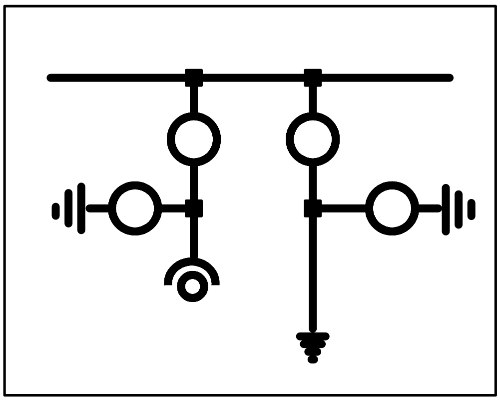
Graphical display	Designation	Binary inputs OFF ON	OFF ON	Parameter text of address 7876
	Circuit breaker bay, drawer with bus−bar earthing			CB BAY 5
	Q15 Q1	7, 8	3, 4	
	Q0		1, 2	
	Q1		3, 4	
	Q8		5, 6	
	Circuit breaker bay, earthing drawer			CB BAY 6
	Q1	3, 4		
	Q0	1, 2		
	Q1	3, 4		
	Circuit breaker bay, earthing drawer with bus−bar earthing			CB BAY 7
	Q15 Q1	7, 8	3, 4	
	Q0		1, 2	
	Q1		3, 4	
	Circuit breaker bay, drawer with load disconnector			CB BAY 8
	Q0	1, 2		
	Q1	3, 4		
	Q8	5, 6		

Diagrams E.1 Circuit breaker bays: single bus–bar (address 7875: "CB BAY")

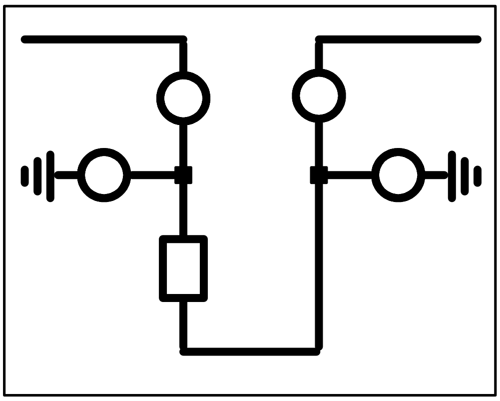
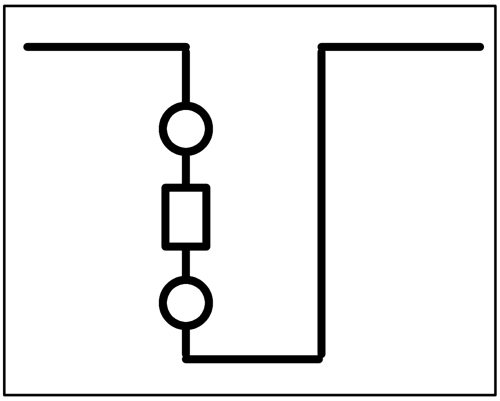
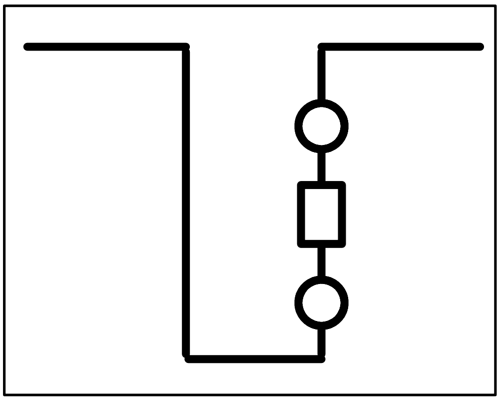
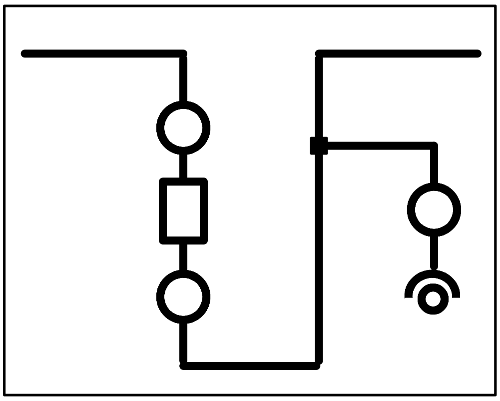
Graphical display	Designation	Binary inputs OFF ON	OFF ON	Parameter text of address 7876
	Circuit breaker bay, with load disconnector with bus–bar earthing Q15 Q0 Q1 *) Q8	 7, 8	 1, 2 3, 4 5, 6	CB BAY 9
	Circuit breaker bay, with bus–bar earthing and feeder earthing Q1 Q15 Q8 Q0	 7, 8	 3, 4 5, 6 1, 2	CB BAY 10

*) Q01 in former version

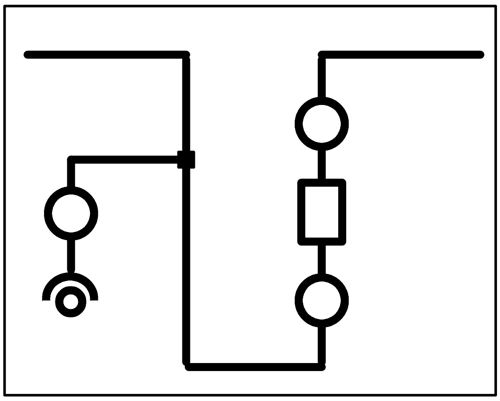
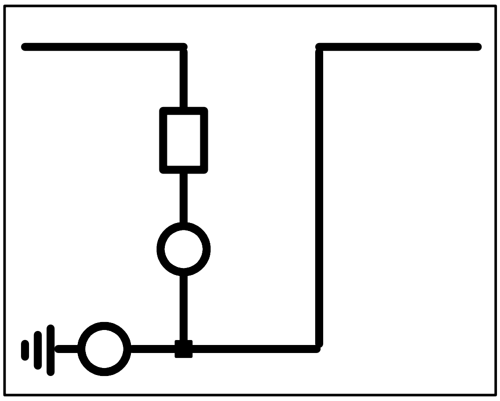
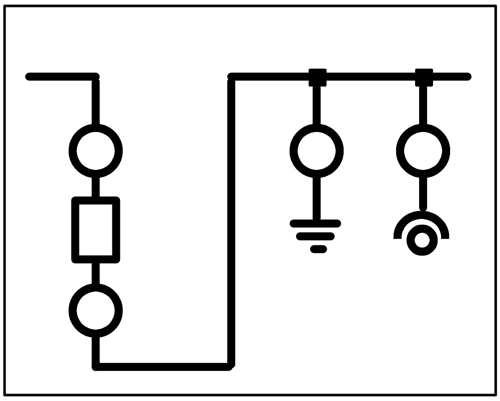
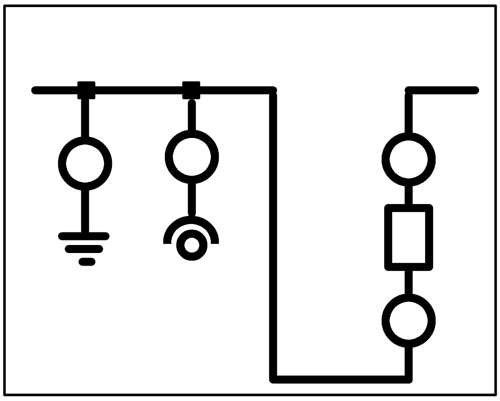
Diagrams E.2 Disconnector bays (address 7875:"DISCON. BAY")

Graphical display	Designation	Binary inputs OFF ON	OFF ON	Parameter text of address 7877
	Disconnector bay (without addition) Q1 Q8	 3, 4 5, 6		DISCON. BAY 1
	Disconnector bay with bus−bar earthing Q15 Q1 Q8	 7, 8	 3, 4 5, 6	DISCON. BAY 2
	Disconnector bay with bus−bar voltage transformer Q6 Q1 Q5 Q8	 9, 10 7, 8	 3, 4 5, 6	DISCON. BAY 3

Diagrams E.3 Coupler bays (address 7875: ”SECTIONALIZER”)

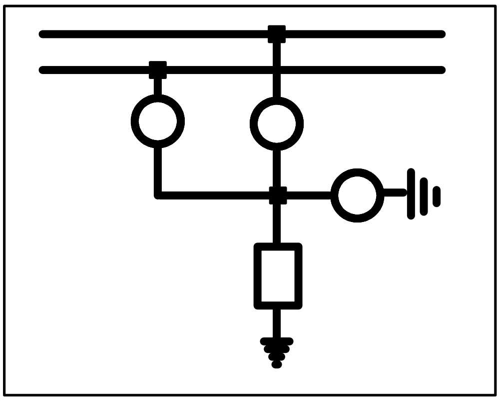
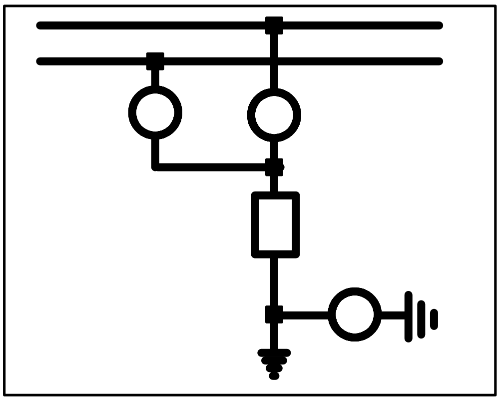
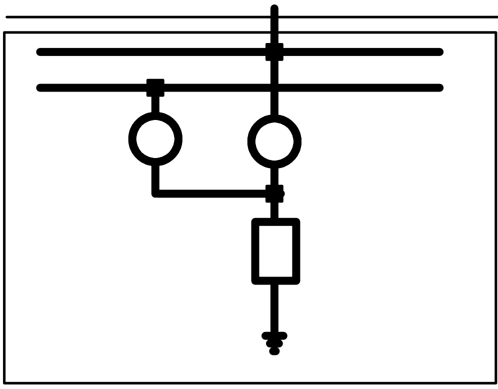
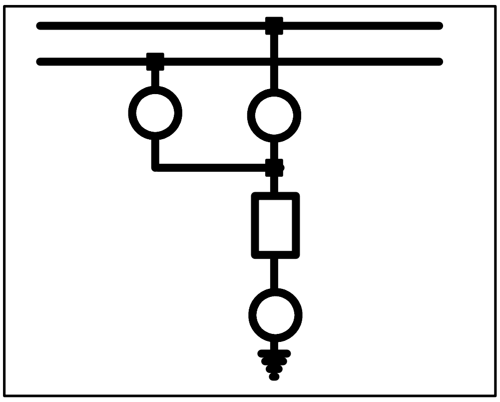
Graphical display	Designation	Binary inputs OFF ON	 OFF ON	Parameter text of address 7878
	Longitudinal coupler Q1 Q10 Q15 Q16 Q0	 3, 4 7, 8 1,2	 5, 6 9, 10	SECTIONALIZER 1
	Longitudinal coupler type 1 riser T2 Q1 Q0 Q1	 3, 4 1, 2 3, 4		SECTIONALIZER 2
	Longitudinal coupler 2 riser T2 Q1 Q0 Q1	 3,4 1,2 3,4		SECTIONALIZER 3
	Longitudinal coupler type 1 riser T1 Q1 Q0 Q6 Q1	 3, 4 1, 2 3, 4	 5, 6	SECTIONALIZER 4

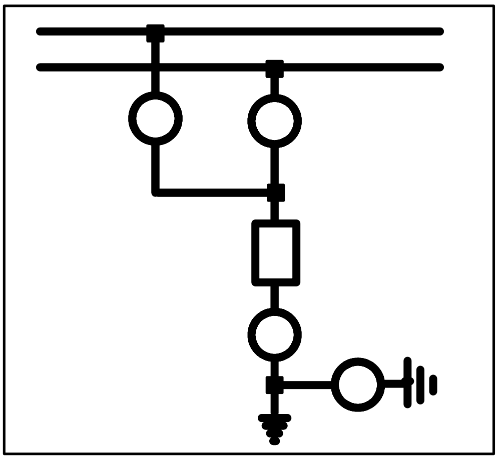
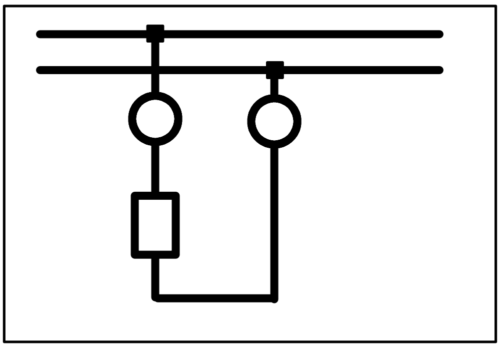
Diagrams E.3 Coupler bays (address 7875: "SECTIONALIZER")

Graphical display	Designation	Binary inputs OFF ON	OFF ON	Parameter text of address 7878
	Longitudinal coupler type 2 riser T1			SECTIONALIZER 5
	Q1		3, 4	
	Q6 Q0	5, 6	1, 2	
	Q1		3, 4	
	Longitudinal coupler, bus–bar sectionalizer			SECTIONALIZER 6
	Q0	1, 2		
	Q1 *)	3, 4		
	Q15	7, 8		
	Longitudinal with bus–bar earthing isola–tor and voltage trans–former, type 1			SECTIONALIZER 7
	Q1 Q15 Q6	3, 4	7, 8	
	Q0	1, 2	5, 6	
	Q1	3, 4		
	Longitudinal, with bus–bar earthing isola–tor and voltage trans–former, type 2			SECTIONALIZER 8
	Q15 Q6 Q1	7, 8	3, 4	
	Q0	5, 6	1, 2	
	Q1		3, 4	

*) Q01 in former version

Diagrams E.4 Circuit breaker bays: Double bus–bar (address 7875: ”DOUBLE–BB”)

Graphical display	Designation	Binary inputs OFF ON	OFF ON	Parameter text of address 7879
	Circuit breaker bay 1, Double bus–bar			CB BAY 1
	Q2 Q1	7, 8	3, 4	
	Q8		5, 6	
	Q0	1, 2		
	Circuit breaker bay 2, Double bus–bar			CB BAY 2
	Q2 Q1	7, 8	3, 4	
	Q0	1, 2		
	Q8		5, 6	
	Circuit breaker bay 2, Double bus–bar			CB BAY 3
	Q2 Q1	5, 6	3, 4	
	Q0		1, 2	
	Circuit breaker bay 2, Double bus–bar			CB BAY 4
	Q2 Q1	5, 6	3, 4	
	Q0		1, 2	
	Q9		7, 8	

Graphical display	Designation	Binary inputs OFF ON	 OFF ON	Parameter text of address 7879
	Circuit breaker bay 1, Double bus–bar Q2 Q1 Q0 Q9 Q8	 5, 6 1, 2 	 3, 4 7, 8 9, 10	CB BAY 5
	Sectionalizer at double bus–bar Q2 Q10 Q0	 3, 4 1, 2	 5, 6 	SECTIONALIZER 1

F Tables

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

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

Note as to Table F.1: The operational measured values for LSA, FNo 602 (current L2) and 624 (voltage L1/L2), different function types and information numbers are valid, dependent on the setting of address 7222 (SYS−MEASUR):

FNo	Address 7222 (SYS−MEASUR)			
	VDEW COMPATIBLE		*VDEW EXTENDED*	
	type	inf	type	inf
602	p	145	134	137
624	p	145	134	137

Annunciations 7SJ531 for LSA (DIN 19244 and according VDEW/ZVEI)

FNo. - Function number of annunciation
Op/Ft - Operation/Fault annunciation
C/CG: Coming/Coming and Going annunciation
V : Annunciation with Value
M : Measurand
LSA No.- Number of annunciation for former LSA (DIN 19244)
according to VDEW/ZVEI:
CA - Compatible Annunciation
GI - Annunciation for General Interrogation
BT - Binary Trace for fault recordings
Typ - Function type (p: according to the configured "Function type")
Inf - Information number

		Ann.		LSA	VDEW/ZVEI				
FNo.	Meaning	Op	Ft	No.	CA	GI	BT	Typ	Inf
11	>User defined annunciation 1	CG			CA	GI	BT	p	27
12	>User defined annunciation 2	CG			CA	GI	BT	p	28
13	>User defined annunciation 3	CG			CA	GI	BT	p	29
14	>User defined annunciation 4	CG			CA	GI	BT	p	30
15	>Testing via system-interface							135	53
16	>Block. of monitoring dir. via sys.-int							135	54
51	Device operative / healthy	CG				GI		135	81
52	Any protection operative	CG			CA	GI		p	18
55	Re-start of processor system	C			CA			p	4
56	Initial start of processor system	C			CA			p	5
59	Real time response to LSA	C							
60	LED Reset	C			CA			p	19
61	Logging and measuring functions blocked	CG			CA	GI		p	20
62	Test mode	CG			CA	GI		p	21
63	PC operation via system interface	CG				GI		135	83
95	Parameters are being set	CG			CA	GI		p	22
96	Parameter set A is active	CG			CA	GI		p	23
97	Parameter set B is active	CG			CA	GI		p	24
110	Annunciations lost (buffer overflow)	C						135	130
112	Annunciations for LSA lost	C						135	131
113	Fault tag lost						BT	135	136
140	General internal failure of device	CG			CA	GI		p	47
141	Failure of internal 24 VDC power supply	CG				GI		135	161
143	Failure of internal 15 VDC power supply	CG				GI		135	163
145	Failure of internal 0 VDC power supply	CG				GI		135	165
151	Failure in I/O module 1	CG				GI		135	166
154	Supervision trip circuit	CG			CA	GI		p	36
160	Common alarm	CG			CA	GI		p	46
161	Measured value supervision of currents	CG			CA	GI		p	32
162	Failure: Current summation supervision	CG				GI		135	182
163	Failure: Current symmetry supervision	CG				GI		135	183
164	Measured value supervision of voltages	CG			CA	GI		p	33
166	Failure: Voltage sum superv. (ph-ph)	CG				GI		135	185
167	Failure: Voltage symmetry supervision	CG				GI		135	186
171	Failure: Phase sequence supervision	CG			CA	GI		p	35
173	Failure: Current sum superv. (IEE)	CG				GI		135	190
175	Failure: Phase seq. supervision Current	CG				GI		135	191
176	Failure: Phase seq. supervision Voltage	CG				GI		135	192
177	Failure: Battery	CG				GI		135	193
204	Fault recording initiated via bin.input						BT	135	204
205	Fault recording initiated via keyboard						BT	135	205

		Ann.		LSA	VDEW/ZVEI				
FNo.	Meaning	Op	Ft	No.	CA	GI	BT	Typ	Inf
206	Fault recording initiated via PC interf						BT	135	206
280	IL1 setting exceeded	CG				GI		135	240
281	IL2 setting exceeded	CG				GI		135	241
282	IL3 setting exceeded	CG				GI		135	242
283	IE setting exceeded	CG				GI		135	243
284	IL< alarm	CG				GI		135	244
285	Power factor alarm	CG				GI		135	245
287	Reactive power exceeded	CG				GI		135	247
288	Active power exceeded	CG				GI		135	246
301	Fault in the power system		CG					135	231
302	Flt. event w. consecutive no.		C					135	232
356	>Manual close	C						150	6
358	>Manual trip	C						150	8
383	>Release highset stages RAR	CG				GI		150	33
391	>Warning stage from Buchholz protection	CG				GI		150	41
392	>Tripp. stage from Buchholz protection	CG				GI		150	42
501	General fault detection of device		CG				BT	150	151
502	General drop-off of device		C					150	152
510	General close of device		C				BT	150	160
511	General trip of device		C				BT	150	161
519	General trip of protection		C					150	168
521	Interrupted current: Phase L1(I/In)		V					150	171
522	Interrupted current: Phase L2(I/In)		V					150	172
523	Interrupted current: Phase L3(I/In)		V					150	173
561	Circuit breaker manually closed (pulse)	C						150	211
601	Current in phase IL1 [%] =	M						134	137
602	Current in phase IL2 [%] =	M			CA			134	137
603	Current in phase IL3 [%] =	M						134	137
604	IE[%]=	M						134	137
621	UL1E [%]=	M						134	137
622	UL2E [%]=	M						134	137
623	UL3E [%]=	M						134	137
624	UL12 [%] =	M			CA			134	137
625	UL23 [%] =	M						134	137
626	UL31 [%] =	M						134	137
641	Active power Pa [%] =	M						134	137
642	Reactive power Pr [%] =	M						134	137
644	Frequency f [%] =	M						134	137
713	IEEw[%]LSA	M						134	137
714	IEEb[%]LSA	M						134	137
900	Power factor cos phi[%]	M						134	137
924	Annunciation to LSA	C						133	51
925	Annuntiation to LSA	C						133	52
928	Annunciation to LSA	C						133	53
929	Annunciation to LSA	C						133	54
1106	>Start fault locator	C						151	6
1118	Fault reactance, Ohm sec.		V					151	18
1119	Distance to fault in km		V					151	19
1122	Distance to fault in miles		V					151	22
1174	Circuit breaker test in progress	CG				GI		151	74
1181	Circuit breaker test: General trip	C						151	81
1201	>Block UE stage of sensitive E/F prot.	CG				GI		151	101
1202	>Block IEE>> stage of sensit. E/F prot.	CG				GI		151	102
1203	>Block IEE> stage of sensit. E/F prot.	CG				GI		151	103
1204	>Block IEEp stage of sensit. E/F prot.	CG				GI		151	104
1208	>Earth fault detection annunciations on	CG				GI		151	108
1211	Earth fault detection switched off	CG				GI		151	111

FNo.	Meaning	Ann. Op	Ann. Ft	LSA No.	VDEW/ZVEI CA	GI	BT	Typ	Inf
1212	Earth fault detection active	CG				GI		151	112
1215	Earth flt. det. by displacement voltage		CG					151	115
1217	Trip by displacement voltage stage		C				BT	151	117
1218	Magnitude of earth current		V					151	118
1219	Active component of earth current		V					151	119
1220	Reactive component of earth current		V					151	120
1221	Fault detec. of sensitive IEE>> stage		CG					151	121
1223	Trip by sensitive IEE>> stage		C				BT	151	123
1224	Fault detec. of sensitive IEE> stage		CG					151	124
1226	Trip by sensitive IEE> stage		C				BT	151	126
1227	Fault detec. of sensitive IEEp stage		CG					151	127
1229	Trip by sensitive IEEp stage		C				BT	151	129
1230	Earth fault detection blocked	CG				GI		151	130
1272	Earth fault (isol./comp.) L1 detected	CG			CA	GI		p	48
1273	Earth fault (isol./comp.) L2 detected	CG			CA	GI		p	49
1274	Earth fault (isol./comp.) L3 detected	CG			CA	GI		p	50
1276	Earth fault (isol./comp.) forward dir.	CG			CA	GI		p	51
1277	Earth fault (isol./comp.) reverse dir.	CG			CA	GI		p	52
1451	Breaker fail protection is switched off	CG				GI		166	151
1452	Breaker failure protection is blocked	CG				GI		166	152
1453	Breaker failure protection is active	CG				GI		166	153
1456	Breaker fail(int): fault detection		CG					166	156
1457	Breaker(ext): fault detection		CG					166	157
1471	Trip by breaker failure protection		C		CA			p	85
1480	Breaker failure protection(int) trip		C				BT	166	180
1481	Breaker failure protection(ext) trip		C				BT	166	181
1482	Breaker failure protection(manual) trip	C						166	182
1504	>Thermal O/L protection: alarm only	CG				GI		167	4
1507	>Thermal O/L protection emergency start	CG				GI		167	7
1511	Thermal overload prot. is switched off	CG				GI		167	11
1512	Thermal overload protection is blocked	CG				GI		167	12
1513	Thermal overload protection is active	CG				GI		167	13
1515	Thermal overload prot.: Current warning	CG				GI		167	15
1516	Thermal overload prot.: Thermal warning	CG				GI		167	16
1517	Thermal overload prot.: Pick-up thermal	CG				GI		167	17
1521	Thermal overload protection trip		C				BT	167	21
1721	>Overcurrent protection:block stage I>>	CG				GI		60	1
1722	>Overcurrent protection:block stage I>	CG				GI		60	2
1723	>Overcurrent protection:block stage Ip	CG				GI		60	3
1724	>Overcurrent protec.: block stage IE>>	CG				GI		60	4
1725	>Overcurrent protection:block stage IE>	CG				GI		60	5
1726	>Overcurrent protection:block stage IEp	CG				GI		60	6
1751	Overcurrent prot. phase is switched off	CG				GI		60	21
1752	Overcurrent prot. phase is blocked	CG				GI		60	22
1753	Overcurrent prot. phase is active	CG				GI		60	23
1756	O/C protection earth is switched off	CG				GI		60	26
1757	O/C protection earth is blocked	CG				GI		60	27
1758	O/C protection earth is active	CG				GI		60	28
1761	General fault detection O/C		CG		CA	GI	BT	p	84
1762	O/C fault detection phase L1		CG		CA	GI	BT	p	64
1763	O/C fault detection phase L2		CG		CA	GI	BT	p	65
1764	O/C fault detection phase L3		CG		CA	GI	BT	p	66
1765	O/C fault detection earth		CG		CA	GI	BT	p	67
1771	O/C fault detection L1 only		C					60	31
1772	O/C fault detection L1-E		C					60	32
1773	O/C fault detection L2 only		C					60	33
1774	O/C fault detection L2-E		C					60	34

FNo.	Meaning	Ann. Op	Ann. Ft	LSA No.	VDEW/ZVEI CA	GI	BT	Typ	Inf
1775	O/C fault detection L1-L2		C					60	35
1776	O/C fault detection L1-L2-E		C					60	36
1777	O/C fault detection L3 only		C					60	37
1778	O/C fault detection L3-E		C					60	38
1779	O/C fault detection L1-L3		C					60	39
1780	O/C fault detection L1-L3-E		C					60	40
1781	O/C fault detection L2-L3		C					60	41
1782	O/C fault detection L2-L3-E		C					60	42
1783	O/C fault detection L1-L2-L3		C					60	43
1784	O/C fault detection L1-L2-L3-E		C					60	44
1785	O/C fault detection E only		C					60	45
1791	O/C general trip command		C		CA		BT	p	68
1800	O/C fault detection stage I>>		CG					60	75
1805	O/C protection I>> phase trip		C		CA		BT	p	91
1810	O/C fault detection stage I>		CG					60	76
1815	O/C protection I> phase trip		C		CA		BT	p	90
1820	O/C fault detection Ip		CG					60	77
1825	O/C protection Ip phase trip		C				BT	60	58
1831	O/C fault detection IE>> earth		CG					60	59
1833	O/C protection IE>> earth trip		C		CA		BT	p	93
1834	O/C fault detection IE> earth		CG					60	62
1836	O/C protection IE> earth trip		C		CA		BT	p	92
1837	O/C fault detection IEp earth		CG					60	64
1839	O/C protection IEp earth trip		C				BT	60	66
2615	>Block O/C I>> directional stage phase	CG				GI		63	73
2616	>Block O/C IE>> directional stage earth	CG				GI		63	74
2621	>Block O/C I> directional stage phase	CG				GI		63	1
2622	>Block O/C Ip directional stage phase	CG				GI		63	2
2623	>Block O/C IE> directional stage earth	CG				GI		63	3
2624	>Block O/C IEp directional stage earth	CG				GI		63	4
2628	Fault I>/Ip L1 forwards	C						63	81
2629	Fault I>/Ip L2 forwards	C						63	82
2630	Fault I>/Ip L3 forwards	C						63	83
2632	Fault I>/Ip L1 reward	C						63	84
2633	Fault I>/Ip L2 reward	C						63	85
2634	Fault I>/Ip L3 reward	C						63	86
2635	Fault IE>/IEp forwards	C						63	87
2636	Fault IE>/IEp reward	C						63	88
2642	O/C prot. fault detection I>> dir.		CG					63	67
2646	O/C prot. fault detection IE>> dir.		CG					63	62
2649	Trip by directional O/C I>> stage		C				BT	63	72
2651	Switch off dir. O/C protection phase	CG				GI		63	10
2652	Block dir. O/C protection phase	CG				GI		63	11
2653	dir. O/C protection phase active	CG				GI		63	12
2656	Switch off dir. O/C protection earth	CG				GI		63	13
2657	Block dir. O/C protection earth	CG				GI		63	14
2658	dir. O/C protection earth active	CG				GI		63	15
2660	O/C prot. fault detection I> dir.		CG					63	20
2665	Trip by directional O/C I> stage		C				BT	63	25
2666	Block forwards failed	C						63	89
2667	Block reward failed	C						63	90
2670	O/C prot. fault detection Ip dir.		CG					63	30
2675	Trip by directional O/C Ip stage		C				BT	63	35
2679	Trip by directional O/C IE>> stage		C				BT	63	64
2681	O/C prot. fault detection IE>		CG					63	41
2683	O/C prot. fault detection IE> dir.		C				BT	63	43
2684	O/C prot. fault detection Iep dir.		CG					63	44

FNo.	Meaning	Ann. Op	Ann. Ft	LSA No.	VDEW/ZVEI CA	GI	BT	Typ	Inf
2686	Trip by directional O/C IEp stage		C				BT	63	46
2691	General fault detection dir. O/C		CG			GI		63	50
2692	dir. O/C fault detection phase L1		CG			GI		63	51
2693	dir. O/C fault detection phase L2		CG			GI		63	52
2694	dir. O/C fault detection phase L3		CG			GI		63	53
2695	dir. O/C fault detection earth		CG			GI		63	54
2696	dir. O/C general trip command		C					63	55
2704	>AR: Reset auto-reclose function	C						40	4
2709	>AR: Block delayed auto-reclose	CG				GI		40	9
2711	>AR: External start for internal AR	CG				GI		40	11
2715	>AR: Trip earth fault	CG				GI		40	15
2716	>AR: Trip phase fault	CG				GI		40	16
2781	AR: Auto-reclose is switched off	CG				GI		40	81
2782	AR: Auto-reclose is switched on	CG			CA	GI		p	16
2783	AR: Auto-reclose is blocked	CG				GI		40	83
2784	AR: Auto-reclose is not ready	CG			CA	GI	BT	p	130
2785	AR: Auto-reclose is dynamically blocked	C						40	85
2787	AR: Circuit breaker not ready	CG				GI		40	87
2801	AR: Auto-reclose in progress	CG				GI		40	101
2813	RAR dead time after earth fault running	C						40	113
2814	RAR dead time after phase fault running	C						40	114
2833	DAR dead time after earth fault running	C						40	133
2834	DAR dead time after phase fault running	C						40	134
2851	AR: Close command from auto-reclose	C			CA		BT	p	128
2854	Reclose command after DAR	C			CA			p	129
4632	>Switching authorization: blocked	CG				GI		101	32
4670	Abort:no switching authority	C						101	70
4671	Abort: fault detection	C						101	71
4672	Abort: codeword incorrect	C						101	72
4673	Abort: entry time expired	C						101	73
4674	Abort: set=is	C						101	74
4675	Abort: cmd being executed	C						101	75
4676	Abort: BI double command	C						101	76
4677	Abort: CB-Test being executed	C						101	77
4678	Abort: switchgear unknown	C						101	78
4682	Abort: command respondtime expired	C						101	82
4683	Switching authorization: local	CG				GI		101	83
4684	Switching authorization:remote	CG				GI		101	84
4689	error CB/DC pos	CG				GI		101	89
4690	error CB pos Q0	CG				GI		101	90
4691	error DC pos Q1	CG				GI		101	91
4693	error DC pos Q5	CG				GI		101	93
4694	error DC pos Q6	CG				GI		101	94
4695	error DC pos Q8	CG				GI		101	95
4696	error DC pos Q10	CG				GI		101	96
4697	error DC pos Q15	CG				GI		101	97
4698	error DC pos Q16	CG				GI		101	98
4699	error DC pos Q2	CG				GI		101	99
4700	error DC pos Q9	CG				GI		101	100
4705	CB-Q0 pos	CG				GI		101	105
4706	DC-Q1 pos	CG				GI		101	106
4708	DC-Q5 pos	CG				GI		101	108
4709	DC-Q6 pos	CG				GI		101	109
4710	DC-Q8 pos	CG				GI		101	110
4711	DC-Q10 pos	CG				GI		101	111
4712	DC-Q15 pos	CG				GI		101	112
4713	DC-Q16 pos	CG				GI		101	113

		Ann.		LSA	VDEW/ZVEI				
FNo.	Meaning	Op	Ft	No.	CA	GI	BT	Typ	Inf
4714	DC-Q2 pos	CG				GI		101	114
4715	DC-Q9 pos	CG				GI		101	115
4801	>Mechanic circuit breaker trip	CG				GI		102	1
4802	>SF6 pressure alarm (feeder)	CG				GI		102	2
4803	>SF6 pressure alarm (busbar)	CG				GI		102	3
4804	>HV fuse blown	CG				GI		102	4
4805	>LV plug removed	CG				GI		102	5
4806	>CB spring not charged	CG				GI		102	6
4807	>Tempalarm	CG				GI		102	7
4808	>Temperature trip	CG				GI		102	8
4823	>Motor start protection emergency start	CG				GI		168	51
4824	Motor start protection is switched off	CG				GI		168	52
4825	Motor start protection is blocked	CG				GI		168	53
4826	Motor start protection is active	CG				GI		168	54
4827	Trip by motor start protection	CG				GI		168	55
5151	Negative sequence prot. is switched off	CG				GI		70	131
5152	Negative sequence prot. is blocked	CG				GI		70	132
5153	Negative sequence prot. is active	CG				GI		70	133
5159	Fault detection neg. seq. stage I2>>		CG					70	138
5165	Fault detection neg. seq. stage I2>		CG					70	150
5170	Trip by negative sequence prot.		C				BT	70	149
6504	>u/v protection: annunciations only	CG				GI		74	4
6506	>Block undervoltage protection U< stage	CG				GI		74	6
6507	>u/v starting criterion	CG				GI		74	7
6508	>Block undervoltage prot. U<< stage	CG				GI		74	8
6509	>vt failure feeder	CG				GI		74	9
6510	>vt failure busbar	CG				GI		74	10
6514	>Overvoltage protection: annunc. only	CG				GI		74	14
6530	Undervoltage protection is switched off	CG				GI		74	30
6531	Undervoltage protection is blocked	CG				GI		74	31
6532	Undervoltage protection is active	CG				GI		74	32
6533	Undervoltage fault detection U<		CG					74	33
6534	Undervoltage fault detection cc U<		CG					74	34
6535	Undervoltage fault detection sc U<		CG					74	35
6536	Undervoltage fault detection cc,sc U<		CG					74	36
6537	Undervoltage fault detection U<<		CG					74	37
6538	Undervoltage fault detection cc U<<		CG					74	38
6539	Undervoltage protection, U< trip		C				BT	74	39
6540	Undervoltage protection, U<< trip		C				BT	74	40
6565	Overvoltage protection is switched off	CG				GI		74	65
6566	Overvoltage protection is blocked	CG				GI		74	66
6567	Overvoltage protection is active	CG				GI		74	67
6568	Overvoltage fault detection U>		CG					74	68
6569	Overvoltage fault detection,SK,U>		CG					74	69
6570	Overvoltage protection U> trip		C				BT	74	70
6811	Starting time supervision off	CG				GI		169	51
6812	Starting time supervision blocked	CG				GI		169	52
6813	Starting time supervision active	CG				GI		169	53
6821	Trip by supervision of starting time		C				BT	169	54
6822	Rotor locked		C					169	55
6823	Starting supervision picked up	CG				GI		169	56
6852	>Trip circuit supervision: Trip relay	CG				GI		170	51
6853	>Trip circuit supervision: CB aux.	CG				GI		170	52
6861	Trip circuit supervision off	CG				GI		170	53
6864	TC superv. blocked: BI not marshalled	CG				GI		170	54
6865	Trip circuit interrupted	CG				GI		170	55

Annunciations 7SJ531 for PC, LC-display and binary inputs/outputs

FNo. - Function number of annunciation
Op/Ft - Operation/Fault annunciation
C/CG: Coming/Coming and Going annunciation
M : Measurand
E - Earth fault annunciation
IOT - I: can be marshalled to binary input
O: can be marshalled to binary output (LED, signal relay)
T: can be marshalled to trip relay

FNo.	Abbreviation	Meaning	Op	Ft	E	IOT
3	>Time Synchro	>Time synchronization				IO
4	>Start FltRec	>Start fault recording	C			IO
5	>LED reset	>Reset LED indicators				IO
7	>ParamSelec.1	>Parameter set selection 1 (with No.8)				IO
11	>Annunc. 1	>User defined annunciation 1	CG			IOT
12	>Annunc. 2	>User defined annunciation 2	CG			IOT
13	>Annunc. 3	>User defined annunciation 3	CG			IOT
14	>Annunc. 4	>User defined annunciation 4	CG			IOT
15	>Sys-Test	>Testing via system-interface				IO
16	>Sys-MM-block	>Block. of monitoring dir. via sys.-int				IO
51	Dev.operative	Device operative / healthy	CG			O
52	Prot. operat.	Any protection operative	CG			O
56	Initial start	Initial start of processor system	C			
60	LED reset	LED Reset	C			O
61	LogMeasBlock	Logging and measuring functions blocked	CG			
62	Test mode	Test mode	CG			
95	Param.running	Parameters are being set	CG			O
96	Param. Set A	Parameter set A is active	CG			O
97	Param. Set B	Parameter set B is active	CG			O
100	Wrong SW-vers	Wrong software-version	C			
101	Wrong dev. ID	Wrong device identification	C			
110	Annunc. lost	Annunciations lost (buffer overflow)	C			
111	Annu. PC lost	Annunciations for PC lost	C			
115	Flt.Buff.Over	Fault annunciation buffer overflow		C		
116	E/F Buff.Over	E/F buffer overflow			E	
120	Oper.Ann.Inva	Operational annunciations invalid	CG			
121	Flt.Ann.Inval	Fault annunciations invalid	CG			
122	E/F.Prot Inva	Earth fault annunciations invalid	CG			
123	Stat.Buff.Inv	Statistic annunciation buffer invalid	CG			
124	LED Buff.Inva	LED annunciation buffer invalid	CG			
129	VDEW-StateInv	VDEW state invalid	CG			
135	Chs Error	Error in check sum	CG			
136	Chs.A Error	Error in check sum for parameter set A	CG			
137	Chs.B Error	Error in check sum for parameter set B	CG			
138	Chs.C Error	Error in check sum for parameter set C	CG			
139	Chs.D Error	Error in check sum for parameter set D	CG			
141	Failure 24V	Failure of internal 24 VDC power supply	CG			OT
143	Failure 15V	Failure of internal 15 VDC power supply	CG			OT
145	Failure 0V	Failure of internal 0 VDC power supply	CG			OT
151	Failure I/O 1	Failure in I/O module 1	CG			OT
154	Fail. TripRel	Supervision trip circuit	CG			
159	LSA disrupted	LSA (system interface) disrupted	CG			
161	I supervision	Measured value supervision of currents				O
162	Failure ∑I	Failure: Current summation supervision	CG			OT
163	Failure Isymm	Failure: Current symmetry supervision	CG			OT
164	U supervision	Measured value supervision of voltages				OT

FNo.	Abbreviation	Meaning	Op	Ft	E	IOT
166	Failure ∑Up-p	Failure: Voltage sum superv. (ph-ph)	CG			OT
167	Failure Usymm	Failure: Voltage symmetry supervision	CG			OT
171	Fail.PhaseSeq	Failure: Phase sequence supervision				OT
173	Fail.∑I (IEE)	Failure: Current sum superv. (IEE)	CG			OT
175	Fail.PhSeq I	Failure: Phase seq. supervision Current	CG			OT
176	Fail.PhSeq V	Failure: Phase seq. supervision Voltage	CG			OT
177	Fail.Battery	Failure: Battery	CG			OT
203	Flt.RecDatDel	Fault recording data deleted	C			
204	Flt.Rec.viaBI	Fault recording initiated via bin.input	C			
205	Flt.Rec.viaKB	Fault recording initiated via keyboard	C			
206	Flt.Rec.viaPC	Fault recording initiated via PC interf	C			
244	D Time=	Diff. time of clock synchronism	M			
280	IL1 exceeded	IL1 setting exceeded	CG			OT
281	IL2 exceeded	IL2 setting exceeded	CG			OT
282	IL3 exceeded	IL3 setting exceeded	CG			OT
283	IE exceeded	IE setting exceeded	CG			OT
284	IL< alarm	IL< alarm	CG			OT
285	cosphi alarm	Power factor alarm	CG			OT
287	Pr exceeded	Reactive power exceeded	CG			OT
288	Pa exceeded	Active power exceeded	CG			OT
301	Syst.Flt	Fault in the power system	CG	C		
302	Fault	Flt. event w. consecutive no.		C		
303	E/F Det.	E/Flt.det. in isol/comp.netw.	CG		E	
356	>Manual Close	>Manual close	C			IOT
358	>Manual Trip	>Manual trip	C			IOT
383	>RAR Release	>Release highset stages RAR	C			IOT
391	>Buchh. Warn	>Warning stage from Buchholz protection	CG			IOT
392	>Buchh. Trip	>Tripp. stage from Buchholz protection	CG			IOT
501	Device FltDet	General fault detection of device				OT
502	Dev. Drop-off	General drop-off of device		C		
510	Device Close	General close of device				OT
511	Device Trip	General trip of device				OT
519	Protect. Trip	General trip of protection				OT
521	IL1/In=	Interrupted current: Phase L1(I/In)		C		
522	IL2/In=	Interrupted current: Phase L2(I/In)		C		
523	IL3/In=	Interrupted current: Phase L3(I/In)		C		
545	T-Drop	Time from fault detection to drop-off				
546	T-Trip	Time from fault detection to trip				
548	Trip-Date	Date of Trip				
561	Manual Close	Circuit breaker manually closed (pulse)				OT
563	CB Alarm Supp	CB alarm suppressed				OT
601	IL1[%] =	Current in phase IL1 [%] =	M			
602	IL2[%] =	Current in phase IL2 [%] =	M			
603	IL3[%] =	Current in phase IL3 [%] =	M			
604	IE[%] =	IE[%]=	M			
651	IL1 =	Current in phase IL1 =	M			
652	IL2 =	Current in phase IL2 =	M			
653	IL3 =	Current in phase IL3 =	M			
654	IEa =	Operational measurement: IEa=	M			
671	UL1E =	Voltage UL1E =	M			
672	UL2E =	Voltage UL2E =	M			
673	UL3E =	Voltage UL3E =	M			
674	UL12 =	Voltage UL12 =	M			
675	UL23 =	Voltage UL23 =	M			
676	UL31 =	Voltage UL31 =	M			
677	U0 =	Voltage U0=	M			
691	Pa =	Active power Pa =	M			
692	Pr =	Reactive power Pr =	M			

FNo.	Abbreviation	Meaning	Op	Ft	E	IOT
694	f [Hz] =	Frequency f [Hz] =	M			
701	IEEa s =	Active component of sec. IEE curr.	M			
702	IEEr s =	Reactive component of sec. IEE curr.	M			
711	IEEa p =	Active component of prim. IEE curr.	M			
712	IEEr p =	Reactive component of prim. IEE curr	M			
801	Θ/Θtrip =	Temperat. rise for warning and trip	M			
802	Θ/ΘtripL1=	Temperature rise for phase L1	M			
803	Θ/ΘtripL2=	Temperature rise for phase L2	M			
804	Θ/ΘtripL3=	Temperature rise for phase L3	M			
805	ΘL/ΘLtrip=	Temperature rise of rotor for trip	M			
901	COS PHI=	Power factor cos phi	M			
920	Wp pos =	Achieve energy Wp positive =	M			
921	Wq pos =	Reactive energy Wq positive =	M			
922	Set.date:	Setting-date (Wp/Wq):	M			
923	date:	Setting-date (Trip Commands):	M			
926	Wp neg =	Achieve Energy Wp negative =	M			
927	Wq neg =	Reactive Energy Wq negative =	M			
1000	Trip No =	Number of trip commands issued	M			
1012	AR 3pole=	No. of auto-reclose commands:3p RAR	M			
1013	DAR 3pol=	No. of auto-reclose commands:3p DAR	M			
1015	Il1/In=	Last trip current L1 IL1/In=	M			
1016	IL2/In=	Last trip current L2 IL2/In=	M			
1017	IL3/In	Last trip current L3 IL3/In=	M			
1020	OPER HOURS	Operation hours:	M			
1106	>Start FltLoc	>Start fault locator	C			IO
1118	Xsec=	Fault reactance, Ohm sec.		C		
1119	d km=	Distance to fault in km		C		
1122	d ml=	Distance to fault in miles		C		
1156	>CB Test	>CB test start				IOT
1174	CB in Test	Circuit breaker test in progress	CG			OT
1181	CB Test Trip	Circuit breaker test: General trip	C			OT
1201	>UE block	>Block UE stage of sensitive E/F prot.	CG			IOT
1202	>IEE>> block	>Block IEE>> stage of sensit. E/F prot.	CG			IOT
1203	>IEE> block	>Block IEE> stage of sensit. E/F prot.	CG			IOT
1204	>IEEp block	>Block IEEp stage of sensit. E/F prot.	CG			IOT
1205	>E/F Det. on	>Earth fault detection switch on				IOT
1206	>E/F Det. off	>Earth fault detection switch off				IOT
1207	>E/F Det.bloc	>Earth fault detection blocked				IOT
1208	>E/F annunc.	>Earth fault detection annunciations on	CG			IOT
1211	E/F Det. off	Earth fault detection switched off	CG			OT
1212	E/F Det.activ	Earth fault detection active				OT
1215	UE Fault	Earth flt. det. by displacement voltage		C		OT
1217	UE Trip	Trip by displacement voltage stage		C		OT
1218	IEE=	Magnitude of earth current		C	E	
1219	IEEa=	Active component of earth current		C	E	
1220	IEEr=	Reactive component of earth current		C	E	
1221	IEE>> Fault	Fault detec. of sensitive IEE>> stage		C		OT
1223	IEE>> Trip	Trip by sensitive IEE>> stage		C		OT
1224	IEE> Fault	Fault detec. of sensitive IEE> stage		C		OT
1226	IEE> Trip	Trip by sensitive IEE> stage		C		OT
1227	IEEp Fault	Fault detec. of sensitive IEEp stage		C		OT
1229	IEEp Trip	Trip by sensitive IEEp stage		C		OT
1230	E/F Det.block	Earth fault detection blocked	CG	CG		OT
1271	E/F Detection	Earth fault in isol./comp. net detected			E	
1272	E/F Detec. L1	Earth fault (isol./comp.) L1 detected		C	E	OT
1273	E/F Detec. L2	Earth fault (isol./comp.) L2 detected		C	E	OT
1274	E/F Detec. L3	Earth fault (isol./comp.) L3 detected		C	E	OT
1276	E/F forwards	Earth fault (isol./comp.) forward dir.		C	E	OT

FNo.	Abbreviation	Meaning	Op	Ft	E	IOT
1277	E/F reverse	Earth fault (isol./comp.) reverse dir.		C	E	OT
1278	E/F undefined	Earth fault (isol./comp.) undef. dir.		C	E	OT
1401	>B/F on	>Switch on breaker fail protection				IOT
1402	>B/F off	>Switch off breaker fail protection				IOT
1403	>B/F block	>Block breaker fail protection				IOT
1431	>B/F Start	>ext. start breaker failure protection				IOT
1451	B/F off	Breaker fail protection is switched off	CG			OT
1452	B/F blocked	Breaker failure protection is blocked	CG			OT
1453	B/F active	Breaker failure protection is active				OT
1456	B/F(int)flt	Breaker fail(int): fault detection		CG		OT
1457	B/F(ext)flt	Breaker(ext): fault detection		CG		OT
1458	B/F(man)flt	Breaker(manual): fault detection				OT
1480	B/F(int) trip	Breaker failure protection(int) trip		C		OT
1481	B/F(ext)trip	Breaker failure protection(ext) trip		C		OT
1482	B/F(man)trip	Breaker failure protection(manual) trip	C			OT
1501	>O/L on	>Switch on thermal overload protection				IOT
1502	>O/L off	>Switch off thermal overload protection				IOT
1503	>O/L block	>Block thermal overload protection				IOT
1504	>O/L alarm	>Thermal O/L protection: alarm only	CG			IOT
1507	>O/L emerg st	>Thermal O/L protection emergency start	CG			
1511	O/L Prot. off	Thermal overload prot. is switched off	CG			OT
1512	O/L blocked	Thermal overload protection is blocked	CG			OT
1513	O/L active	Thermal overload protection is active				OT
1515	O/L Warn I	Thermal overload prot.: Current warning	CG			OT
1516	O/L Warn Θ	Thermal overload prot.: Thermal warning	CG			OT
1517	O/L pickup Θ	Thermal overload prot.: Pick-up thermal	CG			OT
1521	O/L Trip	Thermal overload protection trip		C		OT
1701	>O/C Ph on	>Switch on O/C protection phase				IOT
1702	>O/C Ph off	>Switch off O/C protection phase				IOT
1704	>O/C Ph block	>Block overcurrent protection phases				IOT
1711	>O/C E on	>Switch on overcurrent protection earth				IOT
1712	>O/C E off	>Switch off overcurrent protec. earth				IOT
1714	>O/C E block	>Block overcurrent protection earth				IOT
1721	>I>> block	>Overcurrent protection:block stage I>>	CG			IOT
1722	>I> block	>Overcurrent protection:block stage I>	CG			IOT
1723	>Ip block	>Overcurrent protection:block stage Ip	CG			IOT
1724	>IE>> block	>Overcurrent protec.: block stage IE>>	CG			IOT
1725	>IE> block	>Overcurrent protection:block stage IE>	CG			IOT
1726	>IEp block	>Overcurrent protection:block stage IEp	CG			IOT
1751	O/C Ph off	Overcurrent prot. phase is switched off	CG			OT
1752	O/C Ph block	Overcurrent prot. phase is blocked	CG			OT
1753	O/C Ph active	Overcurrent prot. phase is active				OT
1756	O/C E off	O/C protection earth is switched off	CG			OT
1757	O/C E block	O/C protection earth is blocked	CG			OT
1758	O/C E active	O/C protection earth is active				OT
1761	O/C Gen.Fault	General fault detection O/C				OT
1762	Fault L1	O/C fault detection phase L1				OT
1763	Fault L2	O/C fault detection phase L2				OT
1764	Fault L3	O/C fault detection phase L3				OT
1765	Fault E	O/C fault detection earth				OT
1771	Fault L1	O/C fault detection L1 only		C		
1772	Fault L1E	O/C fault detection L1-E		C		
1773	Fault L2	O/C fault detection L2 only		C		
1774	Fault L2E	O/C fault detection L2-E		C		
1775	Fault L12	O/C fault detection L1-L2		C		
1776	Fault L12E	O/C fault detection L1-L2-E		C		
1777	Fault L3	O/C fault detection L3 only		C		
1778	Fault L3E	O/C fault detection L3-E		C		

FNo.	Abbreviation	Meaning	Op	Ft	E	IOT
1779	Fault L13	O/C fault detection L1-L3		C		
1780	Fault L13E	O/C fault detection L1-L3-E		C		
1781	Fault L23	O/C fault detection L2-L3		C		
1782	Fault L23E	O/C fault detection L2-L3-E		C		
1783	Fault L123	O/C fault detection L1-L2-L3		C		
1784	Fault L123E	O/C fault detection L1-L2-L3-E		C		
1785	Fault E	O/C fault detection E only		C		
1791	O/C Gen.Trip	O/C general trip command				OT
1800	I>> Fault	O/C fault detection stage I>>		C		OT
1805	I>> Trip	O/C protection I>> phase trip		C		OT
1810	I> Fault	O/C fault detection stage I>		C		OT
1815	I> Trip	O/C protection I> phase trip		C		OT
1820	Ip Fault	O/C fault detection Ip		C		OT
1825	Ip Trip	O/C protection Ip phase trip		C		OT
1831	IE>> Fault	O/C fault detection IE>> earth		C		OT
1833	IE>> Trip	O/C protection IE>> earth trip		C		OT
1834	IE> Fault	O/C fault detection IE> earth		C		OT
1836	IE> Trip	O/C protection IE> earth trip		C		OT
1837	IEp Fault	O/C fault detection IEp earth		C		OT
1839	IEp Trip	O/C protection IEp earth trip		C		OT
2601	>dirO/C P on	>Switch on dir. O/C protection phase				IOT
2602	>dirO/C P off	>Switch off dir. O/C protection phase				IOT
2604	>dirO/C P blk	>Block dir. O/C protection phase				IOT
2611	>dirO/C E on	>Switch on dir. O/C protection earth				IOT
2612	>dirO/C E off	>Switch off dir. O/C protection earth				IOT
2614	>dirO/C E blk	>Block dir. O/C protection earth				IOT
2615	>I>>Block dir	>Block O/C I>> directional stage phase	CG			IOT
2616	>IE>>Bloc dir	>Block O/C IE>> directional stage earth	CG			IOT
2621	>I> Block dir	>Block O/C I> directional stage phase	CG			IOT
2622	>Ip Block dir	>Block O/C Ip directional stage phase	CG			IOT
2623	>IE>Block dir	>Block O/C IE> directional stage earth	CG			IOT
2624	>IEpBlock dir	>Block O/C IEp directional stage earth	CG			IOT
2625	>Blk fw fail.	>Block forwards failed				IOT
2626	>Blk rw fail.	>Block reward failed				IOT
2628	FltI>/IpL1 fw	Fault I>/Ip L1 forwards	C			OT
2629	FltI>/IpL2 fw	Fault I>/Ip L2 forwards	C			OT
2630	FltI>/IpL3 fw	Fault I>/Ip L3 forwards	C			OT
2632	FltI>/IpL1 rw	Fault I>/Ip L1 reward	C			OT
2633	FltI>/IpL2 rw	Fault I>/Ip L2 reward	C			OT
2634	FltI>/IpL3 rw	Fault I>/Ip L3 reward	C			OT
2635	FltIE>/IEp fw	Fault IE>/IEp forwards	C			OT
2636	FltIE>/IEp rw	Fault IE>/IEp reward	C			OT
2642	I>> dir.Fault	O/C prot. fault detection I>> dir.		C		OT
2646	IE>>dir.Fault	O/C prot. fault detection IE>> dir.		C		OT
2649	I>> dir. Trip	Trip by directional O/C I>> stage		C		OT
2651	dir.O/C P off	Switch off dir. O/C protection phase	CG			OT
2652	dir.O/C P blk	Block dir. O/C protection phase	CG			OT
2653	dir.O/C P act	dir. O/C protection phase active				OT
2656	dir.O/C E off	Switch off dir. O/C protection earth	CG			OT
2657	dir.O/C E blk	Block dir. O/C protection earth	CG			OT
2658	dir.O/C E act	dir. O/C protection earth active				OT
2660	I> dir.Fault	O/C prot. fault detection I> dir.		C		OT
2665	I> dir. Trip	Trip by directional O/C I> stage		C		OT
2666	Blk fw failed	Block forwards failed	C			OT
2667	Blk rw failed	Block reward failed	C			OT
2670	Ip dir.Fault	O/C prot. fault detection Ip dir.		C		OT
2675	Ip dir. Trip	Trip by directional O/C Ip stage		C		OT
2679	IE>>dir. Trip	Trip by directional O/C IE>> stage		C		OT

FNo.	Abbreviation	Meaning	Op	Ft	E	IOT
2681	IE> dir.Fault	O/C prot. fault detection IE>		C		OT
2683	IE> dir. Trip	O/C prot. fault detection IE> dir.		C		OT
2684	IEp dir.Fault	O/C prot. fault detection Iep dir.		C		OT
2686	IEp dir. Trip	Trip by directional O/C IEp stage		C		OT
2691	dir.OC GenFlt	General fault detection dir. O/C				OT
2692	dir. Fault L1	dir. O/C fault detection phase L1				OT
2693	dir. Fault L2	dir. O/C fault detection phase L2				OT
2694	dir. Fault L3	dir. O/C fault detection phase L3				OT
2695	dir. Fault E	dir. O/C fault detection earth				OT
2696	dirOC GenTrip	dir. O/C general trip command				OT
2701	>AR on	>AR: Switch on auto-reclose function				IOT
2702	>AR off	>AR: Switch off auto-reclose function				IOT
2703	>AR block	>AR: Block auto-reclose function				IOT
2704	>AR reset	>AR: Reset auto-reclose function	C			IOT
2709	>DAR block	>AR: Block delayed auto-reclose	CG			IOT
2711	>Start AR	>AR: External start for internal AR	C			IOT
2715	>Trip E Fail.	>AR: Trip earth fault	C			IOT
2716	>Trip Ph Fail	>AR: Trip phase fault	C			IOT
2730	>CB ready	>AR: Circuit breaker ready for reclose				IOT
2781	AR off	AR: Auto-reclose is switched off	CG			OT
2782	AR on	AR: Auto-reclose is switched on				OT
2783	AR inoperativ	AR: Auto-reclose is blocked	CG			OT
2784	AR not ready	AR: Auto-reclose is not ready				OT
2785	AR block.dyn.	AR: Auto-reclose is dynamically blocked				OT
2787	CB not ready	AR: Circuit breaker not ready	CG			OT
2788	AR T-CB Exp.	AR: CB supervision time expired				OT
2801	AR in prog.	AR: Auto-reclose in progress				OT
2812	RAR T-act.run	AR: Action time for RAR is running				OT
2813	RAR T-E run.	RAR dead time after earth fault running				OT
2814	RAR T-Ph run.	RAR dead time after phase fault running				OT
2817	RAR Zone Rel.	AR: Zone extension for rapid reclosing				OT
2832	DAR T-act.run	AR: Action time for DAR is running				OT
2833	DAR T-E run.	DAR dead time after earth fault running				OT
2834	DAR T-Ph run.	DAR dead time after phase fault running				OT
2837	DAR Zone Rel.	AR: Zone extension for delayed reclose				OT
2851	AR Close Cmd.	AR: Close command from auto-reclose		C		OT
2853	RAR Close	Reclose command after RAR				OT
2854	DAR Close	Reclose command after DAR				OT
2861	AR T-Recl.run	AR: Reclaim time is running				OT
2862	AR successful	AR: Auto-reclose cycle successful				OT
2863	Definit.Trip	AR: Definitive trip				OT
4601	>CBP Q0 cld	>CB position: Q0 closed				IOT
4602	>CBP Q0 opd	>CB position: Q0 open				IOT
4603	>DCP Q1 cld	>DC position: Q1 closed				IOT
4604	>DCP Q1 opd	>DC position: Q1 open				IOT
4607	>DCP Q5 cld	>DC position: Q5 closed				IOT
4608	>DCP Q5 opd	>DC position: Q5 open				IOT
4609	>DCP Q6 cld	>DC position: Q6 closed				IOT
4610	>DCP Q6 opd	>DC position: Q6 open				IOT
4611	>DCP Q8 cld	>DC position: Q8 closed				IOT
4612	>DCP Q8 opd	>DC position: Q8 open				IOT
4613	>DCP Q10 cld	>DC position: Q10 closed				IOT
4614	>DCP Q10 opd	>DC position: Q10 open				IOT
4615	>DCP Q15 cld	>DC position: Q15 closed				IOT
4616	>DCP Q15 opd	>DC position: Q15 open				IOT
4617	>DCP Q16 cld	>DC position: Q16 closed				IOT
4618	>DCP Q16 opd	>DC position: Q16 open				IOT
4619	>DCP Q2 cld	>DC position: Q2 closed				IOT

FNo.	Abbreviation	Meaning	Op	Ft	E	IOT
4620	>DCP Q2 opd	>DC position: Q2 open				IOT
4621	>DCP Q9 cld	>DC position: Q9 closed				IOT
4622	>DCP Q9 opd	>DC position: Q9 open				IOT
4631	>SW.auth.rem	>Switching authorization: remote				IOT
4632	>SW.auth.bloc	>Switching authorization: blocked	CG			IOT
4640	Con. Q0 Close	Control-Close-Command CB-Q0				OT
4641	Con. Q0 Trip	Control-Trip-Command CB-Q0				OT
4670	abort:sw.auth	Abort:no switching authority	C			OT
4671	abort:flt.det	Abort: fault detection	C			OT
4672	abort:cw	Abort: codeword incorrect	C			OT
4673	abort:entime	Abort: entry time expired	C			OT
4674	abort: set=is	Abort: set=is	C			OT
4675	abort:cmd ex.	Abort: cmd being executed	C			OT
4676	abort:BI dbl	Abort: BI double command	C			OT
4677	abort:test	Abort: CB-Test being executed	C			OT
4678	abort:unknown	Abort: switchgear unknown	C			OT
4682	CR time exp	Abort: command respondtime expired	C			OT
4683	sw.auth.loc	Switching authorization: local	CG			OT
4684	sw.auth.rem	Switching authorization:remote	CG			OT
4689	err:CB/DC pos	error CB/DC pos				OT
4690	err:CB pos Q0	error CB pos Q0	CG			OT
4691	err:DC pos Q1	error DC pos Q1	CG			OT
4693	err:DC pos Q5	error DC pos Q5	CG			OT
4694	err:DC pos Q6	error DC pos Q6	CG			OT
4695	err:DC pos Q8	error DC pos Q8	CG			OT
4696	err:DC posQ10	error DC pos Q10	CG			OT
4697	err:DC posQ15	error DC pos Q15	CG			OT
4698	err:DC posQ16	error DC pos Q16	CG			OT
4699	err:DC pos Q2	error DC pos Q2	CG			OT
4700	err:DC pos Q9	error DC pos Q9	CG			OT
4705	CB-Q0 pos	CB-Q0 pos				
4706	DC-Q1 pos	DC-Q1 pos				
4708	DC-Q5 pos	DC-Q5 pos				
4709	DC-Q6 pos	DC-Q6 pos				
4710	DC-Q8 pos	DC-Q8 pos				
4711	DC-Q10 pos	DC-Q10 pos				
4712	DC-Q15 pos	DC-Q15 pos				
4713	DC-Q16 pos	DC-Q16 pos				
4714	DC-Q2 pos	DC-Q2 pos				
4715	DC-Q9 pos	DC-Q9 pos				
4720	CB-Q0	CB-Q0	C			
4721	DC-Q1	DC-Q1	C			
4723	DC-Q5	DC-Q5	C			
4724	DC-Q6	DC-Q6	C			
4725	DC-Q8	DC-Q8	C			
4726	DC-Q10	DC-Q10	C			
4727	DC-Q15	DC-Q15	C			
4728	DC-Q16	DC-Q16	C			
4729	DC-Q2	DC-Q2	C			
4730	DC-Q9	DC-Q9	C			
4801	>MCB trip	>Mechanic circuit breaker trip	CG			IOT
4802	>SF6 pres fd	>SF6 pressure alarm (feeder)	CG			IOT
4803	>SF6 pres bb	>SF6 pressure alarm (busbar)	CG			IOT
4804	>HV fuse bl	>HV fuse blown	CG			IOT
4805	>LV plug rem	>LV plug removed	CG			IOT
4806	>CB sprn.ch	>CB spring not charged	CG			
4807	>tempalarm	>Tempalarm	CG			IOT
4808	>temptrip	>Temperature trip	CG			IOT

FNo.	Abbreviation	Meaning	Op	Ft	E	IOT
4820	>MSP on	>Switch on motor start protection				IOT
4821	>MSP off	>Switch off motor start protection				IOT
4822	>MSP block	>Block motor start protection				IOT
4823	>MSP emerg st	>Motor start protection emergency start	CG			IOT
4824	MSP off	Motor start protection is switched off	CG			OT
4825	MSP blocked	Motor start protection is blocked	CG			OT
4826	MSP active	Motor start protection is active				OT
4827	MSP Trip	Trip by motor start protection	CG			OT
5140	>I2 on	>Switch on negative sequence prot.				IOT
5141	>I2 off	>Switch off negative sequence prot.				IOT
5143	>I2 block	>Block negative sequence prot.				IOT
5144	>negative seq	>Reversed phase rotation				IOT
5151	I2 off	Negative sequence prot. is switched off	CG			O
5152	I2 blocked	Negative sequence prot. is blocked	CG			O
5153	I2 active	Negative sequence prot. is active				O
5159	I2>> Fault	Fault detection neg. seq. stage I2>>		C		OT
5165	I2> Fault	Fault detection neg. seq. stage I2>		C		OT
5170	I2 Trip	Trip by negative sequence prot.		C		OT
6501	>u/v on	>Switch on undervoltage protection				IOT
6502	>u/v off	>Switch off undervoltage protection				IOT
6503	>u/v block	>Block undervoltage protection				IOT
6504	>u/v annunc	>u/v protection: annunciations only	CG			IOT
6506	>U< block	>Block undervoltage protection U< stage	CG			IOT
6507	>U<< s crit	>u/v starting criterion	CG			IOT
6508	>U<< block	>Block undervoltage prot. U<< stage	CG			IOT
6509	>vt fail feed	>vt failure feeder	CG			IOT
6510	>vt fail bb	>vt failure busbar	CG			IOT
6511	>o/v on	>Switch on overvoltage protection				IOT
6512	>o/v off	>Switch off overvoltage protection				IOT
6513	>o/v block	>Block overvoltage protection				IOT
6514	>o/v annunc.	>Overvoltage protection: annunc. only	CG			IOT
6530	u/v off	Undervoltage protection is switched off	CG			OT
6531	u/v blocked	Undervoltage protection is blocked	CG			OT
6532	u/v active	Undervoltage protection is active				OT
6533	U< Fault	Undervoltage fault detection U<		C		OT
6534	U< cc Fault	Undervoltage fault detection cc U<		C		OT
6535	U< sc Fault	Undervoltage fault detection sc U<		C		OT
6536	U< cc sc Flt	Undervoltage fault detection cc,sc U<		C		OT
6537	U<< Fault	Undervoltage fault detection U<<		C		OT
6538	U<< cc Fault	Undervoltage fault detection cc U<<		C		OT
6539	U< Trip	Undervoltage protection, U< trip		C		OT
6540	U<< Trip	Undervoltage protection, U<< trip		C		OT
6565	o/v off	Overvoltage protection is switched off	CG			OT
6566	o/v blk	Overvoltage protection is blocked	CG			OT
6567	o/v active	Overvoltage protection is active				OT
6568	U> Fault	Overvoltage fault detection U>		C		OT
6569	U> cc Flt	Overvoltage fault detection,SK,U>		C		OT
6570	U> Trip	Overvoltage protection U> trip		C		OT
6801	>STRT-SUP blk	>Block starting time supervision				IOT
6803	>STRT-SUP on	>Switch on starting time supervision				IOT
6804	>STRT-SUP off	>Switch off starting time supervision				IOT
6805	>Rotor locked	>Rotor locked				IOT
6811	STRT-SUP off	Starting time supervision off	CG			OT
6812	STRT-SUP blk	Starting time supervision blocked	CG			OT
6813	STRT-SUP act	Starting time supervision active				OT
6821	STRT-SUP trip	Trip by supervision of starting time		C		OT
6822	Rotor locked	Rotor locked		C		OT
6823	STRT-SUP pu	Starting supervision picked up	CG			OT

FNo.	Abbreviation	Meaning	Op	Ft	E	IOT
6852	>SUP trip rel	>Trip circuit supervision: Trip relay	CG			IOT
6853	>SUP CB aux.	>Trip circuit supervision: CB aux.	CG			IOT
6861	SUP off	Trip circuit supervision off	CG			OT
6864	SUP MarshFail	TC superv. blocked: BI not marshalled	CG			OT
6865	Failure TC	Trip circuit interrupted	CG			OT

Reference Table for Functional Parameters 7SJ531

1000 PARAMETERS

1100 POWERSYSTEM DATA

```
1101 CT STARPNT            Current transformer polarity
     TOWARDS LINE      [ ] Towards line
     TOWARDS BUSBAR    [ ] Towards busbar

1103 Un PRIMARY            Primary rated voltage
     min. 0.2              kV
     max. 400.0      ____

1104 Un SECOND.            Secondary rated voltage
     min. 100              V
     max. 125        ____

1105 In PRIMARY            Primary rated current
     min. 10               A
     max. 50000      ____

1110 Uph/Udelta            Matching factor Uph/Udelta (sec.earth voltage)
     min. 0.10
     max. 9.99       ____

1112 Ie/Iph                Matching factor Ie/Iph for earth current
     min. 0.010
     max. 5.000      ____

1114 IEE/IPH               Matching factor Iee/Iph
     min. 0.001
     max. 5.000      ____

1117 RE/RL                 Residual compensating factor RE/RL
     min. -0.33
     max. 7.00       ____

1118 XE/XL                 Residual compensating factor XE/XL
     min. -0.33
     max. 7.00       ____

1122 X SEC                 Secondary reactance per unit line length Xsec
     min. 0.010            Ω/mile
     max. 10.000     ____

1123 X SEC                 Secondary reactance per unit line length Xsec
     min. 0.005            Ω/km
     max. 6.215      ____

1134 T TRIP                Minimum trip command duration
     min. 0.01             s
     max. 32.00      ____

1135 T-CLOSE               Maximum close command duration
     min. 0.01             s
     max. 32.00      ____
```

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1160 BRK CLOSED             Closed breaker current threshold
     min. 0.04              I/In
     max. 1.00        ____

1165 I-STRT-DET             Threshold of start-up detection
     min. 0.60              I/In
     max. 10.00       ____
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```
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. 0.10              I/In
     max. 25.00       ____

1203 T-I>>                  Trip time delay of the high-set stage I>>
     min. 0.00              s
     max. 60.00/∞     ____

1206 MEAS.REPET             Measurement repetition
     NO                 [ ] no
     YES                [ ] yes

1212 I>                     Pick-up value of the overcurrent stage I>
     min. 0.10              I/In
     max. 25.00/∞     ____

1213 T-I>                   Trip time delay of the overcurrent stage I>
     min. 0.00              s
     max. 60.00/∞     ____

1214 Ip                     Pick-up value inverse time O/C stage Ip
     min. 0.10              I/In
     max. 4.00/∞      ____

1215 T-Ip                   Trip time delay inverse time O/C stage Ip
     min. 0.05              s
     max. 3.20/∞      ____

1216 D Ip                   Trip time delay inverse time O/C stage Ip/ANSI
     min. 0.50
     max. 15.00/∞     ____

1217 RMS FORMAT             RMS format for inverse time O/C protection
     FUNDAMENTAL        [ ] Fundamental
     TRUE RMS           [ ] True rms

1218 CHARACTER.             Characteristic of the O/C stage Ip
     NORMAL INVERSE     [ ] Normal inverse
     VERY INVERSE       [ ] Very inverse
     EXTREMELY INVERS   [ ] Extremely inverse
```

```
1219 CHARACTER.              Characteristic of the O/C stage Ip
     INVERSE            [ ] Inverse
     SHORT INVERSE      [ ] Short inverse
     LONG INVERSE       [ ] Long inverse
     MODERATELY INV.    [ ] Moderately inverse
     VERY INVERSE       [ ] Very inverse
     EXTREMELY INV.     [ ] Extremely inverse
     DEFINITE INV.      [ ] Definite inverse
     I-SQUARED-T        [ ] I-squared-t

1221 MAN.CLOSE               Manual close
     I>> UNDELAYED      [ ] I>> undelayed
     I>/Ip UNDELAYED    [ ] I>/Ip undelayed
     INEFFECTIVE        [ ] Ineffective

1223 RAR st. ph              RAR stage phase
     I>> ALWAYS         [ ] I>> always active
     I>> W. RAR ONLY    [ ] I>> with RAR only

1230 USER DEF. CHARACTERISTIC
                             User def. characteristic, O/C stage Ip
```

```
1300 O/C PROT. EARTH

1301 O/C EARTH               O/C protection for earth faults
     ON                 [ ] on
     OFF                [ ] off

1302 IE>>                    Pick-up value of the high-set stage IE>>
     min. 0.05               I/In
     max. 25.00        ____

1303 T-IE>>                  Trip time delay of the high-set stage IE>>
     min. 0.00               s
     max. 60.00/∞      ____

1306 MEAS.REPET              Measurement repetition
     NO                 [ ] no
     YES                [ ] yes

1312 IE>                     Pick-up value of the overcurrent stage IE>
     min. 0.05               I/In
     max. 25.00/∞      ____

1313 T-IE>                   Trip time delay of the overcurrent stage IE>
     min. 0.00               s
     max. 60.00/∞      ____

1314 IEp                     Pick-up value inverse time O/C stage IEp
     min. 0.05               I/In
     max. 4.00/∞       ____

1315 T-IEp                   Trip time delay inverse time O/C stage IEp
     min. 0.05               s
     max. 3.20/∞       ____

1316 D IEp                   Trip time delay inverse time O/C stage IEp
     min. 0.50
     max. 15.00/∞      ____
```

```
1317 RMS FORMAT              RMS format for inverse time O/C protection
     FUNDAMENTAL         [ ] Fundamental
     TRUE RMS            [ ] True rms

1318 CHARACTER.              Characteristic of the O/C stage IEp
     NORMAL INVERSE      [ ] Normal inverse
     VERY INVERSE        [ ] Very inverse
     EXTREMELY INVERS    [ ] Extremely inverse
     LONG EARTH FAULT    [ ] Long earth fault

1319 CHARACTER.              Characteristic of the O/C stage IEp
     INVERSE             [ ] Inverse
     SHORT INVERSE       [ ] Short inverse
     LONG INVERSE        [ ] Long inverse
     MODERATELY INV.     [ ] Moderately inverse
     VERY INVERSE        [ ] Very inverse
     EXTREMELY INV.      [ ] Extremely inverse
     DEFINITE INV.       [ ] Definite inverse
     I-SQUARED-T         [ ] I-squared-t

1321 MAN.CLOSE               Manual close
     IE>> UNDELAYED      [ ] IE>> undelayed
     IE>/IEp UNDELAY.    [ ] IE>/IEp undelayed
     INEFFECTIVE         [ ] Ineffective

1323 RAR st. e               RAR stage ground
     IE>> ALWAYS         [ ] IE>> always active
     IE>> W. RAR ONLY    [ ] IE>> with RAR only

1330 USER DEF. CHARACTERISTIC
                             User def. characteristic, O/C stage IEp
```

```
1400 OVERCURR.DIRECTIONAL PH

1401 O/C DIR.PH              O/C - Directional phase inst/time
     OFF                 [ ] off
     ON                  [ ] on

1402 I>> DIR.                Pick-up value of the dir. O/C stage I>>
     min. 0.10               I/In
     max. 25.00          ____

1403 I>> DIR.                Delay time T-I>> of the dir. O/C stage
     min. 0.00               s
     max. 60.00/∞        ____

1412 I> DIR.                 Pick-up value of the dir. O/C stage I>
     min. 0.10               I/In
     max. 25.00/∞        ____

1413 T-I> DIR.               Delay time T-I> of the dir. O/C stage
     min. 0.00               s
     max. 60.00/∞        ____

1414 Ip DIR.                 Pick-up value of the dir. inv. O/C stage
     min. 0.10               I/In
     max. 4.00/∞         ____
```

```
1415 T-Ip DIR.              Time multipl. T-Ip of the dir. inv. O/C stage
     min. 0.05         ____ s
     max. 3.20/∞       ____

1416 D-Ip DIR.              Time mult. T-Ip of the dir. inv.O/C stage
     min. 0.50
     max. 15.00/∞      ____

1417 RMS FORMAT             RMS format for the dir. inv. O/C stage
     FUNDAMENTAL        [ ] Fundamental
     TRUE RMS           [ ] True rms

1418 CHAR.DIR.              Characteristic of the dir. O/C stage phase
     NORMAL INVERSE     [ ] Normal inverse
     VERY INVERSE       [ ] Very inverse
     EXTREMELY INVERS   [ ] Extremely inverse

1419 CHAR.DIR.              Characteristic of the dir. O/C stage phase
     INVERSE            [ ] Inverse
     SHORT INVERSE      [ ] Short inverse
     LONG INVERSE       [ ] Long inverse
     MODERATELY INV.    [ ] Moderately inverse
     VERY INVERSE       [ ] Very inverse
     EXTREMELY INV.     [ ] Extremely inverse
     DEFINITE INV.      [ ] Definite inverse
     I-SQUARED-T        [ ] I-squared-t

1421 MAN.CLOSE              Manual close
     I>> DIR. UNDEL     [ ] I>> dir. undelayed
     I>/IpDIR.UNDEL     [ ] I>/Ip dir. undelayed
     INEFFECTIVE        [ ] Ineffective

1423 RAR STAGE              RAR stage phase
     I>> DIR. ALWAYS    [ ] I>> always active
     I>> DIR.W.RAR      [ ] I>> with RAR only

1425 DIRECTION              Operating direction of the O/C stages phase
     FORWARDS           [ ] Forwards
     REVERSE            [ ] Reverse

1426 NO DIR INF             Op-mode when phase pickup w/o known direction
     NO PICKUP          [ ] No pickup
     NON-DIR MODE       [ ] Non-directional mode

1430 USER DEF. CHARACTERISTIC
                            User def. charakteristic, dir. O/C stage Ip
```

```
1500 OVERCURR.DIRECTIONAL E

1501 DIREC. IE>             Operating direction of the dir. O/C IE> stage
     OFF                [ ] off
     ON                 [ ] on

1502 IE>> DIR.              Pick-up value of the dir. O/C stage IE>>
     min. 0.05         ____ I/In
     max. 25.00        ____

1503 T-IE>>DIR.             Delay time T-IE>> of the dir. O/C stage
     min. 0.00         ____ s
     max. 60.00/∞      ____
```

```
1512 IE> DIR.              Pick-up value of the dir. O/C stage IE>
     min. 0.05             I/In
     max. 25.00/∞    ____

1513 T-IE> DIR.            Time delay T-IE> of the dir. O/C stage
     min. 0.00             s
     max. 60.00/∞    ____

1514 IEp> DIR.             Pick-up value of the dir. O/C stage IEp>
     min. 0.05             I/In
     max. 4.00/∞     ____

1515 T-IEp DIR.            Time mult.T-IEp of the dir.inv. O/C stage
     min. 0.05             s
     max. 3.20/∞     ____

1516 D-IEp DIR.            Time mult.D-IEp of the dir.inv. O/C stage
     min. 0.50
     max. 15.00/∞    ____

1517 RMS FORMAT            RMS format for the dir.inv. O/C stage
     FUNDAMENTAL       [ ] Fundamental
     TRUE RMS          [ ] True rms

1518 CHAR.DIREC            Characteristic of the dir. O/C stage earth
     NORMAL INVERSE    [ ] Normal inverse
     VERY INVERSE      [ ] Very inverse
     EXTREMELY INVERS  [ ] Extremely inverse
     LONG EARTH FAULT  [ ] Long earth fault

1519 CHAR.DIREC            Characteristic of the dir. O/C stage earth
     INVERSE           [ ] Inverse
     SHORT INVERSE     [ ] Short inverse
     LONG INVERSE      [ ] Long inverse
     MODERATELY INV.   [ ] Moderately inverse
     VERY INVERSE      [ ] Very inverse
     EXTREMELY INV.    [ ] Extremely inverse
     DEFINITE INV.     [ ] Definite inverse
     I-SQUARED-T       [ ] I-squared-t

1521 MAN.CLOSE             Manual close
     IE>> UNDELAYED    [ ] IE>> undelayed
     IE>/Ip UNDELAYED  [ ] IE>/Ip undelayed
     INEFFECTIVE       [ ] Ineffective

1523 RAR ST. E             RAR stage ground
     IE>> DIR. ALWAYS  [ ] IE>> always active
     IE>> DIR.W.RAR    [ ] IE>> with RAR only

1525 DIRECTION             Operating direction of O/C IE> stages earth
     FORWARDS          [ ] Forwards
     REVERSE           [ ] Reverse

1526 NO DIR INF            Op-mode when phase pickup w/o known direction
     NO PICKUP         [ ] No pickup
     NON-DIR MODE      [ ] Non-directional mode

1530 USER DEF. CHARACTERISTIC
                           User def. charakteristic, dir. O/C stage IEp
```

```
1600 UNDER VOLTAGE

1601 UNDERVOLTG              Undervoltage
     OFF                 [ ] off
     ON                  [ ] on
     ALARM ONLY          [ ] Alarm only

1602 U< (PH-E)               Stage U< (phase-earth meas.)
     min. 30                 V
     max. 120           ____

1603 U< (PH-PH)              Stage U< (phase-phase meas.)
     min. 30                 V
     max. 120           ____

1604 r (PH-E)                Reset ratio r (ph-e) of u/v stage U<
     min. 1.05
     max. 3.00          ____

1605 r (PH-PH)               Reset ratio r (ph-ph) of u/v stage U<
     min. 1.05
     max. 3.00          ____

1606 T-U<                    Delay time T-U< of u/v stage U<
     min. 0.00               s
     max. 60.00/∞       ____

1607 START.CRIT              Starting criterion of u/v protection
     OFF                 [ ] off
     ON                  [ ] on

1608 SC I<                   Stage I< for starting crit., u/v prot.
     min. 0.05               I/In
     max. 1.00          ____

1609 T-SC                    Active time for starting criterion u/v
     min. 0.00               s
     max. 60.00         ____

1610 U<< (PH-E)              Stage U<< (phase-earth meas.)
     min. 30                 V
     max. 120           ____

1611 U<<(PH-PH)              Stage U<< (phase-phase meas.)
     min. 30                 V
     max. 120           ____

1612 T-U<<                   Delay time T-U<< of u/v stage U<
     min. 0.00               s
     max. 60.00/∞       ____

1620 C CRIT U/V              Current criterion of undervoltage prot.
     ON                  [ ] on
     OFF                 [ ] off
```

```
1700 OVER VOLTAGE

1701 OVERVOLTG              Overvoltage
     OFF                [ ] off
     ON                 [ ] on
     ALARM ONLY         [ ] Alarm only

1702 U> (PH-E)              Stage U> (phase-earth meas.)
     min. 40                V
     max. 130          ____

1703 U> (PH-PH)             Stage U> (phase-phase meas.)
     min. 40                V
     max. 130          ____

1704 T-U>                   Delay time T-U> of u/v stage U>
     min. 0.00              s
     max. 60.00/∞      ____

1710 C CRIT O/V             Current criterion of overvoltage prot.
     OFF                [ ] off
     ON                 [ ] on
```

```
1800 NEGATIVE SEQUENCE PROT.

1801 NEG. SEQ.              Negative sequence protection
     OFF                [ ] off
     ON                 [ ] on

1802 I2>                    Pick-up value of negative sequence stage I2>
     min. 5                 %
     max. 80           ____

1803 T-I2>                  Trip delay of negative sequence stage T-I2>
     min. 0.00              s
     max. 60.00        ____

1804 I2>>                   Pick-up value of negative sequence stage I2>>
     min. 5                 %
     max. 80           ____

1805 T-I2>>                 Trip delay of negative sequence stage T-I2>>
     min. 0.00              s
     max. 60.00        ____
```

```
2100 START-TIME SUPERVISION

2101 START SUPV             Supervision of starting time
     OFF                [ ] off
     ON                 [ ] on

2102 I-STRT-MAX             Max. permissible starting curr. at T-START-MAX
     min. 1.00              I/In
     max. 16.00        ____

2103 T-STRT-SUP             Max. permissible starting time at I-START-MAX
     min. 1.0               s
     max. 320.0        ____
```

```
2104 T-LOCK-ROT          Permissible locked rotor time
     min. 0.5            s
     max. 120.0/∞   ____

2700 THERMAL OVERLOAD PROT.

2701 THERMAL OL          State of thermal overload protection
     OFF             [ ] off
     ON              [ ] on
     ALARM ONLY      [ ] Alarm only

2702 K-FACTOR            K-factor for thermal overload protection
     min. 0.10
     max. 4.00      ____

2703 T-CONSTANT          Time constant for thermal overload protection
     min. 1.0            min
     max. 999.9     ____

2704 Θ WARN              Thermal warning stage
     min. 50             %
     max. 100       ____

2705 I WARN              Current warning stage
     min. 0.10           I/In
     max. 4.00      ____

2706 O/L CALCUL          Calculation method for thermal stages
     Θ MAX           [ ] Theta max
     Θ MEAN          [ ] Theta mean

2709 kτ-FACTOR           Multiplier of time constant at standstill
     min. 1.0
     max. 10.0      ____

2800 MOT. START PROTECTION

2801 MOT. START          Motor start protection
     OFF             [ ] off
     ON              [ ] on

2802 IA/IB               Starting current / rated motor current
     min. 3.0
     max. 10.0      ____

2803 T STRT MAX          Max. permissible starting time
     min. 3              s
     max. 320       ____

2804 T EQUAL             Temperature equalization time
     min. 0.0            min
     max. 320.0     ____

2805 IB/IN               Rated motor current / rated C.T. current
     min. 0.2
     max. 1.2       ____
```

```
2806 nw                     Maximum permissible number of warm-starts
     min. 1
     max. 4          ____

2807 nc-nw                  Difference between no. of cold and warm-starts
     min. 1
     max. 2          ____

2808 kτ-FACTOR              Factor for tau during standstill
     min. 1
     max. 10         ____
```

```
2900 MEAS.VALUE SUPERVISION

2901 SYM.Uthres             Symmetry threshold for voltage monitoring
     min. 10                V
     max. 100/∞      ____

2902 SYM.Fact.U             Symmetry factor for voltage monitoring
     min. 0.58
     max. 0.90       ____

2903 SYM.Ithres             Symmetry threshold for current monitoring
     min. 0.10              I/In
     max. 1.00/∞     ____

2904 SYM.Fact.I             Symmetry factor for current monitoring
     min. 0.10
     max. 0.95       ____

2905 SUM.Ithres             Summation threshold for current monitoring
     min. 0.05              I/In
     max. 2.00/∞     ____

2906 SUM.Fact.I             Factor for current summation monitoring
     min. 0.00
     max. 0.95       ____

2930 LIMIT IL1              Limit IL1
     min. 0.10              I/In
     max. 25.00      ____

2931 LIMIT IL2              Limit IL2
     min. 0.10              I/In
     max. 25.00      ____

2932 LIMIT IL3              Limit IL3
     min. 0.10              I/In
     max. 25.00      ____

2933 LIMIT IE               Limit IE
     min. 0.05              I/In
     max. 25.00      ____

2934 LIMIT IL<              Limit of minimal phase current
     min. 0.10              I/In
     max. 4.00       ____
```

```
2935 LIMITcosphi<          Limit of power factor
     min. 0.40
     max. 1.00      ____

2936 LIMIT Pa              Limit of active power
     min. 1                kW
     max. 500000    ____

2937 LIMIT Pr              Limit of reactive power
     min. 1                kVAR
     max. 500000    ____
```

```
3000 EARTHFAULT DETECTION

3001 EARTHFAULT            High-sensitivity earth fault protection
     OFF               [ ] off
     ON                [ ] on
     ALARM ONLY        [ ] Alarm only

3002 CT ERR. I1            Second. current I1 for max error angle of C.T.
     min. 0.003            A
     max. 1.600     ____

3003 CT ERR. F1            Error angle of C.T. at I1
     min. 0.0              °
     max. 5.0       ____

3004 CT ERR. I2            Second. current I2 for max error angle of C.T.
     min. 0.003            A
     max. 1.600     ____

3005 CT ERR. F2            Error angle of C.T. at I2
     min. 0.0              °
     max. 5.0       ____

3006 Uph<                  Phase-earth voltage of faulted phase Uph<
     min. 10               V
     max. 100       ____

3007 Uph>                  Phase-earth voltage of healthy phases Uph>
     min. 10               V
     max. 100       ____

3009 Ue> meas.             Pick-up level of measured UE
     min. 1.8              V
     max. 130.0     ____

3010 Ue> cal.              Pick-up level of calculated UE
     min. 6.0              V
     max. 130.0     ____

3011 T-E/F                 Duration of displacement voltage for E/F det.
     min. 0.04             s
     max. 320.00/∞  ____

3012 T-UE                  Delay time T-UE of the UE> stage
     min. 0.10             s
     max. 40000.00/∞ ____
```

```
3013 IEE>>                   IEE>> stage of high-sensitivity E/F prot.
     min. 0.003        ____  A
     max. 1.500        ____

3014 T-IEE>>                 Delay time T-IEE>> of the IEE>> stage
     min. 0.00         ____  s
     max. 320.00/∞     ____

3015 IEE>> DIR.              Dir. IEE>> stage of high-sensitivity E/F prot.
     FORWARDS           [ ] Forwards
     REVERSE            [ ] Reverse
     NON-DIRECTIONAL    [ ] Non-directional

3017 IEE>                    IEE> stage of high-sensitivity E/F prot.
     min. 0.003        ____  A
     max. 1.500        ____

3018 T-IEE>                  Delay time T-IEE> of the IEE> stage
     min. 0.00         ____  s
     max. 320.00/∞     ____

3019 IEEp                    IEEp stage of high-sensitivity E/F prot.
     min. 0.003        ____  A
     max. 1.400        ____

3020 T-IEEp                  Delay time T-IEEp of the IEEp stage
     min. 0.00         ____  s
     max. 4.00/∞       ____

3022 IEE> DIR.               Dir. IEE> stage of high-sensitivity E/F prot.
     FORWARDS           [ ] Forwards
     REVERSE            [ ] Reverse
     NON-DIRECTIONAL    [ ] Non-directional

3023 IEE>/pDIR.              Operating direction of the IEE> or IEEp stage
     min. 0.003        ____  A
     max. 1.200        ____

3024 PHI CORR                Correction angle for direc. determination
     min. -45.0        ____  °
     max. 45.0         ____

3025 E/F MEAS.               Measurement mode for direc. determination
     COS PHI            [ ] Cos phi
     SIN PHI            [ ] Sin phi

3026 T DIR STAB              Drop-off delay for dir. stabilization
     min. 0            ____  s
     max. 60           ____

3030 USER DEF. CHARACTERISTIC
                             User def. charakteristic, O/C stage IEEp
```

```
3400 AUTORECLOSE FUNCTION

3401 AR FUNCT                Auto-reclose function
     OFF                [ ] off
     ON                 [ ] on
```

3403	M/C BLK		AR block with manual / control close
	YES	[ ]	yes
	NO	[ ]	no
3405	T-RECLAIM		Reclaim time after successful AR
	min. 0.50		s
	max. 320.00	____	
3406	T-LOCK		Lock-out time after unsuccessful AR
	min. 0.50		s
	max. 320.00/∞	____	
3407	T-BLOC M/C		AR: blocking duration with manual close
	min. 0.50		s
	max. 320.00	____	
3412	CB? 1.TRIP		CB ready interrogation at 1st trip command
	NO	[ ]	no
	YES	[ ]	yes
3413	CB? CLOSE		CB ready interrogation before reclosing
	CB? NEVER	[ ]	CB? never
	CB? WITH EACH AR	[ ]	CB? with each AR
	CB? WITH 2nd AR	[ ]	CB? with 2nd AR
3415	T-CB-SUPV		Circuit breaker supervision time
	min. 0.10		s
	max. 320.00	____	
3424	RAR T-ACT.		Rapid auto-reclose action time
	min. 0.01		s
	max. 320.00/∞	____	
3425	RAR T-PHA.		Dead time after trip by phase fault stage
	min. 0.01		s
	max. 320.00	____	
3426	RAR T-EAR.		Dead time after trip by earth fault stage
	min. 0.01		s
	max. 320.00	____	
3443	DAR SHOT E		Permissible DAR shots after earth faults
	min. 0		
	max. 9	____	
3444	DAR SHOT P		Permissible DAR shots after phase faults
	min. 0		
	max. 9	____	
3445	DAR T-ACT.		Delayed auto-reclose action time
	min. 0.01		s
	max. 320.00/∞	____	
3446	DAR T-EAR.		Dead time after trip by earth fault stage
	min. 0.01		s
	max. 1800.00	____	
3447	DAR T-PHA.		Dead time after trip by phase fault stage
	min. 0.01		s
	max. 1800.00	____	

```
3700 TRIP CIR'T SUPERVISION

3701 TRIP SUP               Trip circuit supervision
     OFF                [ ] off
     ON                 [ ] on

3702 T FAIL TC              Delay of trip circuit failure message
     min. 1                 s
     max. 900         ____
```

```
3800 FAULT LOCATION

3802 START                  Start condition for fault locator
     DROP-OFF or TRIP [ ] Drop-off or trip
     TRIP COMMAND     [ ] Trip command
```

```
3900 BREAKER FAILURE PROTEC.

3901 B/F PROT.              Circuit breaker failure protection
     OFF                [ ] off
     ON                 [ ] on

3902 INT ORIGIN             B/F prot. with internal trip
     ON                 [ ] on
     OFF                [ ] off

3903 EXT ORIGIN             B/F prot. with external trip (via BI)
     ON                 [ ] on
     OFF                [ ] off

3904 CONTR ORIG             B/F prot. with control switch off
     OFF                [ ] off
     ON                 [ ] on

3905 AUX CONT.              B/F prot. with CB auxiliary contacts
     OFF                [ ] off
     ON                 [ ] on

3907 T-B/F                  Delay time T-B/F
     min. 0.06              s
     max. 60.00/∞     ____
```

Tests and Commissioning Aids 7SJ531

4000 TESTS

4300 CB TEST TRIP-CLOSE CYCLE

4304 CB TEST Circuit breaker test with AR 3pole

4400 CB TEST LIVE TRIP

4404 CB TRIP Circuit breaker trip test 3pole

4900 TEST FAULT RECORDING

4901 FAULT REC. Initiation of fault recording

Annunciations, Measured Values etc. 7SJ531

5000 ANNUNCIATIONS

5100 OPERATIONAL ANNUNCIATIONS

5200 LAST FAULT

5300 2nd TO LAST FAULT

5400 3rd TO LAST FAULT

5500 ISOLATED EARTH FLT DATA

5600 CB OPERAT. STATISTICS

```
5602 AR 3pole=          No. of auto-reclose commands:3p RAR
5603 DAR 3pol=          No. of auto-reclose commands:3p DAR
5604 Trip No =          Number of trip commands issued
5605 date:              Setting-date (Trip Commands):
5610 Il1/In=            Last trip current L1 IL1/In=
5611 IL2/In=            Last trip current L2 IL2/In=
5612 IL3/In             Last trip current L3 IL3/In=
5613 OPER HOURS         Operation hours:
```

5700 OPERATIONAL MEASURED VALUES

```
5701 IL1[%] =           Current in phase IL1 [%] =
5702 IL2[%] =           Current in phase IL2 [%] =
5703 IL3[%] =           Current in phase IL3 [%] =
5704 IE[%]  =           IE[%]=
5705 IL1    =           Current in phase IL1 =
5706 IL2    =           Current in phase IL2 =
5707 IL3    =           Current in phase IL3 =
5708 IEa    =           Operational measurement: IEa=
5710 UL1E   =           Voltage UL1E =
5711 UL2E   =           Voltage UL2E =
5712 UL3E   =           Voltage UL3E =
5713 UL12   =           Voltage UL12 =
5714 UL23   =           Voltage UL23 =
5715 UL31   =           Voltage UL31 =
5716 U0     =           Voltage U0=
5720 Pa     =           Active power Pa =
5721 Pr     =           Reactive power Pr =
5722 COS PHI=           Power factor cos phi
5723 f [Hz] =           Frequency f [Hz] =
5724 Wp pos =           Achieve energy Wp positive =
5725 Wq pos =           Reactive energy Wq positive =
```

```
5726 Wp neg =             Achieve Energy Wp negative =
5727 Wq neg =             Reactive Energy Wq negative =
5728 Set.date:            Setting-date (Wp/Wq):
```

```
5800 ISOL. E/F MEASURED VALUES

5801 IEEa s =             Active component of sec. IEE curr.
5802 IEEr s =             Reactive component of sec. IEE curr.
5803 IEEa p =             Active component of prim. IEE curr.
5804 IEEr p =             Reactive component of prim. IEE curr
```

```
5900 OVERLOAD MEASURED VALUES

5901 Θ/ΘtripL1=           Temperature rise for phase L1
5902 Θ/ΘtripL2=           Temperature rise for phase L2
5903 Θ/ΘtripL3=           Temperature rise for phase L3
5904 Θ/Θtrip  =           Temperat. rise for warning and trip
5905 ΘL/ΘLtrip=           Temperature rise of rotor for trip
```

Reference Table for Configuration Parameters 7SJ531

6000 MARSHALLING

6100 MARSHALLING BINARY INPUTS

6101 BINARY INPUT 1 Binary input 1

6102 BINARY INPUT 2 Binary input 2

6103 BINARY INPUT 3 Binary input 3

6104 BINARY INPUT 4 Binary input 4

6105 BINARY INPUT 5 Binary input 5

6106 BINARY INPUT 6 Binary input 6

6107 BINARY INPUT 7 Binary input 7

6108 BINARY INPUT 8 Binary input 8

6109 BINARY INPUT 9 Binary input 9

6110 BINARY INPUT 10 Binary input 10

6111 BINARY INPUT 11 Binary input 11

6200 MARSHALLING SIGNAL RELAYS

6201 SIGNAL RELAY 1 Signal relay 1

6202 SIGNAL RELAY 2 Signal relay 2

6203 SIGNAL RELAY 3 Signal relay 3

6204 SIGNAL RELAY 4 Signal relay 4

6300 MARSHALLING LED INDICATORS

6301 LED 1 LED 1

6302 LED 2 LED 2

6303 LED 3 LED 3

6304 LED 4 LED 4

6305 LED 5 LED 5

6306 LED 6 LED 6

6400 MARSHALLING TRIP RELAYS

6401 TRIP RELAY 1 Trip relay 1

6402 TRIP RELAY 2 Trip relay 2

6403 TRIP RELAY 3 Trip relay 3

6404 TRIP RELAY 4 Trip relay 4

6700 MARSHALLING LCD-ANNOUNCEMENT

6701 MARSHALLING SPONT. VALUES
Operational messages for display

```
6702 MARSHALLING SPONT. MESSAGES
                         Fault messages for display

     ____________________    ____________________    ____________________

     ____________________    ____________________    ____________________

     ____________________    ____________________    ____________________
```

```
7000 OP. SYSTEM CONFIGURATION
```

```
7100 INTEGRATED OPERATION

7101 LANGUAGE                Language
     DEUTSCH            [ ]  German
     FRANCAIS           [ ]  French
     ENGLISH            [ ]  English

7102 DATE FORMAT             Date format
     DD.MM.YYYY         [ ]  dd.mm.yyyy
     MM/DD/YYYY         [ ]  mm/dd/yyyy

7103 DIST. UNIT              Measurement unit for distance to fault
     km                 [ ]  km
     miles              [ ]  miles

7110 FAULT INDIC             Fault indication: LED and LCD
     WITH FAULT DETEC   [ ]  With fault detection
     WITH TRIP COMM.    [ ]  With trip command

7130 CONTRAST                Contrast of the display
     min. 3
     max. 9             ____

7151 CW-LEVEL 1              Codeword for level 1
     min. 1
     max. 999999        ____

7152 CW-LEVEL 2              Codeword for level 2
     min. 1
     max. 999999        ____

7153 CW-LEVEL 3              Codeword for level 3
     min. 1
     max. 999999        ____

7154 CW-LEVEL 4              Codeword for level 4
     min. 1
     max. 999999        ____
```

```
7200 PC/SYSTEM INTERFACES

7201 DEVICE ADD.             Device address
     min. 1
     max. 254           ____
```

```
7202 FEEDER ADD.          Feeder address
     min. 1
     max. 254        ____

7203 SUBST. ADD.          Substation address
     min. 1
     max. 254        ____

7208 FUNCT. TYPE          Function type in accordance with VDEW/ZVEI
     min. 1
     max. 254        ____

7209 DEVICE TYPE          Device type
     min. 0
     max. 255        ____

7214 PC GAPS              Transmission gaps for PC-interface
     min. 0.0             s
     max. 5.0        ____

7215 PC BAUDRATE          Transmission baud rate for PC-interface
     9600 BAUD        [ ] 9600 Baud
     19200 BAUD       [ ] 19200 Baud
     1200 BAUD        [ ] 1200 Baud
     2400 BAUD        [ ] 2400 Baud
     4800 BAUD        [ ] 4800 Baud

7216 PC PARITY            Parity and stop-bits for PC-interface
     DIGSI V3         [ ] DIGSI V3
     NO 2 STOP        [ ] No parity,2 stopbits
     NO 1 STOP        [ ] No parity,1 stopbit

7221 SYS INTERF.          Data format for system-interface
     VDEW COMPATIBLE  [ ] VDEW compatible
     VDEW EXTENDED    [ ] VDEW extended
     DIGSI V3         [ ] DIGSI V3

7222 SYS MEASUR.          Measurement format for system-interface
     VDEW COMPATIBLE  [ ] VDEW compatible
     VDEW EXTENDED    [ ] VDEW extended

7224 SYS GAPS             Transmission gaps for system-interface
     min. 0.0             s
     max. 5.0        ____

7225 SYS BAUDR.           Transmission baud rate for system-interface
     9600 BAUD        [ ] 9600 Baud
     19200 BAUD       [ ] 19200 Baud
     1200 BAUD        [ ] 1200 Baud
     2400 BAUD        [ ] 2400 Baud
     4800 BAUD        [ ] 4800 Baud

7226 SYS PARITY           Parity and stop-bits for system-interface
     VDEW/DIGSIV3/LSA [ ] VDEW/DIGSI V3/LSA
     NO 2 STOP        [ ] No parity,2 stopbits
     NO 1 STOP        [ ] No parity,1 stopbit

7227 SYS-SWITCH           Online-switch VDEW-DIGSI enabled
     NO               [ ] no
     YES              [ ] yes
```

```
7235 SYS PARAMET          Parameterizing via system-interface
     NO               [ ] no
     YES              [ ] yes
```

```
7400 FAULT RECORDINGS

7402 INITIATION           Initiation of data storage
     STORAGE BY FD.   [ ] Storage by fault det
     STORAGE BY TRIP  [ ] Storage by trip
     START WITH TRIP  [ ] Start with trip

7403 SCOPE                Scope of stored data
     FAULT EVENT      [ ] Fault event
     FAULT IN POW.SYS [ ] Fault in power syst.

7410 T-MAX                Maximum time period of a fault recording
     min. 0.30            s
     max. 5.00        ____

7411 T-PRE                Pre-trigger time for fault recording
     min. 0.05            s
     max. 0.25        ____

7412 T-POST               Post-fault time for fault recording
     min. 0.05            s
     max. 0.50        ____

7431 T-BINARY IN          Storage time by initiation via binary input
     min. 0.10            s
     max. 5.00/∞      ____

7432 T-KEYBOARD           Storage time by initiation via keyboard
     min. 0.10            s
     max. 5.00        ____
```

```
7500 BREAKER CONTROL

7501 SW AUTH REM          Switching authority REMOTE is
     REMOTE ONLY      [ ] REMOTE only
     INCL. LOCAL      [ ] incl. LOCAL

7502 SW AUTH BI           Switching authority of binary input
     LOCAL            [ ] LOCAL
     REMOTE           [ ] REMOTE
     LOCKED           [ ] locked

7503 SW AUTH DIG          Switching authority of DIGSI
     LOCAL            [ ] LOCAL
     REMOTE           [ ] REMOTE
     LOCKED           [ ] locked

7510 CONTROL              Control permitted
     W/O CODEWD       [ ] without codeword
     WITH CW          [ ] with codeword

7511 T-ENTRY              Keypad entry supervision time T-ENTRY
     min. 5               s
     max. 30          ____
```

```
7512 LOC/REM SEL          Local / remote selection
     W/O CODEWD       [ ] without codeword
     WITH CW          [ ] with codeword

7520 T-FB CB              Feed back time of circuit breaker T-FB
     min. 1               s
     max. 600/∞     _____

7522 T-EXT CB             Trip cmd extension time for CB
     min. 0.0             s
     max. 10.0      _____

7524 T-SFB END            End of feedback supervision time
     STOPS TRIP CMD   [ ] stops trip command
     STOPS NOT TRIP C [ ] does not stop trip

7525 T-DWI                Wrong indication delay time
     min. 0               s
     max. 60/∞      _____

7598 SWITCH AUTH          Switching authorization
     LOCAL            [ ] LOCAL
     LOCAL/REMOTE     [ ] LOCAL/REMOTE
     VIA BI           [ ] via binary input
     LOCKED           [ ] locked

7599 SWITCH AUTH          Switching authorization
     LOCAL            [ ] LOCAL
     REMOTE           [ ] REMOTE
     VIA BI           [ ] via binary input
     LOCKED           [ ] locked
```

```
7800 SCOPE OF FUNCTIONS

7812 CHARAC. PH           Characteristic O/C protection phases
     DEFINITE TIME    [ ] Definite time
     INV. TIME IEC    [ ] Inverse time (IEC)
     INV. TIME ANSI   [ ] ANSI inv
     USER CHARACTER.  [ ] User characteristics

7813 CHARAC. E            Characteristic O/C protection earth
     DEFINITE TIME    [ ] Definite time
     INV. TIME IEC    [ ] Inverse time (IEC)
     INV. TIME ANSI   [ ] ANSI inv
     USER CHARACTER.  [ ] User characteristics

7814 O/C DIR.PH           O/C - Directional phase inst/time
     DEFINITE TIME    [ ] Definite time
     INV. TIME IEC    [ ] Inverse time (IEC)
     INV. TIME ANSI   [ ] ANSI inv
     USER CHARACTER.  [ ] User characteristics
     NON-EXIST        [ ] Non-existent

7815 O/C DIR. E           O/C - Directional earth inst/time
     DEFINITE TIME    [ ] Definite time
     INV. TIME IEC    [ ] Inverse time (IEC)
     INV. TIME ANSI   [ ] ANSI inv
     USER CHARACTER.  [ ] User characteristics
     NON-EXIST        [ ] Non-existent
```

```
7816 VOLT. PROT.             Voltage protection
     NON-EXIST           [ ] Non-existent
     EXIST               [ ] Existent

7818 NEQ. SEQ.               Negative sequence protection
     NON-EXIST           [ ] Non-existent
     EXIST               [ ] Existent

7821 START SUPV              Supervision of starting time
     NON-EXIST           [ ] Non-existent
     EXIST               [ ] Existent

7827 THERMAL OL              Thermal overload protection
     NON-EXIST           [ ] Non-existent
     EXIST               [ ] Existent

7828 MOTOR START             Motor start protection
     NON-EXIST           [ ] Non-existent
     EXIST               [ ] Existent

7830 EARTH FAULT             Configuration: earth fault protection
     NON-EXIST           [ ] Non-existent
     DEFINITE TIME       [ ] Definite time
     USER CHARACTER.     [ ] User characteristics

7834 INTERNAL AR             Internal auto-reclose function
     NON-EXIST           [ ] Non-existent
     EXIST               [ ] Existent

7837 TRIP SUPERV             Trip circuit supervision
     NON-EXIST           [ ] Non-existent
     WITH 2 BI           [ ] No resist., 2 BI
     BYPASS RESISTOR     [ ] bypass resistor,1 BI

7838 FAULT LOCAT             Fault locator
     NON-EXIST           [ ] Non-existent
     EXIST               [ ] Existent

7839 BREAK. FAIL             Breaker fail protection
     NON-EXIST           [ ] Non-existent
     EXIST               [ ] Existent

7875 BAY TYPE                Bay type
     CB BAY              [ ] circuit breaker bay
     DISCON. BAY         [ ] disconnector bay
     SECTIONALIZER       [ ] sectionalizer bay
     DOUBLE-BB           [ ] Double-busbar
     NON-EXIST           [ ] Non-existent

7876 CB BAY                  Circuit breaker bay
     CB BAY 1            [ ] without addition
     CB BAY 2            [ ] with busbar earthing
     CB BAY 3            [ ] with busbar VT
     CB BAY 4            [ ] withdrawable 2
     CB BAY 5            [ ] withdr. 2, BB earth.
     CB BAY 6            [ ] withdrawable 1
     CB BAY 7            [ ] withdr. 1, BB earth.
     CB BAY 8            [ ] with disconnector
     CB BAY 9            [ ] with disc.,BB earth.
     CB BAY 10           [ ] feeder and BB earth.
```

```
7877 DIS BAY                    Disconnector bay
     DISCON. BAY 1      [ ] without addition
     DISCON. BAY 2      [ ] with busbar earthing
     DISCON. BAY 3      [ ] with busbar VT

7878 SECT BAY                   Sectionalizer bay
     SECTIONALIZER 1    [ ] sectionalizer bay
     SECTIONALIZER 2    [ ] Typ1, bus riser Typ2
     SECTIONALIZER 3    [ ] Typ2, bus riser Typ2
     SECTIONALIZER 4    [ ] Typ1, bus riser Typ1
     SECTIONALIZER 5    [ ] Typ2, bus riser Typ1
     SECTIONALIZER 6    [ ] busbar sectionalizer
     SECTIONALIZER 7    [ ] T1,BR T2,BB VT eart.
     SECTIONALIZER 8    [ ] T2,BR T2,BB VT eart.

7879 DOUBLE-BB                  Double-busbar
     CB BAY 1           [ ] CB bay 1, double-BB
     CB BAY 2           [ ] CB bay 2, double-BB
     CB BAY 3           [ ] CB bay 3, double-BB
     CB BAY 4           [ ] CB bay 4, double-BB
     CB BAY 5           [ ] CB bay 5, double-BB
     SECTIONALIZER 1    [ ] Sec.1, double-BB

7885 PARAM. C/O                 Parameter change-over
     NON-EXIST          [ ] Non-existent
     EXIST              [ ] Existent

7899 FREQUENCY                  Rated system frequency
     fN 50 Hz           [ ] fN 50 Hz
     fN 60 Hz           [ ] fN 60 Hz
```

```
7900 DEVICE CONFIGURATION

7901 I>>                        With trip by I>> stage phase faults
     START AR           [ ] start of AR
     NO AR              [ ] no start of AR

7902 I>/Ip                      With trip by I> or Ip stage phase faults
     START AR           [ ] start of AR
     NO AR              [ ] no start of AR

7903 I>/Ip DIR.                 With trip by dir. I> or Ip stage phase faults
     START AR           [ ] start of AR
     NO AR              [ ] no start of AR

7904 IE>>                       With trip by IE>> stage earth faults
     START AR           [ ] start of AR
     NO AR              [ ] no start of AR

7905 IE>/IEp                    With trip by IE> or IEp stage earth faults
     START AR           [ ] start of AR
     NO AR              [ ] no start of AR

7906 IE>/IEp DIR                With trip by dir. IE> or IEp stage earth fault
     START AR           [ ] start of AR
     NO AR              [ ] no start of AR

7907 I>> DIR.                   With trip by dir. I>> stage phase faults
     START AR           [ ] start of AR
     NO AR              [ ] no start of AR
```

```
7908 IE>> DIR.              With trip by dir. IE>> stage earth faults
     START AR           [ ] start of AR
     NO AR              [ ] no start of AR

7909 NEG. SEQ.              With trip by negative sequence faults
     START AR           [ ] start of AR
     NO AR              [ ] no start of AR

7910 CB TEST BI             CB test via binary input program
     THREE-POLE TRIP    [ ] Three-pole trip
     TRIP-CLOSE 3POLE   [ ] Trip-close 3pole

7911 VT CONNECT             Voltage transformer connection
     PH-E CALC PH-E     [ ] ph-e, protec. ph-e
     P-E,UE, PROT P-E   [ ] ph-e, UE, prot. ph-e
     P-E,UE, PROT P-P   [ ] ph-e,UE, prot. ph-ph
     PH-E CALC PH-PH    [ ] ph-e, protec. ph-ph
     PH-PH CALC PH-PH   [ ] ph-ph, protec. ph-ph

7930 E FLT DET              Earth fault detection with
     WITH UE OR IEE     [ ] Pick-up UE or IEE
     WITH UE AND IEE    [ ] Pick-up UE and IEE
```

Operational Device Control Facilities 7SJ531

8000 DEVICE CONTROL

8100 SETTING REAL TIME CLOCK

8101 DATE / TIME	Actual date and time
8102 DATE	Setting new date
8103 TIME	Setting new time
8104 DIFF. TIME	Setting difference time

8200 RESET

8201 RESET	Reset of LED memories
8202 RESET	Reset of operational annunciation buffer
8203 RESET	Reset of fault annunciation buffer
8204 Trip No =	Setting new number of CB-closings
8206 RESET	Reset of earth fault report buffer
8207 RESET	Reset of autoreclosing-counters
8208 Set WP pos=	Setting new energy WP positive
8209 Set WQ pos=	Setting new energy WQ positive
8210 Set WP neg=	Setting new energy WP negative
8211 Set WQ neg=	Setting new energy WQ negative
8212 HOUR METER=	Set breaker operation hour meter

8300 SYS-VDEW ANNUNC.-MEAS.VAL

```
8301 SYS TEST               Testing via system-interface
     OFF                [ ] off
     ON                 [ ] on

8302 SYS BLOCK              Blocking of monitoring direction via sys.-int.
     OFF                [ ] off
     ON                 [ ] on
```

```
8500 PARAMETER CHANGE-OVER

8501 ACTIV PARAM          Actual active parameter set

8503 ACTIVATING           Activation of parameter set
     SET A            [ ] Set a
     SET B            [ ] Set b
     SET BY BIN.INPUT [ ] Set via binary input
     SET BY LSA CONTR [ ] Set by lsa control

8510 COPY                 Copy original parameter set to set A

8511 COPY                 Copy original parameter set to set B

8514 COPY                 Copy parameter set A to set B

8517 COPY                 Copy parameter set B to set A
```

```
9800 OPERATING SYSTEM CONTROL

9802 MONITOR              Monitor
```

To

SIEMENS AKTIENGESELLSCHAFT

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Germany

Dear reader,

printing errors can never be entirely eliminated: therefore, should you come across any when reading this manual, kindly enter them in this form together with any comments or suggestions for improvement that you may have.

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Name

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Corrections/Suggestions

Substantial alterations against previous issue:

Complete revision with regard to firmware version V.3

Subject to technical alteration

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