SIEMENS

# Numerical Time Overcurrent Protection
## and Thermal Overload Relay with Auto-Reclosure Option
## SIPROTEC 7SJ600 V3.2

**Instruction Manual** Order No: C53000–G1176–C106–9


Figure 1 Illustration of the numerical time overcurrent protection relay 7SJ600 (in flush mounting case)

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## Indication of Conformity

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

Conformity is proved by tests that had been performed according to article 10 of the Council Directive in accordance with the generic standards EN 50081 – 2 and EN 50082 – 2 (for EMC directive) and the standards EN 60255 – 6 (for low-voltage directive) by Siemens AG.

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

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

Further applicable standards: ANSI/IEEE C37.90, C37.90.1, and C37.90.2.

The following models of this product are UL-certified with the values specified in the technical data:

c UL US LISTED

IND. CONT. EQ.
TYPE 1
69CA

UL-Listed:

7SJ600* – *B*** – ***1
7SJ600* – *E*** – ***1

# Matching the rated frequency

When the relay is delivered from factory, it is preset to operate with a rated frequency of 50 Hz. If the rated system frequency is 60 Hz, this must be matched accordingly. Switch-over to 60 Hz is explained in detail in the operation instructions in Section 6.3.3, first item. In the following, switch-over to 60 Hz is described in an abbreviated form.

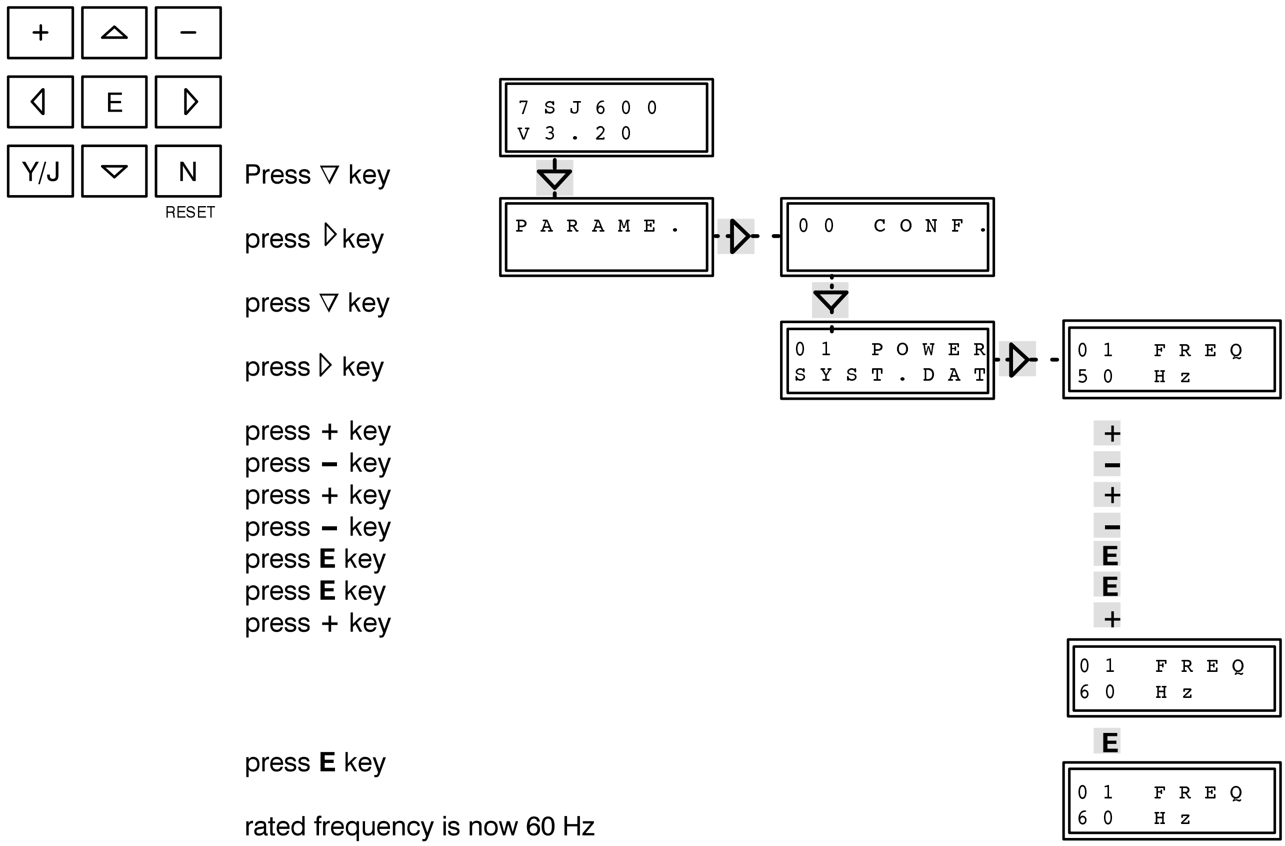
The operating interface is built up by a hierarchically structured menu tree, which can be passed through by means of the scrolling keys ◁ , ▷ , △ , and ▽. Thus, each operation object can be reached as illustrated in the example below for change-over of the rated frequency.

After the relay has been switched on, the green LED ("Service") illuminates and the red LED ("Blocked") lights up until the processor system has started up. The display shows the type identification of the relay ("7SJ600") and the version of the implemented firmware ("V3.20*").

Pressing the key ▽ leads to the main menu item "PARAME." (parameters). Switch over to the second operation level with key ▷. The first address block is "00 CONF." (configuration). Key ▽ leads to the second address block "01 POWER SYST.DAT" (power system data). On the third operation level, which is obtained with ▷ , the first item is "01 FREQ" (frequency).

Press the following keys in sequence: ⊞ ⊟ ⊞ ⊟ **E** **E** ⊞. The display shows the new rated frequency 60 Hz. Confirm again with **E**. ⊞

Press twice the key ◁ to return to the first operation level.



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*NOTE:*

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

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

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

# 1 Introduction

## 1.1 Application

The relay SIPROTEC 7SJ600 is used as definite time overcurrent protection or inverse time overcurrent protection for overhead lines, cables, transformers, and motors in high voltage distribution systems with infeed from one single end or radial feeders or open ring feeders. It is also used as back-up protection for comparison protection such as line, transformer, generator, motor, and busbar protection. The treatment of the system star point is of no concern.

Besides the time overcurrent protection, 7SJ600 includes a thermal overload protection and an unbalanced load protection as well as a start-up time monitor for motors. Thus, for example, cables can be protected against overloading and motors can be protected against overloading, excessive start-up time and negative sequence currents.

For use on overhead lines, a model with integrated auto-reclosure function is available which allows up to nine auto-reclosure attempts.

Throughout a fault in the network the magnitudes of the instantaneous values are stored for a period of max. 5 seconds and are available for subsequent fault analysis. In order to achieve this, the relay is equipped with a serial RS485 interface. Thus, comfortable and clear evaluation of the fault history including fault recording is possible as well as comfortable operation of the relay, by means of a personal computer with appropriate programs. This interface is suited to communication via a modem link.

Continuous monitoring of the hardware and software of the relay permits rapid annunciation of internal faults. This ensures the high reliability and availability of the device.

## 1.2 Features

– Processor system with powerful 16-bit-microcontroller;

– 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 analog input transducers, binary input and output modules, and d.c./d.c. converter;

– phase segregated overcurrent detection; the residual (earth) current $I_E$ is calculated from the three phase currents; alternatively, the residual current can be fed directly to the relay terminals, instead of the phase current $I_{L2}$; in this case the relay calculates the phase current $I_{L2}$. Thus the relay is able to evaluate all four currents (three phase currents and the residual current);

– insensitive against d.c. components, inrush or charging currents and high frequency transients in the measured currents;

– selectable tripping time characteristics: either definite time lag or inverse time lag with a large number of characteristics according to IEC or ANSI/IEEE;

– each characteristic with an independent instantaneous or definite time lag I>> stage; additional instantaneous very high current stage I>>> for phase currents;

– dynamic switch-over of sets of current thresholds even during fault, via binary inputs;

– thermal overload protection, optionally without or with total memory (thermal replica of the current heat losses);

– start-up time monitor for use on motors (locked rotor monitor);

– unbalanced load protection for detection of phase failure, wrong phase rotation, and impermissible unsymmetrical load;

– three-pole auto-reclosure function, single- or multi-shot (up to nine auto-reclosure attempts), with separately allocated timers for the first four shots;

– circuit breaker operation test facility by test trip-close cycle (models with auto-reclosure) or test trip of the breaker;

– optional circuit breaker control;

– trip circuit supervision for the tripping coil including the circuitry;

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

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

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

## 1.3 Application examples

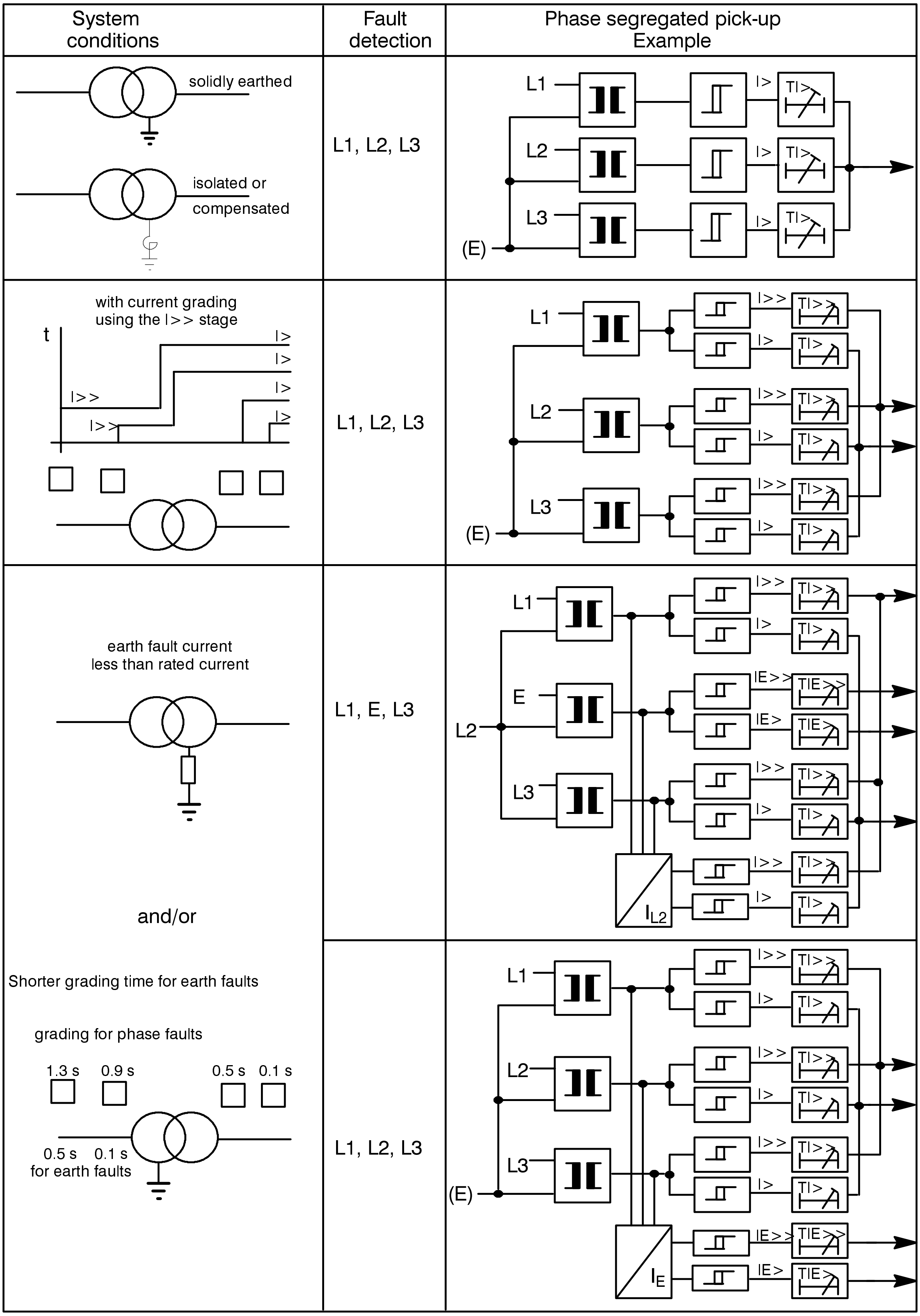



Figure 1.1 Application examples for definite time overcurrent protection

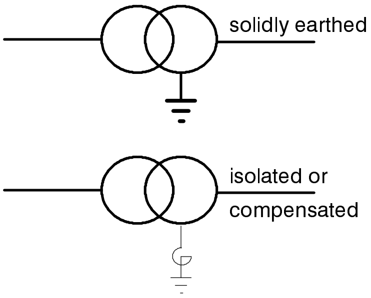
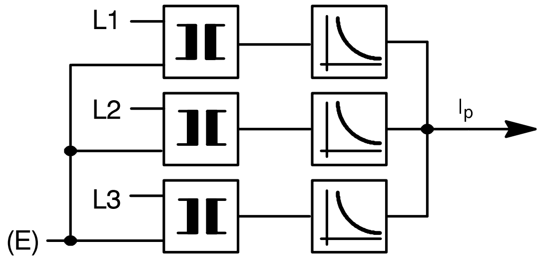
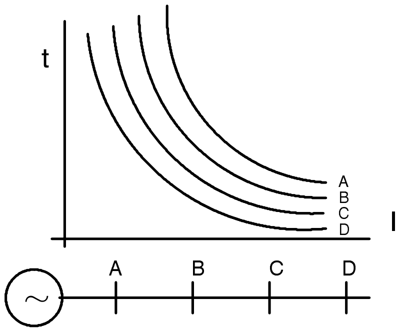
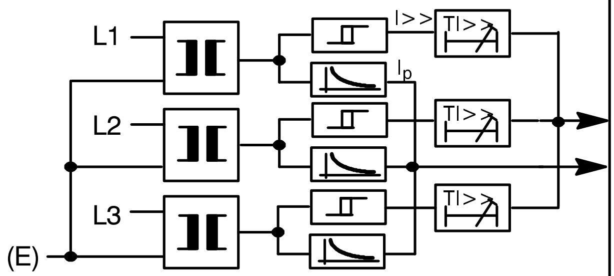
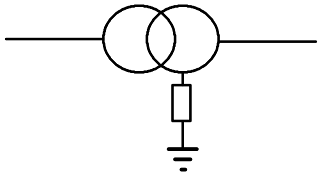
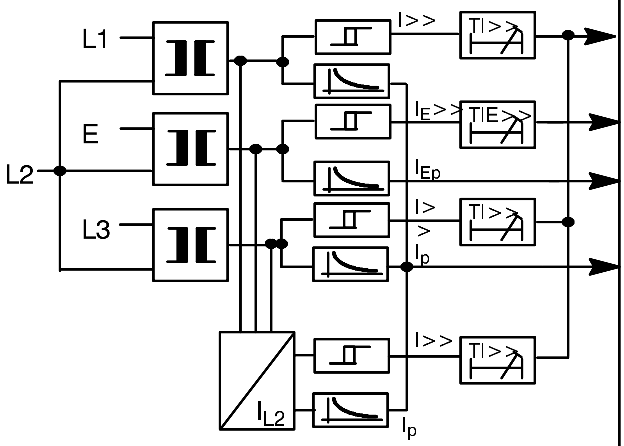
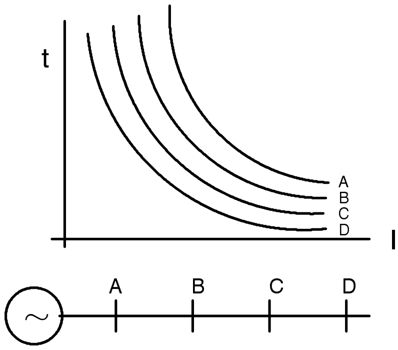
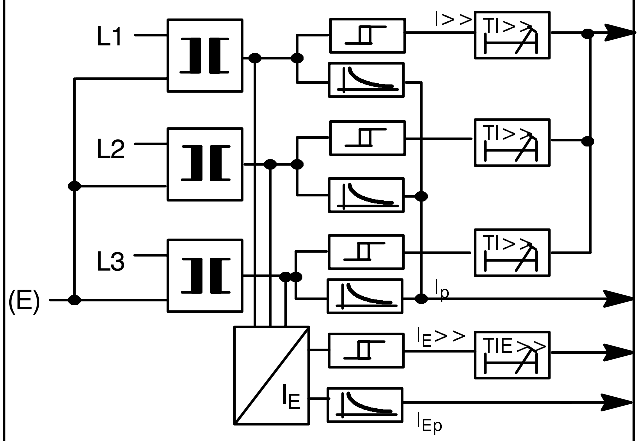
| System Conditions | Fault detection | Phase segregated pick-up Example |
| --- | --- | --- |
|   | L1, L2, L3 |   |
|   | L1, L2, L3 |   |
| earth fault current less than rated current  Shorter grading time for earth faults | L1, E, L3 |   |
|   | L1, L2, L3 |   |

Figure 1.2 Application examples for inverse time overcurrent protection

# 2 Design

## 2.1 Arrangements

All protection functions including dc/dc converter are accommodated on a printed circuit board of Double Europa Format. This p.c.b. forms, complemented by a guide plate, a multi-pin connector module and a front unit, a plug-in module which is installed in a housing 7XP20.

The guide plate cams in conjunction with distance pieces on the p.c.b. and the shaping of the connector modules ensure proper mounting and fixing of the module. The inner part of the housing is free from enamel and thus functions as a large contact plane and shield with solid electrical conductivity and mates with the earthing blades of the module. Connection to earth is made before the plugs make contact. An earthing area has been provided at the housing to which grounding strips can be connected in order to ensure solid low-impedance earthing.

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 degree of protection for the housing is IP51, for the terminals IP21.

Three different types of housings can be delivered:

– **7SJ600⋆–⋆B⋆⋆⋆–** in housing 7XP20 with terminals at both sides for **panel surface mounting**

  The housing is built of a metal tube and carries a terminal block with four holes for fixing the relay to the panel.

  All external signals are connected to the terminal block which is mounted without screws at the rear of the housing. For each electrical connection, one screwed terminal for the use of up to two ring cable lugs is provided. Alternatively, up to two solid bare wires (even with different diameter) can be connected directly. Use copper conductors only!

  For dimensions please refer to Figure 2.1.

– **7SJ600⋆--⋆D⋆⋆⋆–** in housing 7XP20 with terminal top and bottom for **panel surface mounting**

  The housing is built of a metal tube and carries fixing angles for mounting on the panel.

  All external signals are connected to 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. Use copper conductors only!

  For dimensions please refer to Figure 2.2.

– **7SJ600⋆--⋆E⋆⋆⋆–** in housing 7XP20 for **panel flush mounting** or **cubicle installation**

  The housing is built of a metal tube and carries fixing angles for mounting into the panel cut-out or into the cubicle rack.

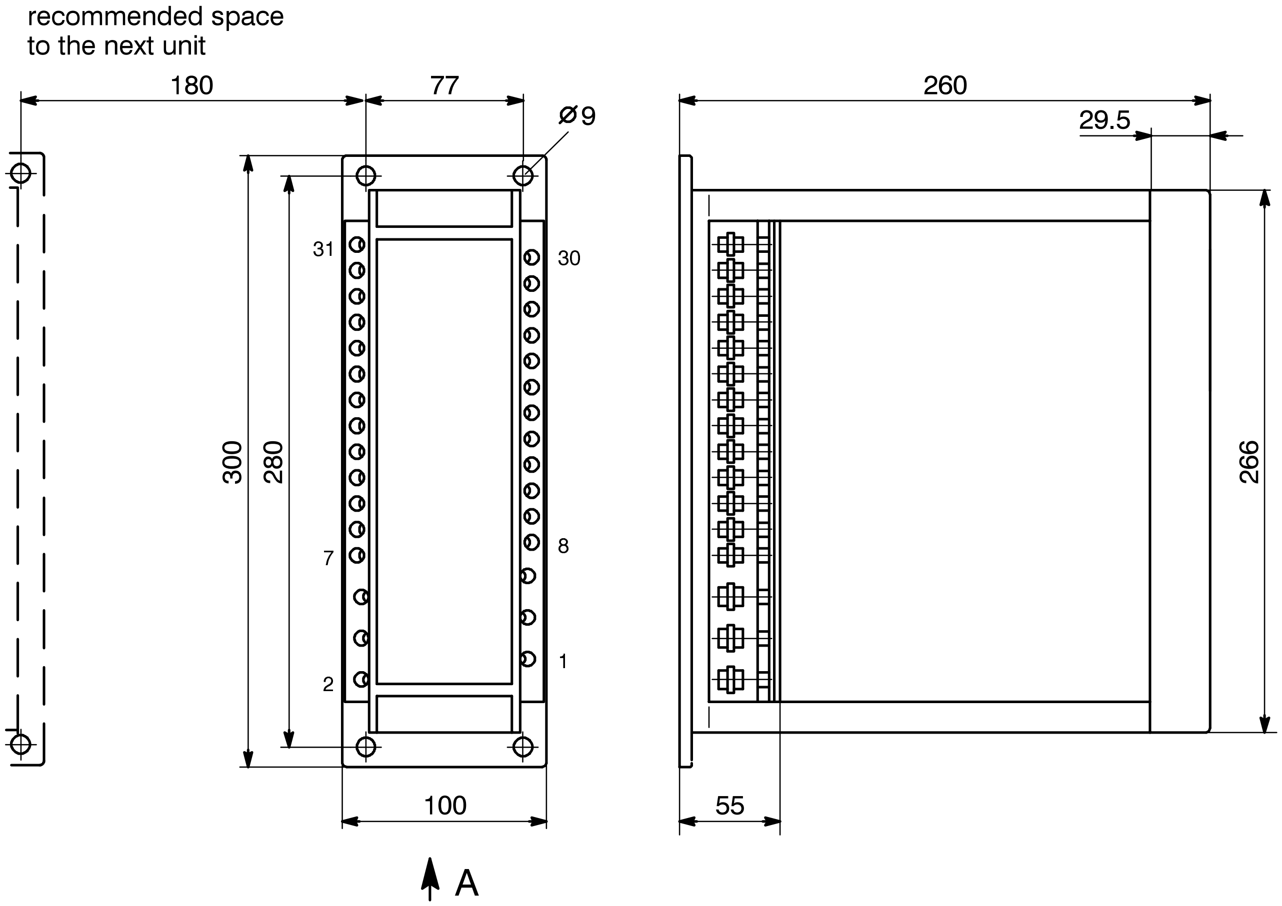
  All external signals are connected to a connector block which is mounted without screws at the rear of the housing. For each electrical connection, one screwed terminal for the use of up to two ring cable lugs and one parallel snap-in terminal are provided. For field wiring, the use of the screwed terminals is recommended; snap-in connection requires special tools. Use copper conductors only!

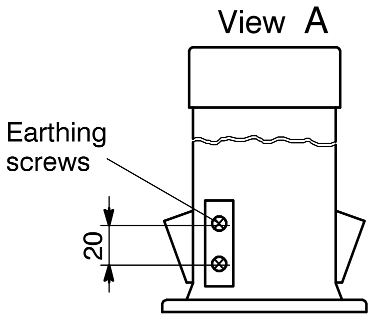
  For dimensions please refer to Figure 2.3.

## 2.2 Dimensions

Figures 2.1 to 2.3 show the dimensions of the various types of housings available.

**7SJ600★–★B★★★** Housing for **panel surface mounting** 7XP20 with terminals at both sides




Dimensions in mm

**Heavy current connectors (terminals 1 to 6):**

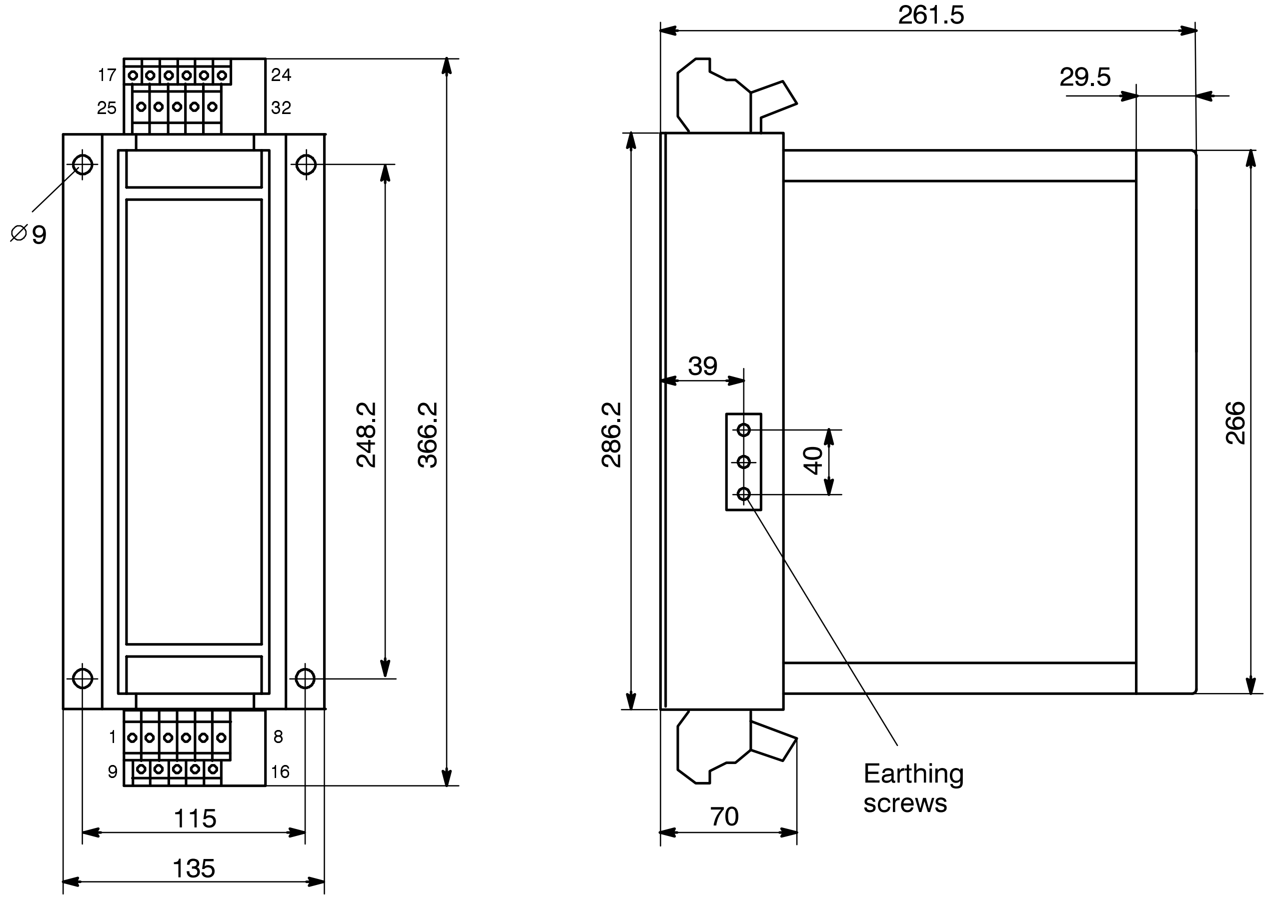
| | |
|---|---|
| isolated ring cable lug: | for bolts 6 mm diameter<br>max. major diameter 13 mm<br>type: e.g. PIDG of Messrs AMP<br>for copper wires with cross–section<br>2.7 mm$^2$ to 6.6 mm$^2$<br>AWG 12 to 10 |
| solid bare copper wire directly: | cross–section 2.5 mm$^2$ to 4.0 mm$^2$<br>AWG 13 to 11<br>flexible wire requires end sleeves |
| max. torque value | 3.5 Nm or 34 in-lbs |

**Voltage connectors (terminals 7 to 31):**

| | |
|---|---|
| isolated ring cable lug: | for bolts 4 mm diameter<br>max. major diameter 9 mm<br>type: e.g. PIDG of Messrs AMP<br>for copper wires with cross–section<br>1.0 mm$^2$ to 2.6 mm$^2$<br>AWG 17 to 13 |
| solid bare copper wire directly: | cross–section 0.5 mm$^2$ to 2.6 mm$^2$<br>AWG 20 to 13<br>flexible wire requires end sleeves |
| max. torque value | 1.8 Nm or 16 in-lbs |

Figure 2.1 Dimensions for housing 7XP20 for panel surface mounting with terminals at both sides

**7SJ600★−★D★★★** in housing for **panel surface mounting** 7XP20 with terminals top and bottom



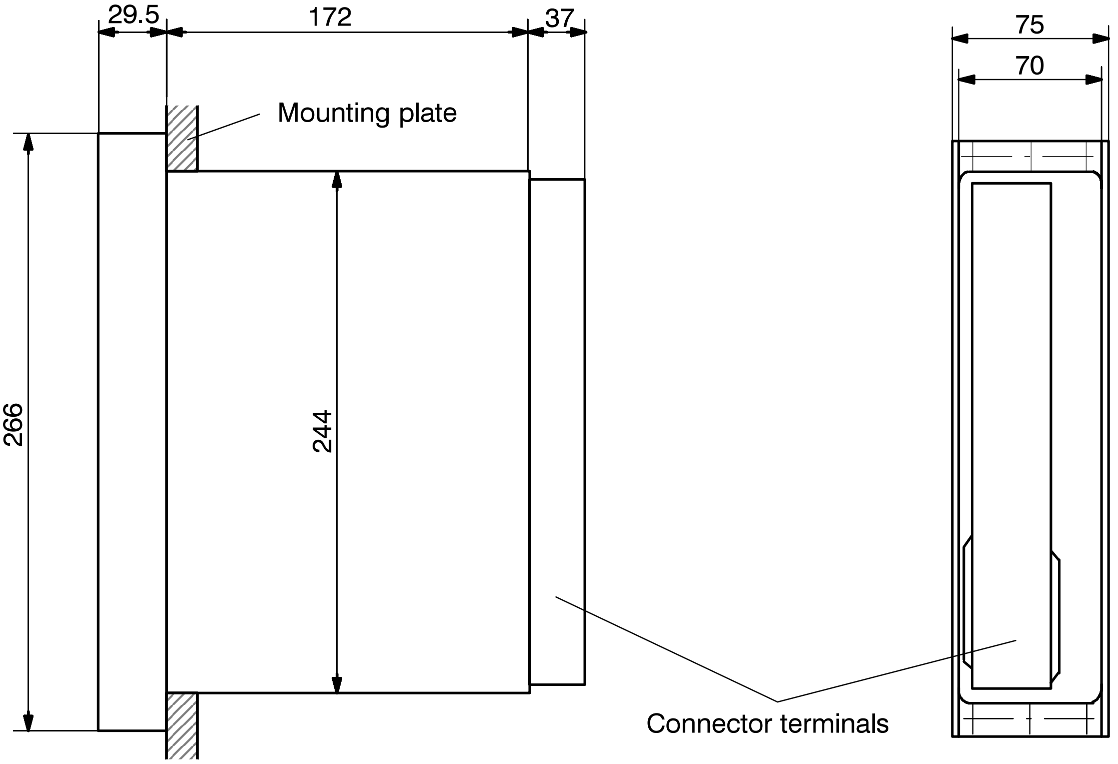

Max. 32 terminals for copper wires with cross-section max. 5 $mm^2$ or AWG 10
Max. torque value 1.7 Nm or 15 in-lbs

Installation on the panel shall be carried out with studs or screws size M6.
If the relay is to be mounted on (e.g. existing) bolts size M8, then slot nuts acc. DIN 546 shall be used.

Dimensions in mm

Figure 2.2 Dimensions for housing 7XP20 for panel surface mounting with terminals top and bottom

**7SJ600★–★E★★★** Housing for **panel flush mounting** or **cubicle installation** 7XP20

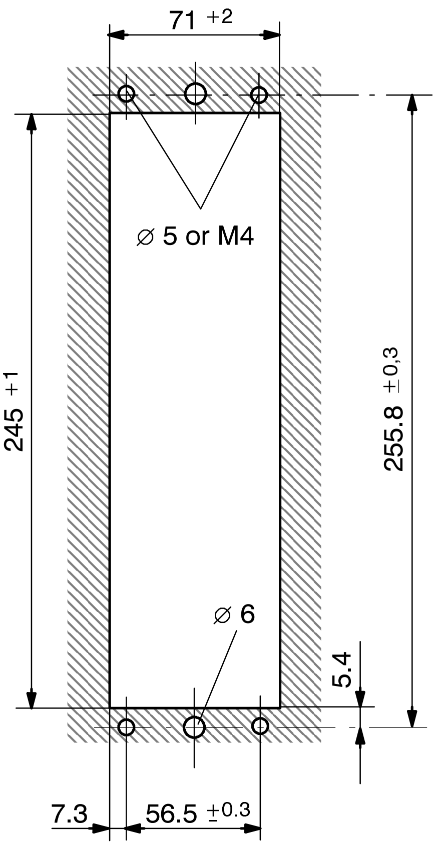



**Heavy current connectors (terminals 1 to 6):**

| | |
|---|---|
| Screwed terminal (ring cable lug): | for bolts 6 mm diameter<br>max. major diameter 13 mm<br>type: e.g. PIDG of Messrs AMP<br>for copper wires with cross–section<br>2.7 mm² to 6.6 mm²<br>AWG 12 to 10 |
| Snap-in terminal: | for copper wires with cross–section<br>2.5 mm² to 4.0 mm²<br>AWG 13 to 11 |
| max. torque value | 3.5 Nm or 34 in-lbs |

**Voltage connectors (terminals 7 to 31):**

| | |
|---|---|
| isolated ring cable lug: | for bolts 4 mm diameter<br>max. major diameter 9 mm<br>type: e.g. PIDG of Messrs AMP<br>for copper wires with cross–section<br>1.0 mm² to 2.6 mm²<br>AWG 17 to 13 |
| Snap-in terminal: | for copper wires with cross–section<br>0.5 mm² to 2.5 mm²<br>AWG 20 to 13 |
| max. torque value | 1.8 Nm or 16 in-lbs |




Panel cut-out

Dimensions in mm

Figure 2.3 Dimensions for housing 7XP20 for panel flush mounting or cubicle installation

## 2.3 Ordering data

**Numerical Time Overcurrent and Overload Protection** **7 S J 6 0 0** ☐ – ☐ ☐ A ☐ 0 – ☐ D ☐ ☐

| 7. | | 8. | 9. | 10. | 11. | 12. | | 13. | 14. | 15. | 16. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ☐ | – | ☐ | ☐ | A | ☐ | 0 | – | ☐ | D | ☐ | ☐ |

**Rated current; rated frequency** (7th digit)

1 A; 50/60 Hz . . . . . . . . 1

5 A; 50/60 Hz . . . . . . . . 5

**Auxiliary voltage** (8th digit)

24/48 V dc . . . . . . . . 2

60/110/125 V dc . . . . . . . . 4

220/250 V dc / 115 V ac, 50/60 Hz . . . . . . . . 5

230 V ac, 50/60 Hz [1]) . . . . . . . . 6

**Construction** (9th digit)

in housing for panel surface mounting with terminals at both sides . . . . . . . . B

in housing for panel surface mounting with terminals top and bottom [1]) . . . . . . . . D

in housing for panel flush mounting/cubicle installation . . . . . . . . E

**Presetting of language and specific characteristics** (11th digit)

preset operation texts: English . . . . . . . . 0

**Options** (13th digit)

without auto-reclosure . . . . . . . . 0

with auto-reclosure . . . . . . . . 1

**Breaker control (without feedback)** (15th digit)

without breaker control . . . . . . . . A

with breaker control . . . . . . . . B

**UL-listing** (16th digit)

without UL-listing . . . . . . . . 0

with UL-listing [2]) . . . . . . . . 1

[1]) not possible in conjunction with 16th digit = "1"

[2]) not possible in conjunction with 8th digit = "6" or 9th digit = "D"

## 2.4 Accessories

A connecting cable of 1 m length is attached to the converter V.24-to-RS485. This is used to connect the terminals of the relay with the 25-pole socket at the converter which is designated with “RS485”.

The copper connecting cable 7XV5100 is to connect the 25-pole connector at the converter which is designated with “RS232”, with the personal computer or laptop.

A copper connecting cable, a converter V.24-to-RS485, and an operating program DIGSI are necessary for communication between the protection relay and a personal computer or laptop.

A fibre-optic converter is necessary when the relay is to be connected via an optical fibre cable to a central station.

<u>Copper connecting cable</u>
between PC (9pin socket) and converter/protective device **7XV5100 – 2**

<u>Converter V.24 – RS485</u>
with connecting cable 1 m, PC adapter with connector
for power supply 230 Vac, 50 Hz **7XV5700 – 0AA00**
for power supply 110 Vac, 60 Hz **7XV5700 – 1AA00**

<u>Converter full-duplex fibre-optic cable – RS485</u>
with connecting cable 1 m, with aux. supply 24 – 250 Vdc and 110/230 Vac . . . . . **7XV5600 – 0AA00**

<u>Operating software DIGSI:</u>

**Operating software DIGSI 4**:
The 7SJ600 protection relay is operated by 7SJ600 DIGSI 3, which is integrated into DIGSI 4.

<u>Basic</u>
Full version with license for 10 computers, on DIGSI 4 CD-ROM
(authorization with license number)
Additional: DIGSI 3 CD-ROM **7XS5400 – 0AA00**

<u>Professional</u>
Complete version: Basic and all optional packages, full version
with license for 10 computers on DIGSI 4 CD-ROM
Additional: DIGSI 3 CD-ROM **7XS5402 -- 0AA00**

<u>Basic Upgrade 3 → 4</u>
(Basic, SIGRA, Graphic Tools)
Full version with license for 10 computers on DIGSI 4 CD-ROM
(authorization with license number, service agreement
for version 3 expires automatically)
Additional: DIGSI 3 CD-ROM **7XS5405 – 0AA00**

<u>Professional Upgrade 3 → 4</u>
Complete version: Basic and all optional packages,
full version with license for 10 computers on DIGSI 4 CD-ROM
(authorization with license number, service agreement
for version 3 expires automatically)
Additional:: DIGSI 3 CD-ROM **7XS5406 – 0AA00**

<u>Graphic evaluation program SIGRA</u>
for visualization of fault recordings;
requirements: NT4/95/98/2000/ME XP Prof. Ed. and DIGSI . . . . . . . . . . . . . . . . . . . . **7XS5410 -- 0AA00**

# 3 Technical data

## 3.1 General data

### 3.1.1 Inputs/outputs

**Measuring circuits**

| | | |
|---|---|---|
| Rated current $I_N$ | | 1 A or 5 A |
| Rated frequency $f_N$ | | 50 Hz/60 Hz (selectable) |
| Power consumption | current path at $I_N$ = 1 A<br>current path at $I_N$ = 5 A | <0.1 VA<br><0.2 VA |
| Overload capability<br>– thermal (rms) | current path | <br>100 $\times I_N$ for $\leq$1 s<br>30 $\times I_N$ for $\leq$10 s<br>4 $\times I_N$ continuous |
| – dynamic (pulse current) | | 250 $\times I_N$ one half cycle |

**Auxiliary voltage**

Power supply via integrated dc/dc converter

| Rated auxiliary voltage $U_H$ dc | 24/48 Vdc | 60/110/125 Vdc | 220/250 Vdc |
|---|---|---|---|
| Permissible variations | 19 to 58 Vdc | 48 to 150 Vdc | 176 to 300 Vdc |

| | | |
|---|---|---|
| Superimposed ac voltage,<br>peak-to-peak | | $\leq$ 12 % at rated voltage<br>$\leq$ 6 % at limits of admissible voltage |
| Power consumption | quiescent<br>energized | approx. 2 W<br>approx. 4 W |
| Bridging time during failure/short-circuit<br>of auxiliary voltage | | $\geq$ 50 ms at $U_{rated} \geq$ 110 Vdc<br>$\geq$ 20 ms at $U_{rated} \geq$ 24 Vdc |

| Rated auxiliary voltage $U_H$ ac | 115 Vac, 50/60 Hz | 230 Vac, 50/60 Hz |
|---|---|---|
| Permissible variations | 88 to 133 Vac | 176 to 265 Vac |

| | | |
|---|---|---|
| Power consumption | quiescent | approx. 2 Va to 4 VA |
| Bridging time during failure/short-circuit<br>of auxiliary voltage | | $\geq$ 50 ms |

**Heavy duty (command) contacts**

| | | |
|---|---|---|
| Command (trip) relays, number<br>Contacts per relays | | 2 (can be marshalled)<br>2 NO |
| Switching capacity | MAKE<br>BREAK | 1000 W/VA<br>30 W/VA |
| Switching voltage | | 250 V |
| Permissible current | | 5 A continuous<br>30 A for 0.5 s |

| **Signal contacts** | | |
|---|---|---|
| Signal/alarm relays | | 2 (can be marshalled) |
| Contact per relays | | 1 CO |
| Switching capacity | MAKE | 1000 W/VA |
| | BREAK | 30 W/VA |
| Switching voltage | | 250 V |
| Permissible current | | 5 A |

| **Binary inputs,** number | | 3 (can be marshalled) |
|---|---|---|
| Rated operating voltage | | 24 to 250 Vdc |
| Current consumption | | approx. 2.5 mA, independent of operating voltage |
| Pick-up threshold | | reconnectable by solder bridges |
| – rated aux. voltage 24/48/60 Vdc | $U_{pick\text{-}up}$ | $\geq$17 Vdc |
| | $U_{drop\text{-}off}$ | < 8 Vdc |
| – rated aux. voltage 110/125/220/250 Vdc | $U_{pick\text{-}up}$ | $\geq$ 74 Vdc |
| | $U_{drop\text{-}off}$ | < 45 Vdc |
| Max permissible control voltage | | 300 Vdc |

| **Serial interface** | isolated |
|---|---|
| – Standard | RS485 |
| – Test voltage | 2.8 kV d.c. |
| – Connection | data cable at housing terminals, two data wires, one frame reference, for connection of a personal computer or similar; core pairs with screening, screen must be earthed; communication possible via modem |
| – Transmission speed | as delivered 9600 Baud<br>min. 1200 Baud; max. 19200 Baud |

## 3.1.2 Electrical tests

| **Insulation tests** | |
|---|---|
| Standards: | IEC 60255–5; ANSI/IEEE C37.90.0 |
| – High voltage test (routine test)<br>except d.c. voltage supply input and RS485 | 2.5 kV (rms); 50 Hz |
| – High voltage test (routine test)<br>only d.c. voltage supply input and RS485 | 3.5 kV dc |
| – High voltage test (type test) | |
| across open contacts of trip relays | 1.5 kV (rms), 50 Hz |
| across open contacts of alarm relays | 1 kV (rms), 50 Hz |
| – Impulse voltage test (type test)<br>all circuits, class III | 5 kV (peak); 1.2/50 µs; 0.5 J; 3 positive and 3 negative shots at intervals of 5 s |

**EMC tests; immunity** (type tests)

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

**Further EMC tests; immunity** (type tests)

| | |
|---|---|
| – Oscillatory surge withstand capability<br>ANSI/IEEE C37.90.1<br>(common mode) | 2.5 kV to 3 kV (peak); 1 MHz to 1.5 MHz,<br>decaying oscillation; 50 shots per s; duration 2 s;<br>$R_i$ = 150 Ω to 200 Ω |
| – Fast transient surge withstand capability<br>ANSI/IEEE C37.90.1<br>(common mode) | 4 kV to 5 kV; 10/150 ns; 50 shots per s;<br>both polarities; duration 2 s; $R_i$ = 80 Ω |
| – Radiated electromagnetic interference<br>ANSI/IEEE C37.90.2 | 10 V/m to 20 V/m; 25 MHz to 1000 MHz;<br>amplitude and pulse modulated |
| – High frequency test<br>document 17C (SEC) 102 | 2.5 kV (peak, alternating polarity);<br>100 kHz, 1 MHz, 10 MHz and 50 MHz,<br>decaying oscillation; $R_i$ = 50 Ω |

**EMC tests; emission** (type tests)

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

### 3.1.3 Mechanical stress tests

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

## 3.1.4 Climatic stress tests

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

Storage and transport with standard works packaging!

| | |
|---|---|
| – Permissible humidity | mean value per year ≤ 75 % relative humidity;<br>on 30 days per year 95 % relative humidity;<br>condensation not permissible! |

All units shall be installed such that they are not subjected to direct sunlight, nor to large temperature fluctuations which may give rise to condensation.

## 3.1.5 Service conditions

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

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

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

– The screen of the RS485 cable must be earthed.

– 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. 4.5 kg |
| – in housing for flush mounting | approx. 4.0 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) | $I/I_N$ | 0.1 to 25.0 | (steps 0.1); or ∞ |
| Overcurrent pick-up $I_E$> (earth) | $I/I_N$ | 0.05 to 25.00 | (steps 0.01); or ∞ |
| Overcurrent pick-up I>> (phases) | $I/I_N$ | 0.1 to 25.0 | (steps 0.1); or ∞ |
| Overcurrent pick-up $I_E$>> (earth) | $I/I_N$ | 0.05 to 25.00 | (steps 0.01); or ∞ |
| Overcurrent pick-up I>>> (phases) | $I/I_N$ | 0.3 to 12.5 | (steps 0.1); or ∞ |
| Delay times T | for I>, $I_E$>, I>> and $I_E$>> | 0.00 s to 60.00 s | (steps 0.01 s) |

The set times are pure delay times.

**Pick-up times**

I>, I>>, $I_E$>, $I_E$>>

| | |
|---|---|
| – at 2 x setting value, without meas. repetition | approx. 35 ms |
| – at 2 x setting value, with meas. repetition | approx. 50 ms |
| Pick-up times for I>>> at 2 x setting value | approx. 20 ms |

**Reset times**

| | |
|---|---|
| I>, I>>, $I_E$>, $I_E$>> | approx. 35 ms |
| I>>> | approx. 65 ms |
| **Reset values** | approx. 0.95 of the stage with the smallest setting value |
| **Overshot time** | approx. 25 ms |

**Tolerances**

| | |
|---|---|
| – Pick-up values I>, I>>, $I_E$>, $I_E$>> | 5 % of setting value |
| – Delay times T | 1 % of setting value or 10 ms |

**Influence variables**

| | |
|---|---|
| – Auxiliary voltage in range $0.8 \leq U_H/U_{HN} \leq 1.2$ | $\leq$ 1 % |
| – Temperature in range $0\ °C \leq \vartheta_{amb} \leq 40\ °C$ | $\leq$ 0.5 %/10 K |
| – Frequency in range $0.98 \leq f/f_N \leq 1.02$ | $\leq$ 1.5 % |
| – Frequency in range $0.95 \leq f/f_N \leq 1.05$ | $\leq$ 2.5 % |
| – Harmonics | |
| up to 10 % of 3rd harmonic | $\leq$ 1 % |
| up to 10 % of 5th harmonic | $\leq$ 1 % |

## 3.3 Inverse time overcurrent protection

**Setting range**/steps

| | | | |
|---|---|---|---|
| Overcurrent pick-up $I_p$> (phases) | $I/I_N$ | 0.1 to 4.0 | (steps 0.1) |
| Overcurrent pick-up $I_{Ep}$> (earth) | $I/I_N$ | 0.05 to 4.00 | (steps 0.01) |
| Time multiplier for $I_p$, $I_{Ep}$ | $T_p$ (IEC charac.) | 0.05 to 3.20 s | (steps 0.01 s) |
| | D (ANSI charac.) | 0.5 to 15.0 s | (steps 0.1 s) |
| Overcurrent pick-up I>> (phases) | $I/I_N$ | 0.1 to 25.0 | (steps 0.1); or ∞ |
| Overcurrent pick-up I>>> (phases) | $I/I_N$ | 0.3 to 12.5 | (steps 0.1); or ∞ |
| Overcurrent pick-up $I_E$>> (earth) | $I/I_N$ | 0.05 to 25.00 | (steps 0.01); or ∞ |
| Delay time for I>>, $I_E$>> | T (definite time) | 0.00 s to 60.00 s | (steps 0.01 s) |

**Trip time characteristics acc. IEC** — acc. IEC 60255−3 and BS 142 (refer to Figures 3.1 and 3.2)

Normal inverse ("inverse") (IEC 60255−3 type A)

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

Very inverse ("short in") (IEC 60255−3 type B)

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

Extremely inverse ("extr.inv") (IEC 60255−3 type C)

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

Long time inverse ("long inv") (IEC 60255−3 type B)

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

where:
- t tripping time
- $T_p$ set time multiplier
- I fault current
- $I_p$ set pick-up value

in the range $1.1 \leq I/I_p \leq 20$;
tripping times do not decrease above $I/I_p > 20$

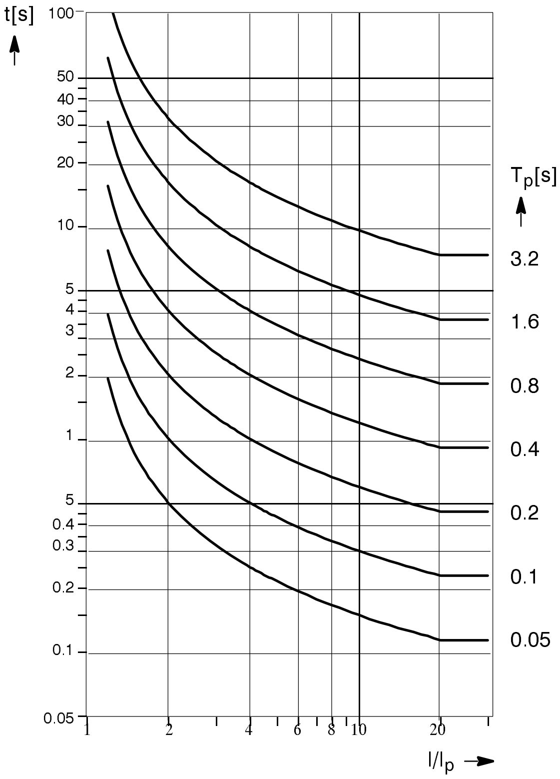
| | |
|---|---|
| Pick-up threshold of inverse time stages | approx. $1.1 \cdot I_p$ |
| Drop-off threshold of inverse time stages | approx. 1.03 x $I_p$ |
| Drop-off time | approx. 35 ms |

**Tolerances**

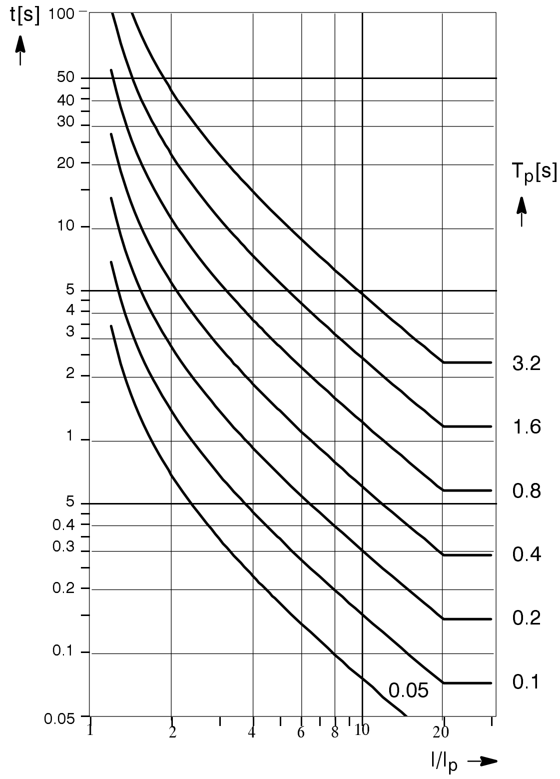
| | |
|---|---|
| − Pick-up values | 5 % |
| − Delay time for $2 \leq I/I_p \leq 20$ and $0.5 \leq I/I_N \leq 24$ | 5 % of theoretical value ± 2 % current tolerance; at least 30 ms |

**Influence variables**

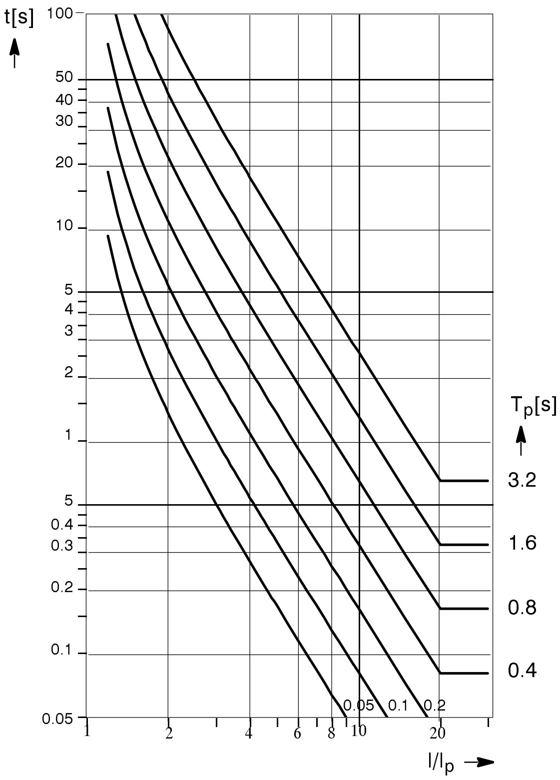
| | |
|---|---|
| − Auxiliary voltage in range $0.8 \leq U_H/U_{HN} \leq 1.2$ | ≤ 1 % |
| − Temperature in range $-5\ °C \leq \vartheta_{amb} \leq 40\ °C$ | ≤ 0.5 %/10 K |
| − Frequency in range $0.95 \leq f/f_N \leq 1.05$ | ≤ 8 % referred to theoretical time value |




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




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

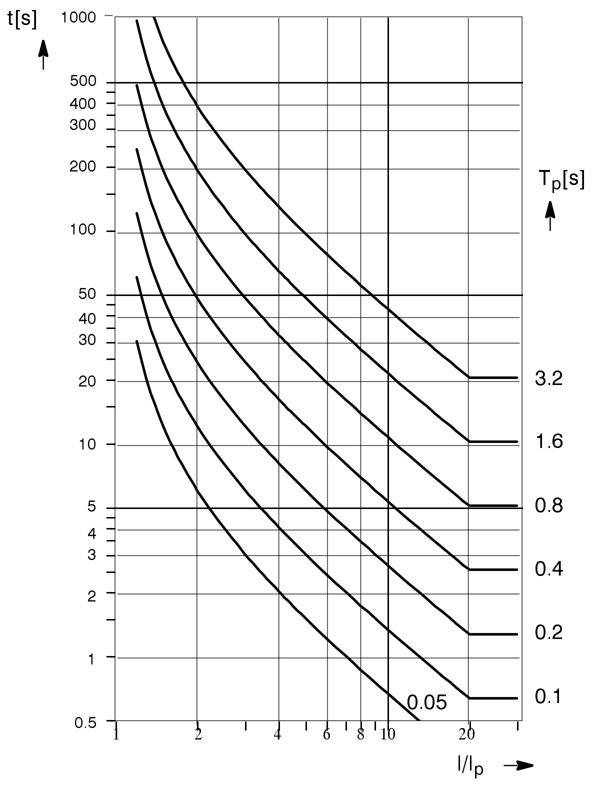



Extremely inverse: $t = \frac{80}{(I/I_p)^2 - 1} \cdot T_p$ [s]

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

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

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




Long time inverse $t = \frac{120}{(I/I_p)^1 - 1} \cdot T_p$ [s]

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

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

Figure 3.2 Trip time characteristic of inverse time overcurrent protection, according IEC

*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** (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 in”) | $t = \left( \frac{0.2663}{(I/I_p)^{1.2969} - 1} + 0.03393 \right) \cdot D$ |
| Long inverse (“long inv”) | $t = \left( \frac{5.6143}{(I/I_p) - 1} + 2.18592 \right) \cdot D$ |
| Moderately inverse (“mode inv”) | $t = \left( \frac{0.0103}{(I/I_p)^{0.02} - 1} + 0.0228 \right) \cdot D$ |
| Very inverse (“very inv”) | $t = \left( \frac{3.922}{(I/I_p)^{2} - 1} + 0.0982 \right) \cdot D$ |
| Extremely inverse (“extr inv”) | $t = \left( \frac{5.64}{(I/I_p)^{2} - 1} + 0.02434 \right) \cdot D$ |
| definite inverse (“def inv”) | $t = \left( \frac{0.4797}{(I/I_p)^{1.5625} - 1} + 0.21359 \right) \cdot D$ |
| I−squared−t (“IsquaredT”) | $t = \frac{50.7 \cdot D + 10.14}{(I/I_p)^2}$ |

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

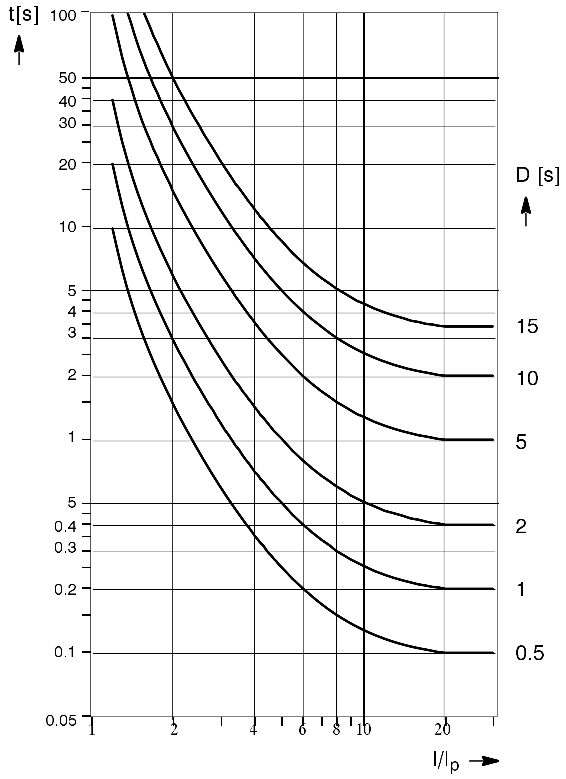
| | |
|---|---|
| **Pick-up threshold** | approx. $1.06 \cdot I_p$ |
| **Drop-off threshold** | approx. $1.01 \cdot I_p$ |

**Tolerances**

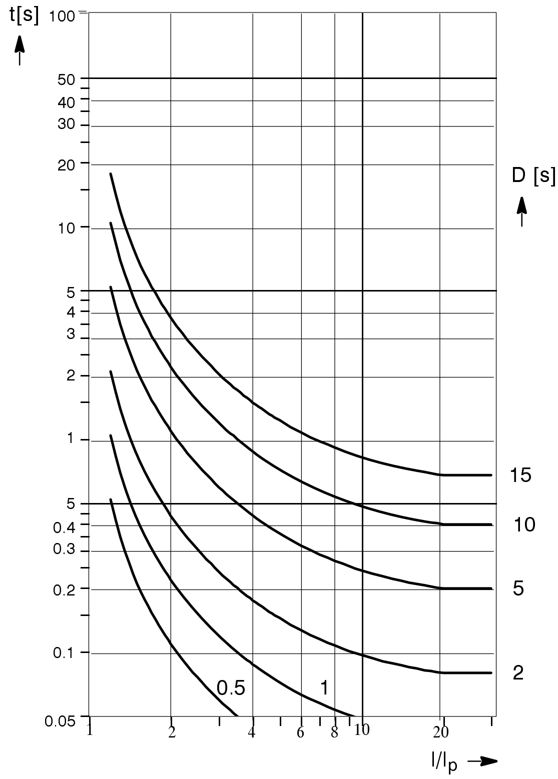
| | |
|---|---|
| – Pick-up values | 5 % |
| – Delay time for $2 \leq I/I_p \leq 20$ and $0.5 \leq I/I_N \leq 24$ | 5 % of theoretical value ± 2 % current tolerance; at least 30 ms |

**Influence variables**

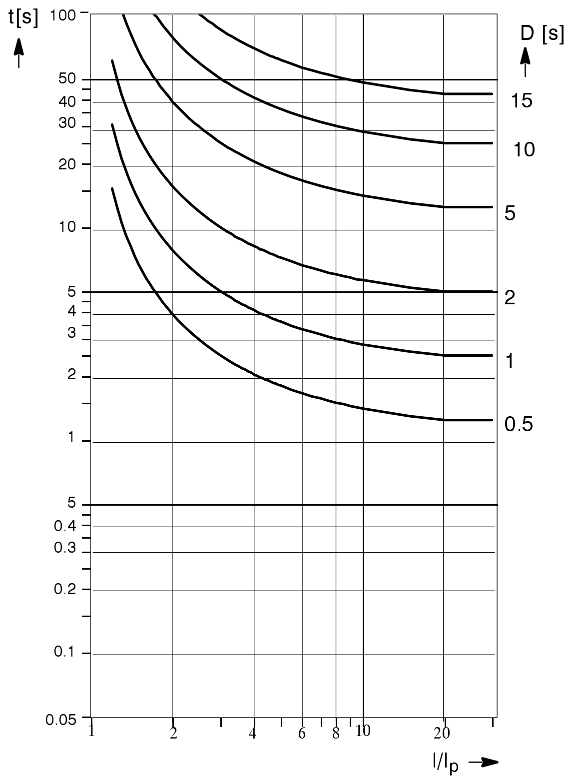
| | |
|---|---|
| – Auxiliary voltage in range $0.8 \leq U_H/U_{HN} \leq 1.2$ | ≤ 1 % |
| – Temperature in range $-5\ °C \leq \vartheta_{amb} \leq 40\ °C$ | ≤ 0.5 %/10 K |
| – Frequency in range $0.95 \leq f/f_N \leq 1.05$ | ≤ 8 % referred to theoretical time value |



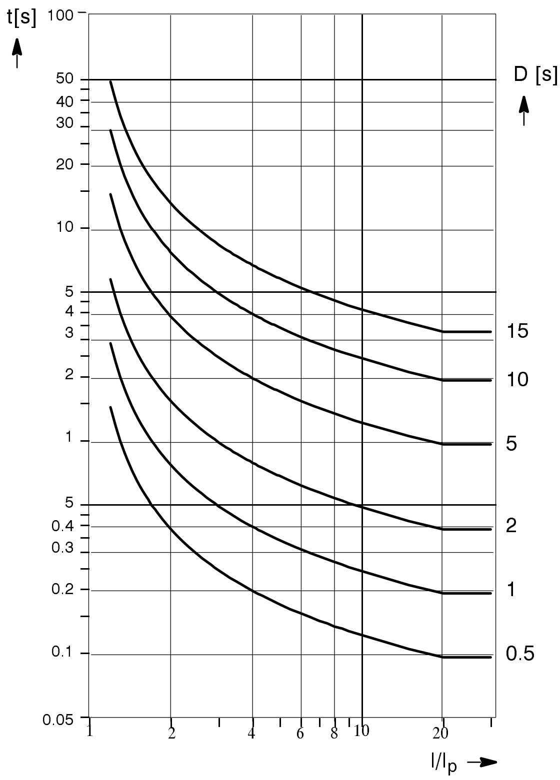

Inverse: $t = \left( \frac{8.9341}{(I/I_p)^{2.0938} - 1} + 0.17966 \right) \cdot D$ [s]




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

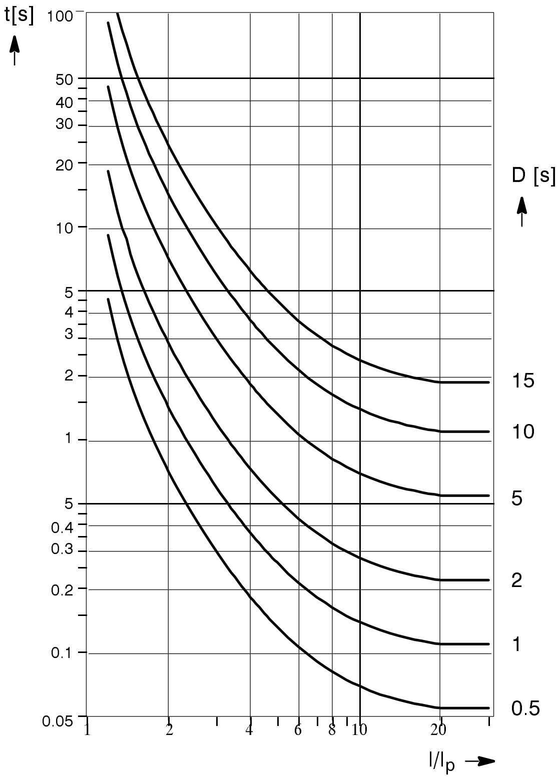



long inverse: $t = \left( \frac{5.6143}{(I/I_p) - 1} + 2.18592 \right) \cdot D$ [s]

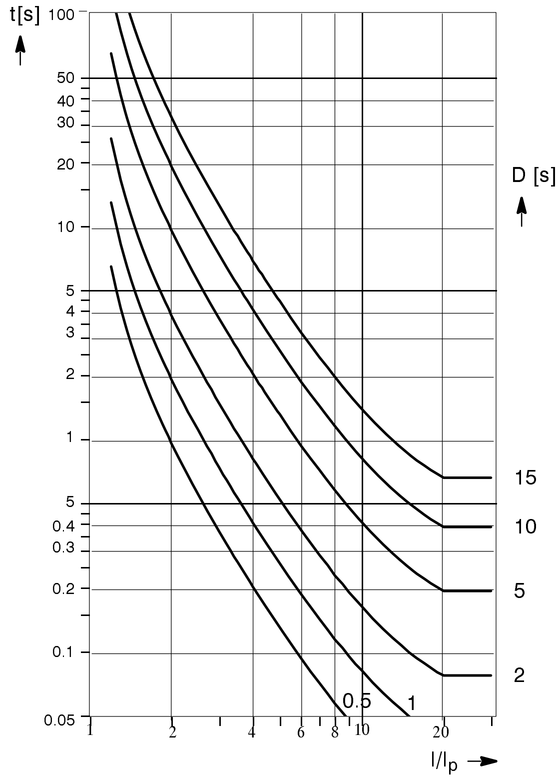



moderately inverse: $t = \left( \frac{0.0103}{(I/I_p)^{0.02} - 1} + 0.0228 \right) \cdot D$ [s]

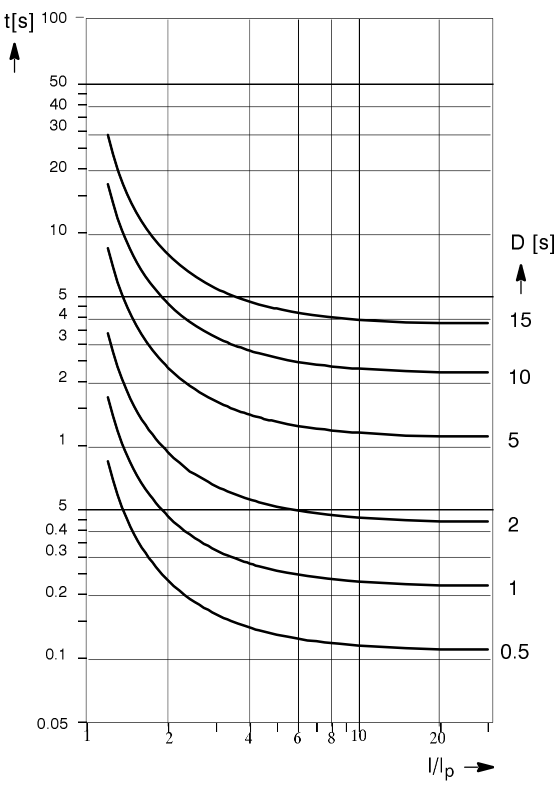
Figure 3.3 Trip time characteristic of inverse time overcurrent protection, according ANSI/IEEE



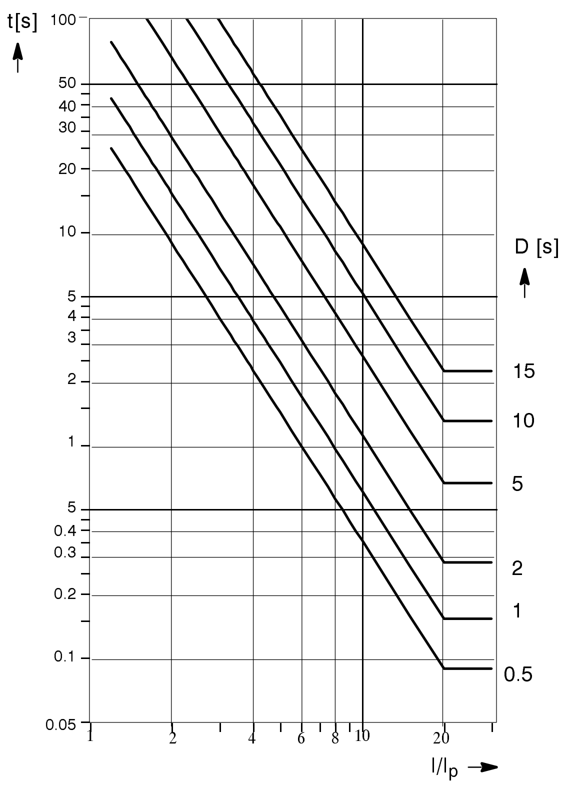

very inverse: $t = \left( \frac{3.922}{(I/I_p)^2 - 1} + 0.0982 \right) \cdot D$ [s]




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

## 3.4 Unbalanced load protection

**Setting ranges**/steps

| | | |
|---|---|---|
| Tripping stage $I_2>$ | 8 % to 80 % of $I_N$ | (steps 1 %) |
| Tripping stage $I_2\gg$ | 8 % 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 $\geq 0.1 \cdot I_N$

| Pick-up times | at $f_N$ = 50 Hz | at $f_N$ = 60 Hz |
|---|---|---|
| – Tripping stage $I_2>$, tripping stage $I_2>>$ | approx. 60 ms | approx. 75 ms |
| – but with currents $I/I_N > 1.5$ (overcurrent case) or neg. sequence current < (set value + 0.1 x $I_N$) | approx. 200 ms | approx. 310 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. 42 ms |

Reset ratios
– 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 |
| | current $I/I_N > 1.5$ | ± 5 % of $I_N$ ± 5 % of set value |
| – stage delay times | | ± 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 $0.98 \leq f/f_N \leq 1.02$ | $\leq$ 2 % of $I_N$ |
| in range $0.95 \leq f/f_N \leq 1.05$ | $\leq$ 5 % of $I_N$ |

# 3.5 Thermal overload protection

## 3.5.1 Overload protection with memory (total memory according to IEC 60255−8)

**Setting ranges**/steps

| | | |
|---|---|---|
| Factor k according to IEC 60255−8 | 0.40 to 2.00 | (steps 0.01) |
| Thermal time constant $\tau_{th}$ | 1.0 to 999.9 min | (steps 0.1 min) |
| Thermal warning stage $\Theta_{warn}/\Theta_{trip}$ | 50 to 99 % referred to trip temperature rise | (steps 1 %) |
| Prolongation factor at motor stand-still $k_\tau$ | 1.00 to 10.00 | (steps 0.01) |

**Trip time characteristic**

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

t trip time
$\tau_{th}$ time constant
I load current
$I_{pre}$ preload current
k factor according to IEC 60255−8
refer also Figures 3.5 and 3.6

in the range $I/k \cdot I_N \leq 8$; tripping times do not decrease above $I/I_p > 8$

**Reset ratios**

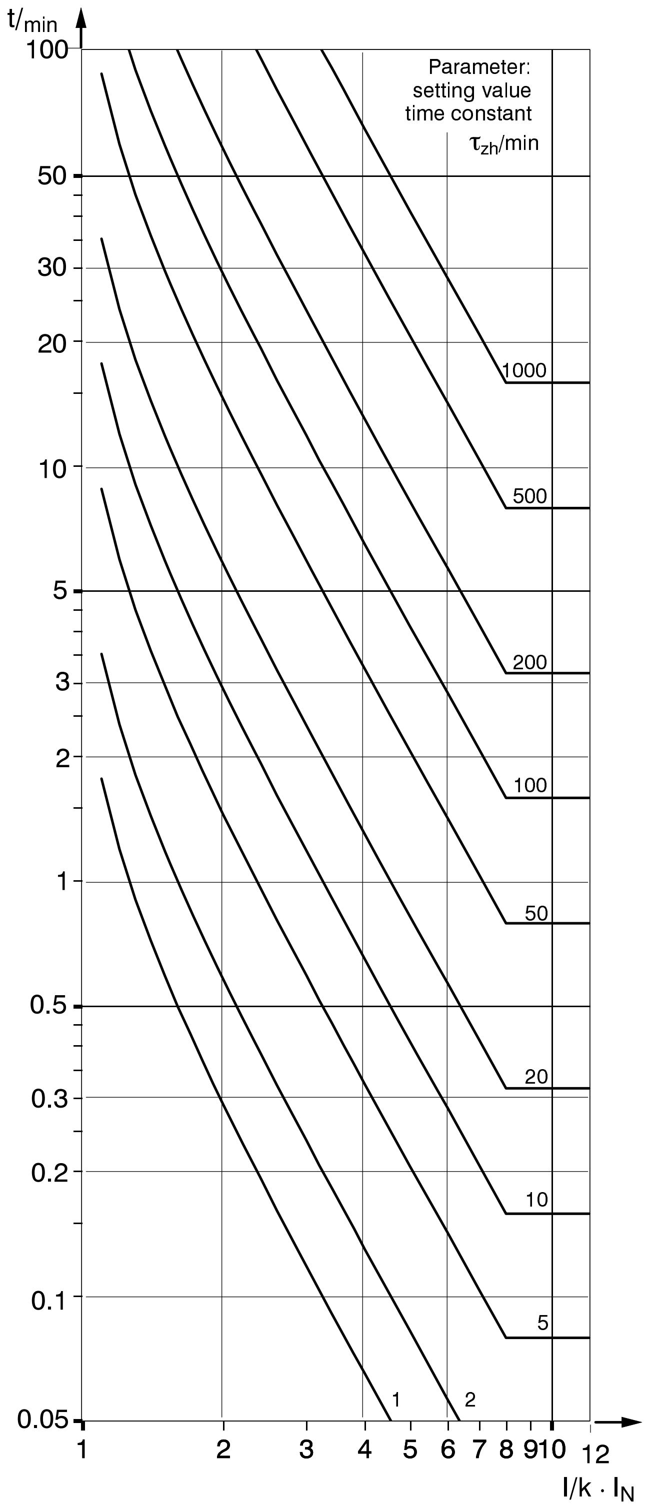
| | |
|---|---|
| $\Theta/\Theta_{trip}$ | reset below $\Theta_{warn}$ |
| $\Theta/\Theta_{warn}$ | approx. 0.99 |

**Tolerances**

| | | |
|---|---|---|
| − referring to $k \cdot I_N$ | ± 5 % | class 5% acc. IEC 60255−8 |
| − referring to trip time | ± 5 % ± 2 s | class 5% acc. IEC 60255−8 |

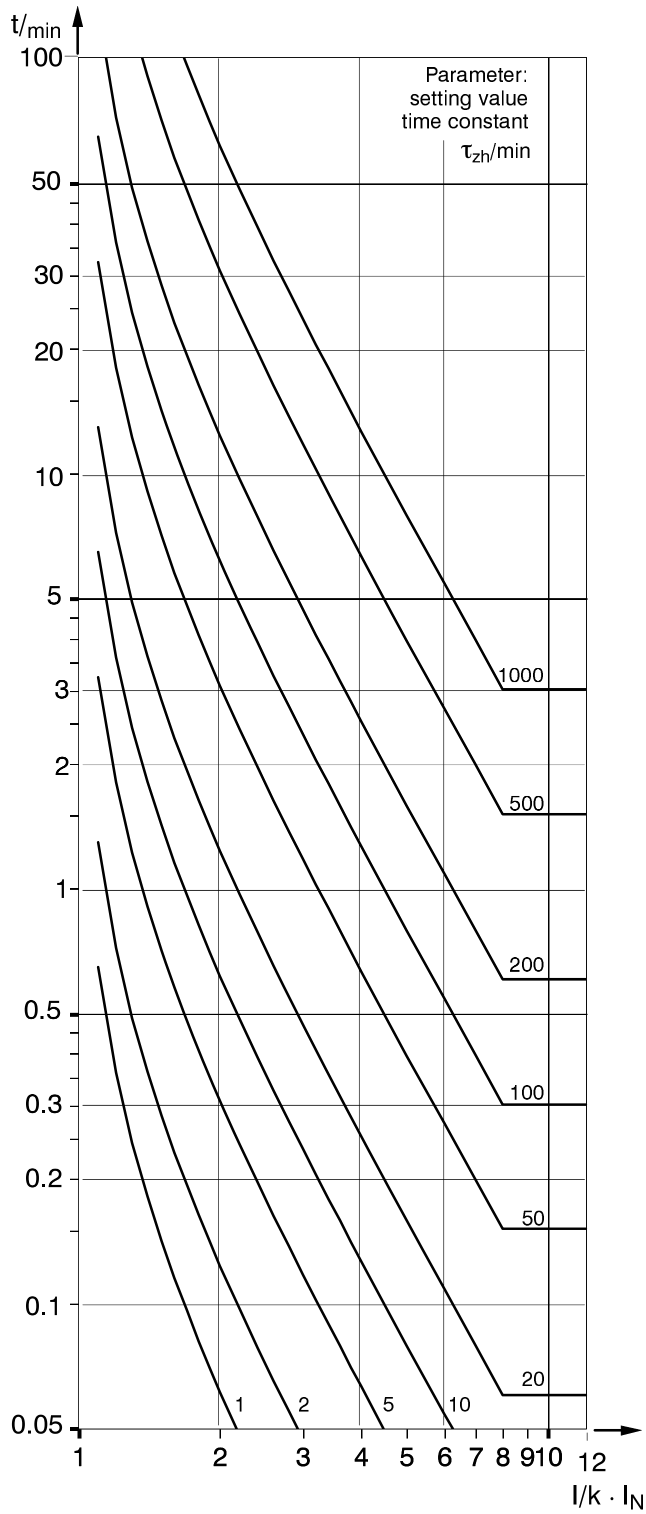
**Influence variables** referred to $k \cdot I_N$

| | |
|---|---|
| − Auxiliary dc 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 % |




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

Figure 3.5 Trip time characteristic of overload protection – with total memory – (without preload)




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

for 90 % preload

Figure 3.6 Trip time characteristic of overload protection – with total memory – (with 90 % preload)

### 3.5.2 Overload protection without memory

**Setting ranges**/steps

| | | | |
|---|---|---|---|
| Pick-up value | $I_L/I_N$ | 0.4 to 4.0 | (steps 0.1) |
| Time multiplier | $t_L$ (= $t_6$-time) | 1.0 to 120.0 s | (steps 0.1 s) |

**Trip time characteristic**

$$t = \frac{35}{(I\,/\,I_L)^2 - 1} \cdot t_L \qquad \text{for } I > 1.1 \cdot I_L$$

| | |
|---|---|
| $t$ | trip time |
| $t_L$ | time multiplier (= tripping time for six times current setting $I_L$) |
| $I$ | load current |
| $I_L$ | pick-up current |

refer also to Figure 3.7

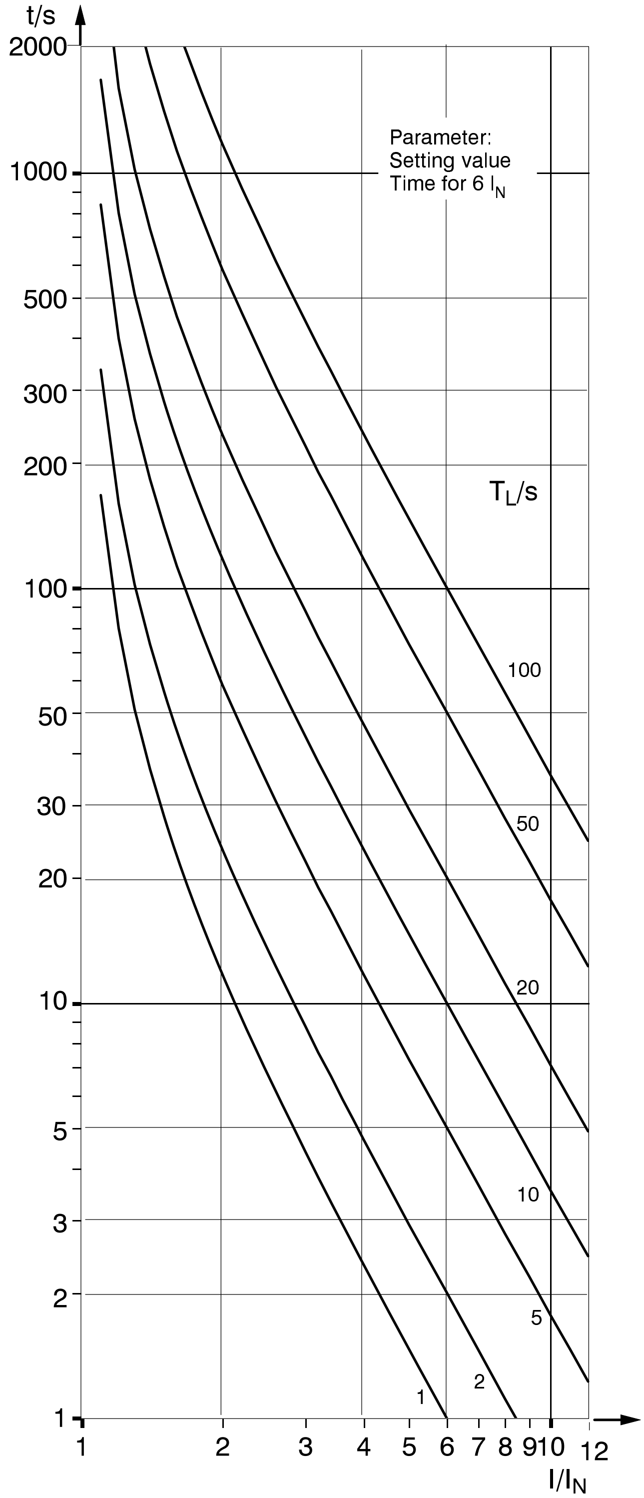
**Reset ratio** $I/I_L$ approx. 0.94

**Tolerances**

| | |
|---|---|
| – referring to pick-up threshold $1.1 \cdot I_L$ | ± 5 % |
| – referring to trip time | ± 5 % ± 2 s |

**Influence variables**

| | |
|---|---|
| – Auxiliary dc 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 % |




$$t = \frac{35}{(I/I_L)^2 - 1} \cdot T_L$$

Figure 3.7 Trip time characteristic of overload protection – without memory –

## 3.6 Start-up time monitoring

**Setting ranges**/steps

| | | |
|---|---|---|
| Permissible start-up current | $I_{start}/I_N$ | 0.4 to 20.0 (steps 0.1) |
| Permissible start-up time | $t_{start}$ | 1.0 s to 360.0 s (steps 0.1 s) |

**Tripping characteristic** $t = \left(\frac{I_{start}}{I_{rms}}\right)^2 \cdot t_{start}$ for $I_{rms} > I_{start}$

**Reset ratio** $I_{rms}/I_{start}$ approx 0.94

**Tolerances**

| | |
|---|---|
| Pick-up value | 5 % |
| Delay time | 5 % of setting value or 330 ms |

## 3.7 Auto-reclosure (optional)

| | |
|---|---|
| Number of possible shots | 1 up to 9 |
| Auto-reclose modes | three-pole |

| | |
|---|---|
| Dead time for 1st shot | 0.05 s to 1800.00 s (steps 0.01 s) |
| Dead time for 2nd shot | 0.05 s to 1800.00 s (steps 0.01 s) |
| Dead time for 3rd shot | 0.05 s to 1800.00 s (steps 0.01 s) |
| Dead time for fourth and any further shot | 0.05 s to 1800.00 s (steps 0.01 s) |
| Reclaim time after successful AR | 0.05 s to 320.00 s (steps 0.01 s) |
| Lock-out time after unsuccessful AR | 0.05 s to 320.00 s (steps 0.01 s) |
| Reclaim time after manual close | 0.50 s to 320.00 s (steps 0.01 s) |
| Duration of RECLOSE command | 0.01 s to 60.00 s (steps 0.01 s) |

## 3.8 Ancillary functions

**Operational value measurements**

| | |
|---|---|
| – operational current values | $I_{L1}$; $I_{L2}$; $I_{L3}$ |
| measurement range | 0 % to 240 % $I_N$ |
| tolerance | 3 % of rated value or of measured value |
| – thermal overload values | |
| calculated temperature rises | $\Theta/\Theta_{trip}$ |
| measurement range | 0 % to 300 % |
| tolerance | 5 % referred to $\Theta_{trip}$ |

**Fault event data storage**

storage of annunciations of the last eight faults

**Time assignment**

| | |
|---|---|
| resolution for operational annunciations | 1 s |
| resolution for fault event annunciations | 1 ms |
| max time deviation | 0.01 % |

| | | |
|---|---|---|
| **Data storage for fault recording** | | max. 8 fault events |
| storage time (fault detection or trip command = 0 ms) | | total 5 s<br>incl. 3 s power-fail safe<br>selectable pre-trigger and post-fault time |
| max. storage period per fault event | $T_{max}$ | 0.30 to 5.00 s (steps 0.01 s) |
| pre-trigger time | $T_{pre}$ | 0.05 to 0.50 s (steps 0.01 s) |
| post-fault time | $T_{post}$ | 0.05 to 0.50 s (steps 0.01 s) |
| sampling rate | | 1 instantaneous value per ms at 50 Hz<br>1 instantaneous value per 0.83 ms at 60 Hz |

| | |
|---|---|
| **Trip circuit supervision** | with one or two binary inputs |
| **Circuit breaker trip test** | with live trip or<br>trip/reclose cycle (models with auto-reclosure) |

**Circuit breaker control**

| | |
|---|---|
| control of a circuit breaker | CLOSE and TRIP |

# 4 Method of operation

## 4.1 Operation of complete unit

The numerical time overcurrent protection SIPROTEC 7SJ600 is equipped with a powerful and proven 16-bit microcontroller. This provides fully digital processing of all functions from data acquisition of measured values to the trip and close signals to the circuit breaker.

Figure 4.1 shows the base structure of the unit.

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

The analog input section AE contains input amplifiers for each input, analog-to-digital converters and memory circuits for the data transfer to the microcontroller.

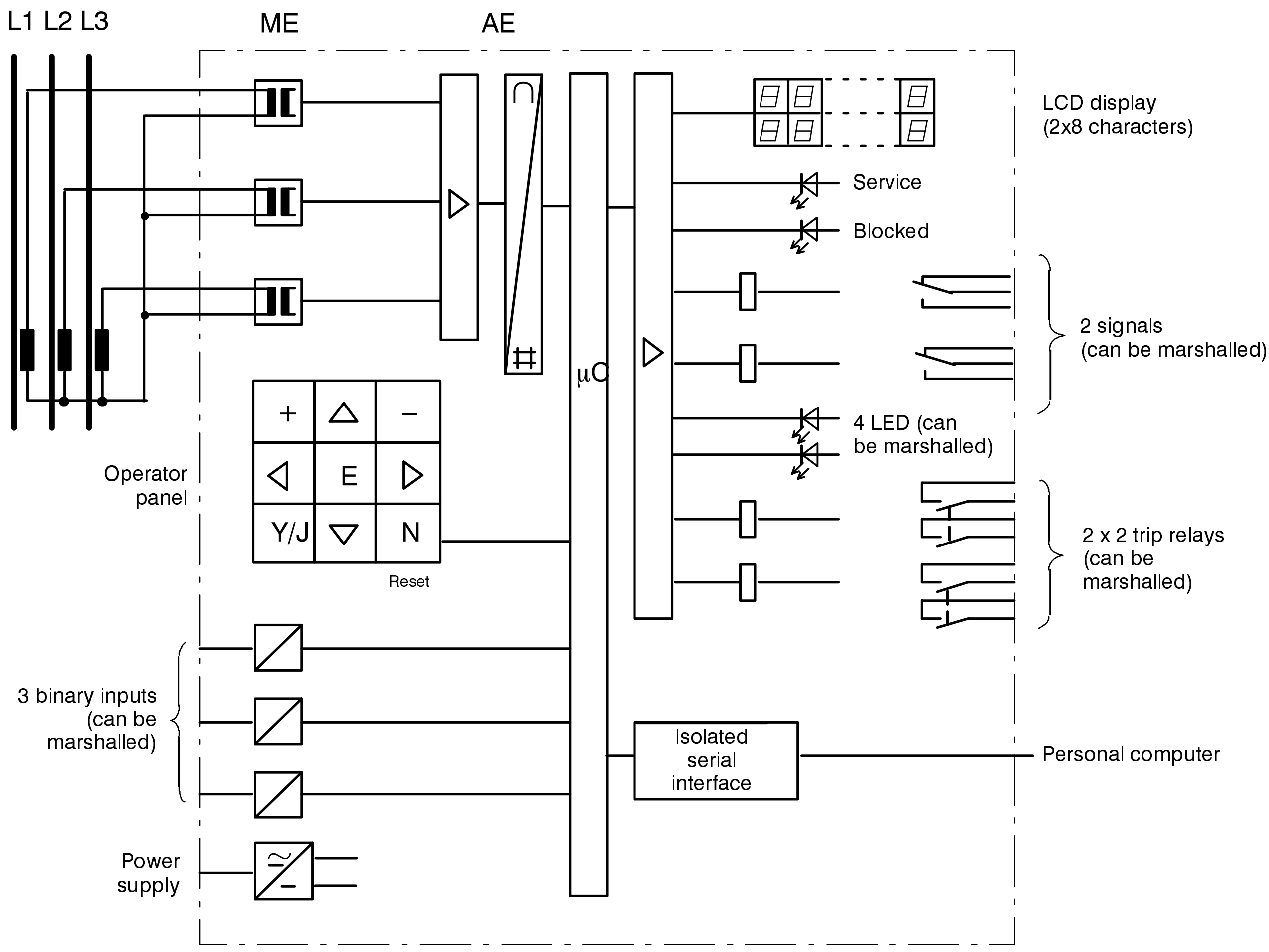



Figure 4.1 Hardware-structure of time overcurrent protection relay 7SJ600

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

– filtering and formation of the measured quantities,

– scanning of limit values and time sequences,

– calculation of the trip time in accordance with the selected characteristic,

– calculation of negative and positive sequence currents for unbalanced load detection,

– calculation of r.m.s. values for overload detection,

– decision about trip and reclose commands,

– storage of measured quantities during a fault for analysis.

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

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

A power supply unit provides the auxiliary supply to the described functional units with +5 V. Transient failures in the supply voltage, up to 50 ms (for ≥ 110 Vdc), which may occur during short-circuits in the d.c. supply system of the plant are bridged by a d.c. voltage storage element.

## 4.2 Time overcurrent protection

The time overcurrent protection can be used as definite time and as inverse time overcurrent protection. Four standardized inverse time characteristics according to IEC 60255−3 and eight standardized inverse time characteristics according to ANSI/IEEE are available for inverse time mode. The trip time characteristics and the applied formulae are given in the Technical data, refer to Figures 3.1 to 3.4, Section 3.3.

The selected overcurrent time characteristics can be superimposed by a high-set instantaneous or definite time delayed stage. Additionally, a very high set instantaneous phase current stage I>>> is available.

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.

The pick-up thresholds can be switched over dynamically via a binary input even during pick-up of the protection.

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

### 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. The residual (earth) current is calculated by the protection from the sum of the three phase currents. Alternatively, the $I_{L2}$-input may be connected to the star-point of the current transformer set; in this case the relay calculates the non-connected phase current $I_{L2}$ from the currents $I_{L1}$, $I_{L3}$, and the residual current. All four currents (three phase currents and residual current) are evaluated in both cases.

### 4.2.2 Definite time overcurrent protection stages I> and I>>

The high-set stages I>> (for phase currents) and $I_E$>> (for residual current) are always available, regardless whether or not further definite time stages (I>, $I_E$>) or inverse time stages ($I_p$, $I_{Ep}$) are intended to be used.

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 I> stage is delayed with T I>, the high-set stage I>> is delayed with T I>>.

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

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

The logic diagram of the definite time overcurrent stages is shown in Figure 4.2, that of the high-set stages is shown in Figure 4.3.

### 4.2.3 High-speed stages I>>>

The high-speed stages for phase currents I>>> complement the high-set stages I>> for very high fault currents. In contrast to the high-set stages which operate with filtered RMS-values, the I>>>-stages operate with the instantaneous signals of the currents thus allowing very short tripping times. In order to avoid transient overreach in case of DC offset in fault currents, these stages pick up only when the instantaneous current values exceed $2\cdot\sqrt{2}$ times the set (RMS) value. This prevents from faulty pick-up even in case of full DC offset in the fault current. On the other hand, these stages may respond only to symmetrical currents (without DC component) of accordingly higher magnitude but allow very fast tripping on very high fault current. Therefore, they should be used as fast instantaneous stage in conjunction with the I>>-stages.

The function is in principle the same like that of the I>>-stages. See Figure 4.4 for the logic diagram.

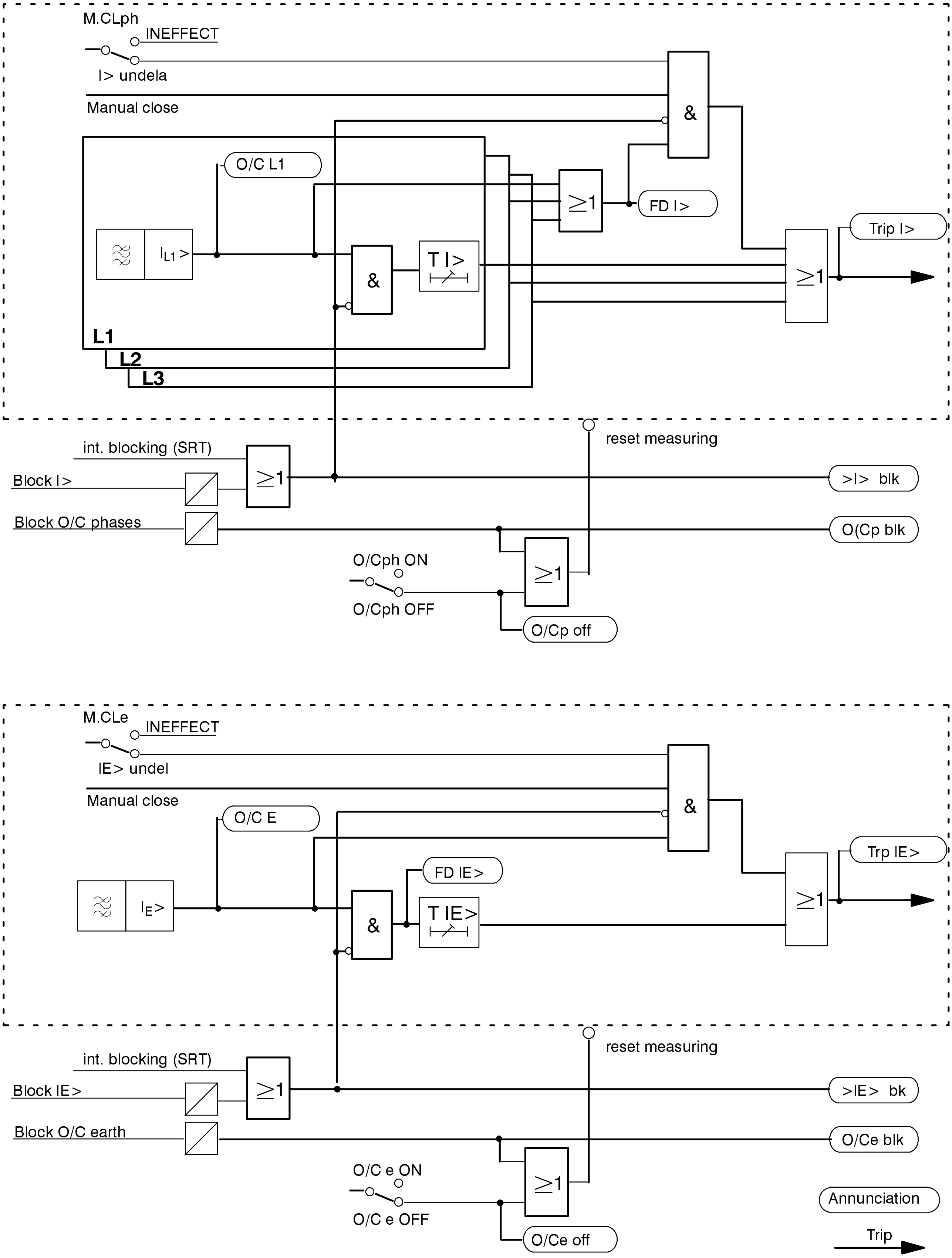



Figure 4.2 Logic diagram of the definite time overcurrent stages I> (phase currents) and $I_E$> (earth current)

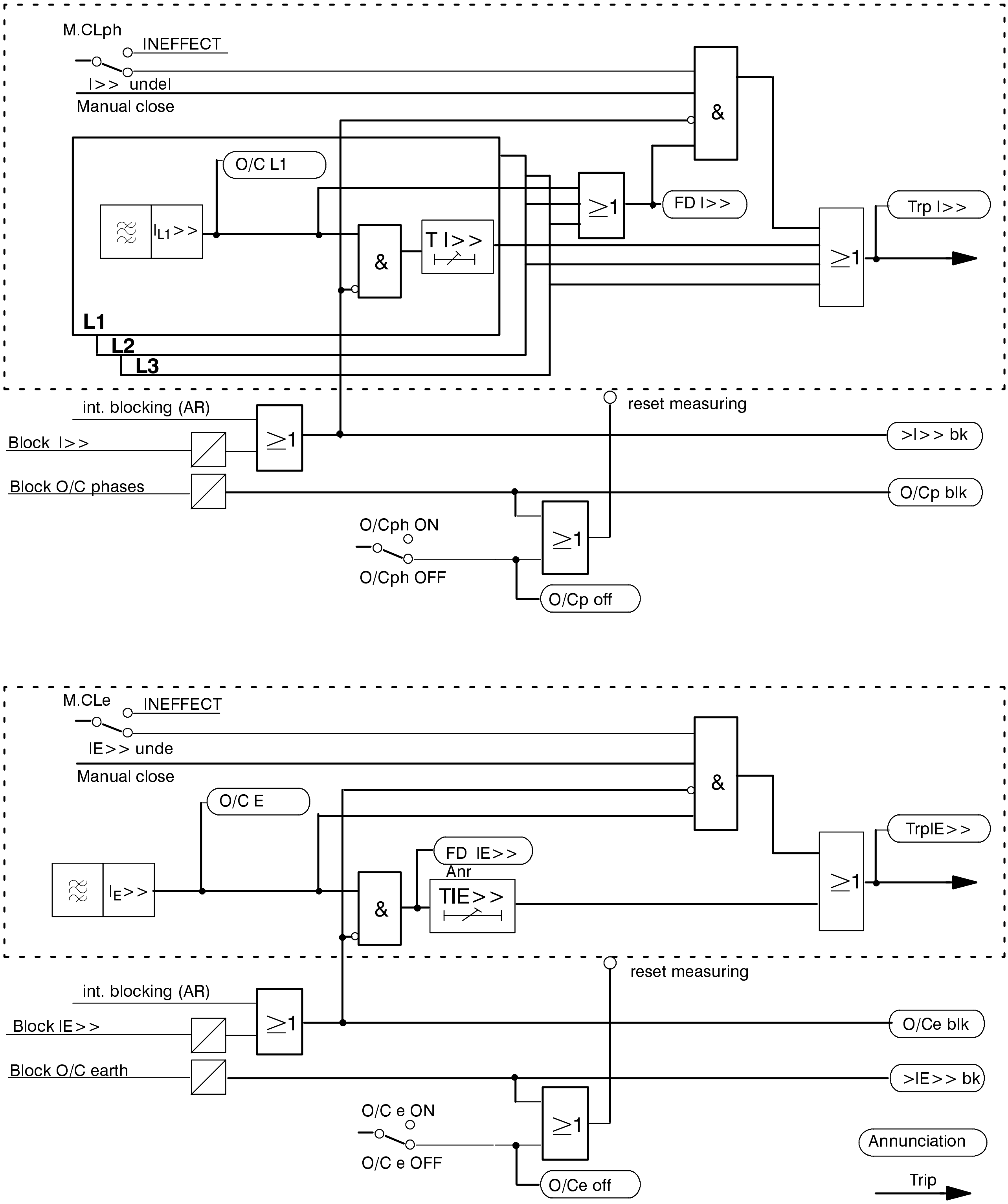



Figure 4.3 Logic diagram of the definite time high-set stages I>> (phase currents) and $I_E$>> (earth current)

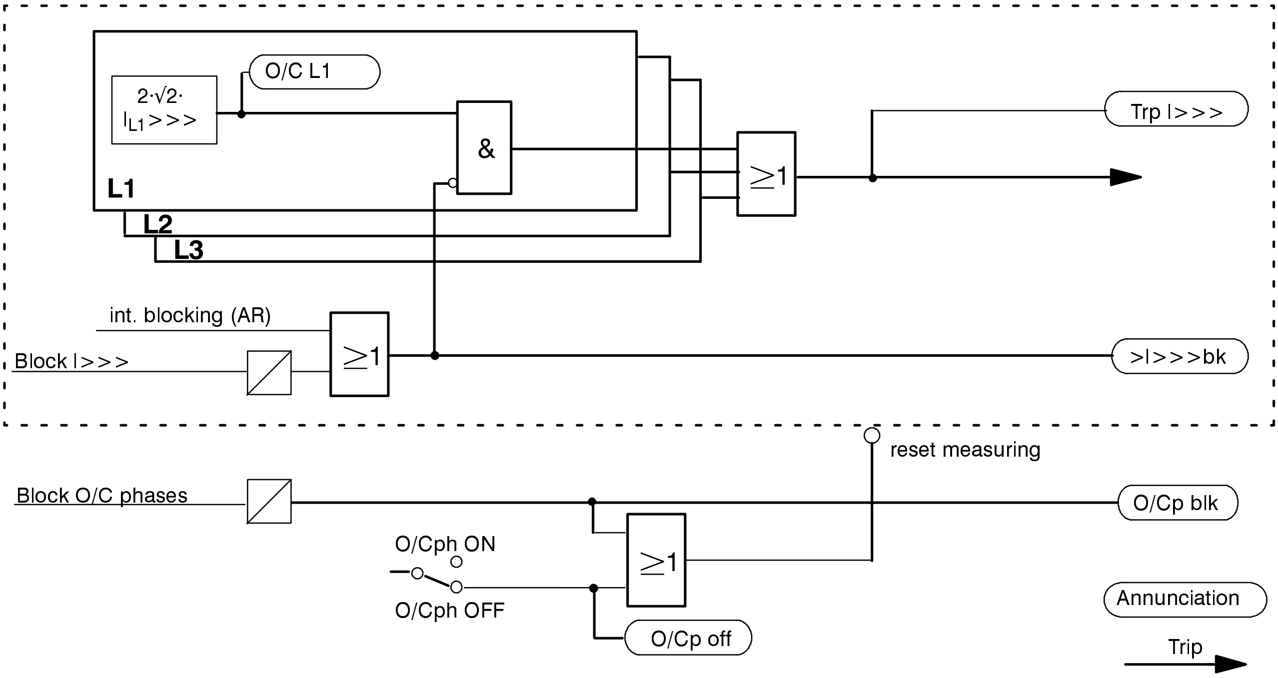



Figure 4.4 Logic diagram of the high-speed stages I>>>

### 4.2.4 Inverse time overcurrent protection stages $I_p$

In addition to the definite time stages mentioned before, inverse time stages can be enabled for each of the phase currents (with common setting) and the earth current.

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.

The pick-up values of the stages $I_p$ (phases) and for the stage $I_{Ep}$ (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 4.5.

For inverse time overcurrent protection stages, one can select whether the fundamental wave of the currents or the true r.m.s. values be processed.

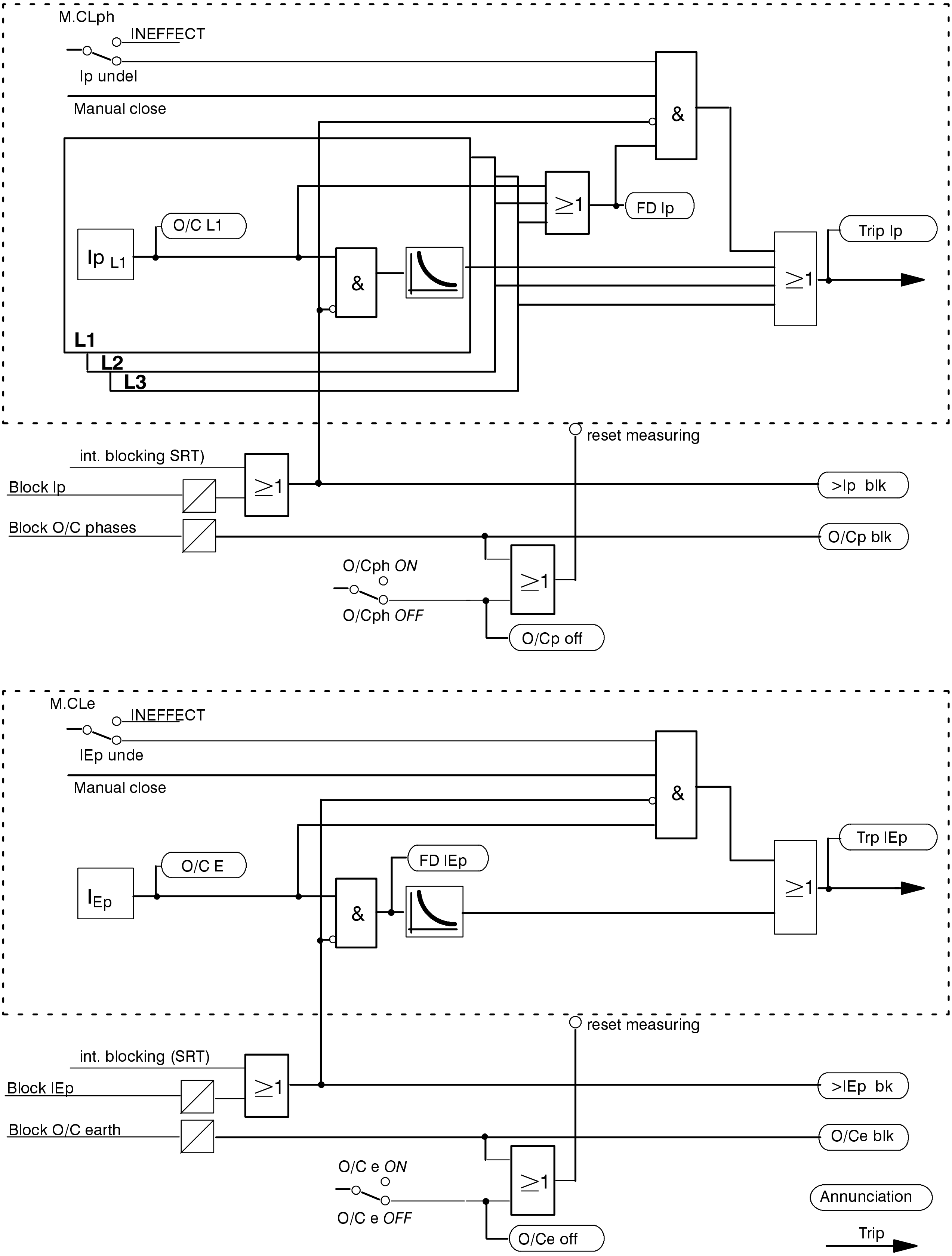
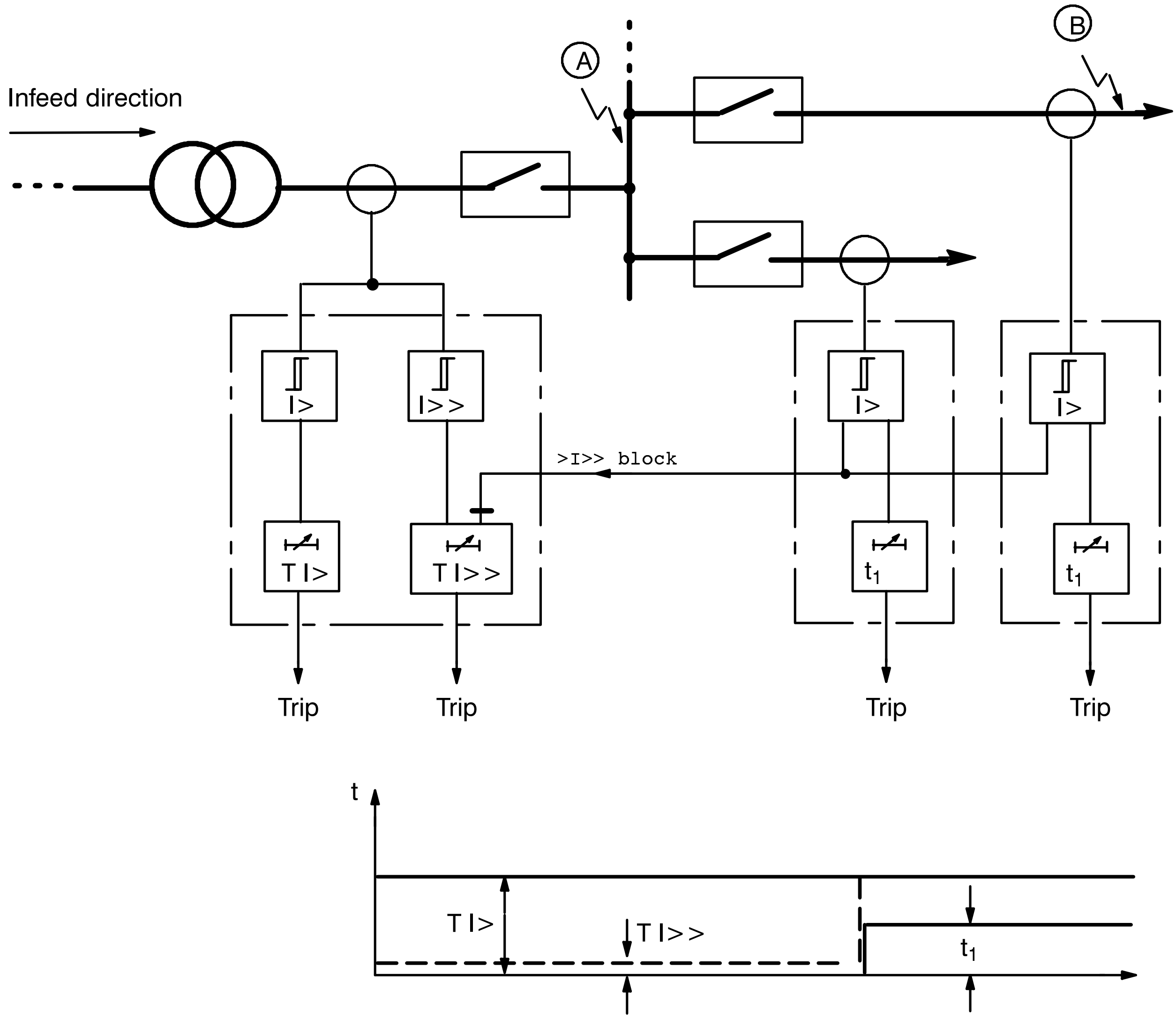



Figure 4.5 Logic diagram of the inverse time overcurrent protection stages

### 4.2.5 Fast bus-bar protection using reverse interlocking scheme

Each of the overcurrent stages can be blocked via binary inputs of the relay. A setting parameter determines whether the binary input operates in the “normally open” (i.e. energize input to block) or the “normally closed” (i.e. energize input to release) mode. Thus, the time overcurrent protection can be used as fast busbar protection in star connected networks or in open ring networks (ring open at one location), using the “reverse interlock” principle. This is used in high voltage systems, in power station auxiliary supply networks, etc., in which cases a transformer feeds from the higher voltage system onto a busbar with several outgoing feeders (refer Figure 4.6).

“Reverse interlocking” means, that the time overcurrent protection can trip within a short time T I>>, which is independent of the grading time, if it is not blocked by pick-up of one of the next downstream time overcurrent relays (Figure 4.6). 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 4.6 Busbar protection using reverse interlocking principle – scheme

## 4.3 Unbalanced load protection

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 can 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 time overcurrent protection.

In the unbalanced load protection of the 7SJ600, 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 ration $I_2/I_N$ ($I_N$ = 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 4.7). 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.

Figure 4.8 shows the logic diagram of the unbalanced load protection.

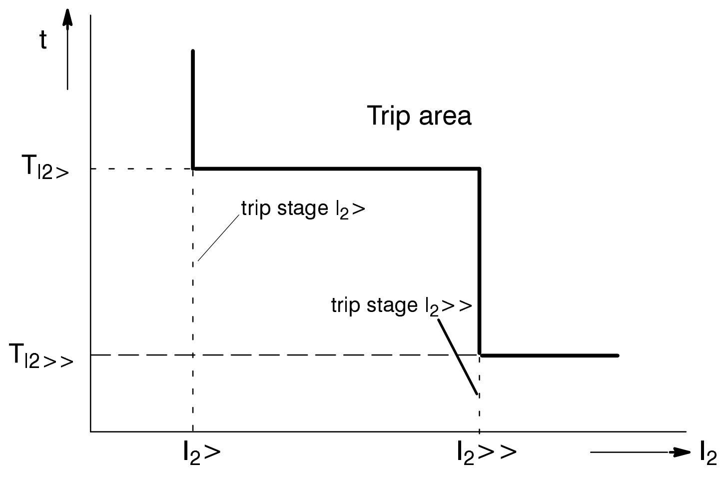



Figure 4.7 Trip time characteristic of the unbalanced load protection

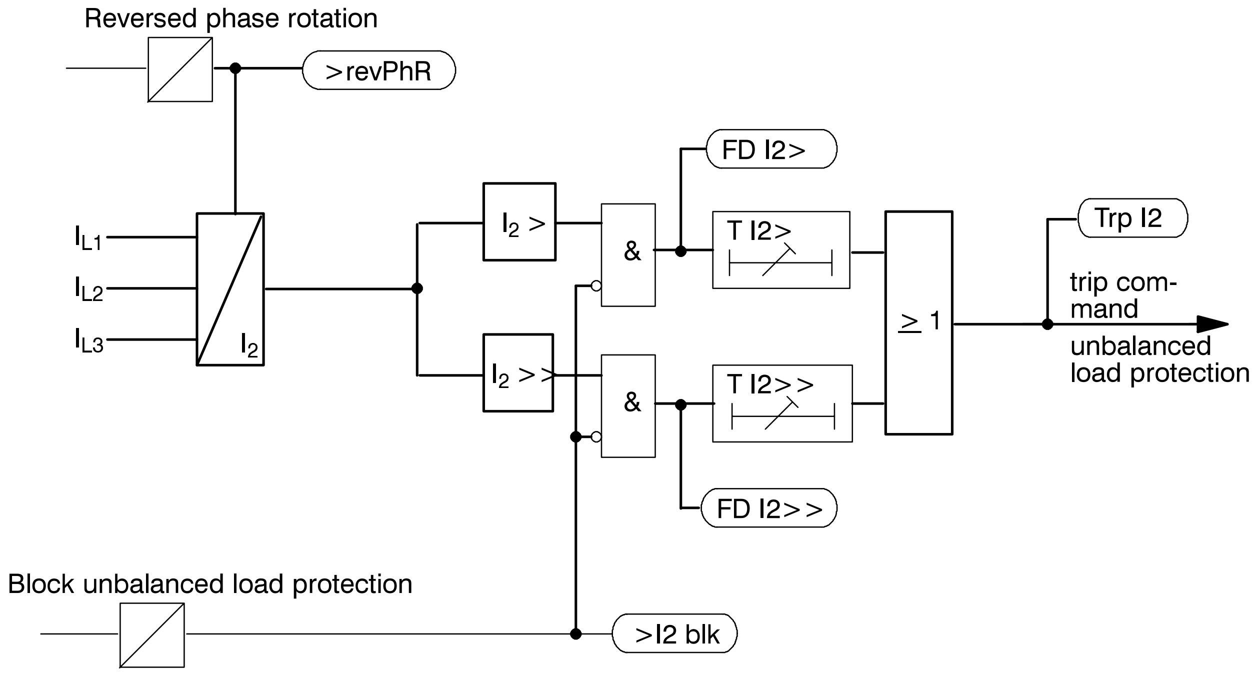



Figure 4.8 Logic diagram of the unbalanced load protection

# 4.4 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. This protection operates independent on the time overcurrent and unbalanced load protection.

The protection can be optionally set to evaluate all load currents even when overload is not yet present (thermal overload protection with total memory) or to evaluate only the load currents when an adjustable overload threshold has been exceeded (overload protection without memory).

## 4.4.1 Overload protection with total memory

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

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

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

$\tau_{th}$ – thermal time constant for heating-up of the protected object

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

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

The temperature rises are calculated separately for each individual phase. The maximum calculated temperature rise of the three phases is decisive for the set thresholds. 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 $I_N$:

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

where k = factor according to IEC 60255–8 or VDE 0435 part 3011

In addition to the k-factor, the thermal time constant $\tau_{th}$ as well as the alarm temperature $\Theta_{warn}$ must be entered into the protection unit.

When the warning threshold $\Theta_{warn}$ has been reached, the protection computes the expected time until trip (steady-state current assumed) and makes it available in the operational measured values. The applied formula is:

$$t_{trip} = \tau_{th} \cdot ln \frac{I^2 - \Theta}{I^2 - 1}$$

with $t_{trip}$ – expected time until trip

$\Theta$ actual temperature rise related on the final temperature rise for the maximum permissible current $k \cdot I_N$

$\tau_{th}$ – thermal time constant for heating-up of the protected object

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

After the overload protection has tripped, the time is calculated and indicated until the temperature rise will have been fallen below the warning temperature rise, i.e. until the protection will drop off. This is the time period before which the protected object should not be re-energized. The protection uses for this calculation the cooling-down time constant which can be set as a factor of the heating-up time constant. Thus, it is considered that, with motors with self-ventilation, the cooling-down process lasts longer because the rotor does not ventilate. In this aspect, the motor is assumed to stand still when the current consumption is less than 0.1 times rated (relay) current.

$$t_{close} = k_\tau \cdot \tau_{th} \cdot ln \frac{I^2 - \Theta}{I^2 - \Theta_{warn}} \quad \text{for } I < 0.1 \cdot I_N$$

with $t_{close}$ – time after which reclosure is permitted

$I$ – actual current

$\tau_{th}$ – heating-up time constant

$k_\tau$ – prolongation factor for cooling down

$\Theta$ – actual temperature rise

$\Theta_{warn}$ – parameterized warning temperature rise

### 4.4.2 Overload protection without memory

If the overload protection without memory is selected, the tripping time is calculated according to the simplified formula:

$$t = \frac{35}{(I / I_L)^2 - 1} \cdot t_L \qquad \text{for } I > 1.1 \cdot I_L$$

with t – tripping time
I – overload current
$I_L$ – parameterized threshold value
$t_L$ – parameterized time multiplier (= tripping time with 6 times the threshold value $I_L$)

When the current of at least one phase has exceeded the limit value ($1.1 \cdot I_L$), pick-up is indicated and the timer is started. Trip command is given after the time has elapsed.

When pick-up has occurred, the protection computes the expected time until trip (steady-state current assumed) and makes it available in the operational measured values.

Figure 4.9 shows the logic diagram of the overload protection with and without memory.

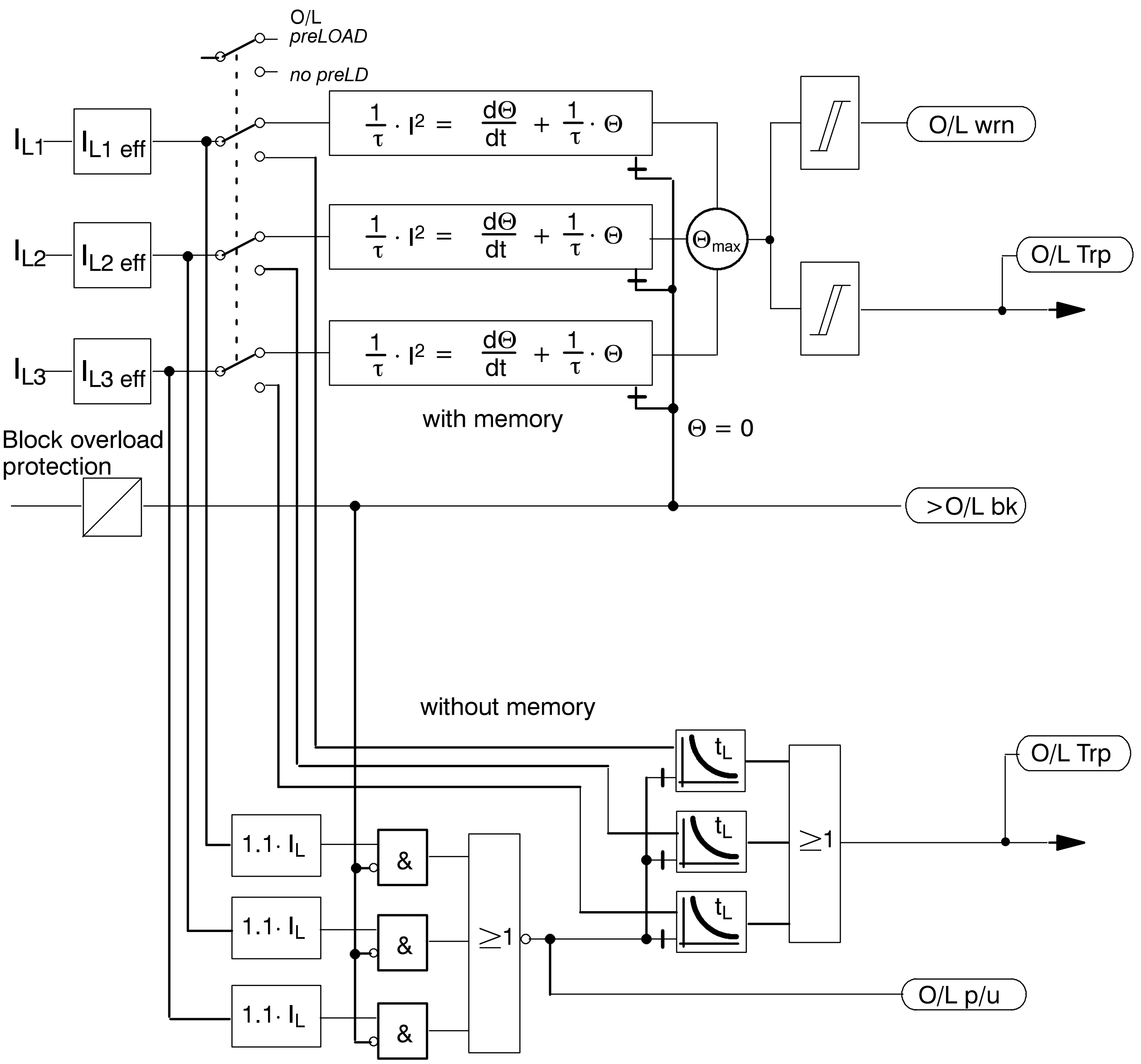



Figure 4.9 Logic diagram of overload protection

## 4.5 Start-up time monitoring

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.

The tripping time depends on the magnitude of the start-up current. The following formula is valid:

$$t = \left(\frac{I_{srt}}{I}\right)^2 \cdot t_{srt} \qquad \text{for } I > I_{srt}$$

with t – tripping time
I – actual current (r.m.s.)
$I_{srt}$ – parameterized start-up current
$t_{srt}$ – parameterized start-up time

Figure 4.10 shows the logic diagram of the start-up time monitoring.

The start-up time monitor can block the time overcurrent stages (I>, Ip) after approximately 70 ms (selectable).

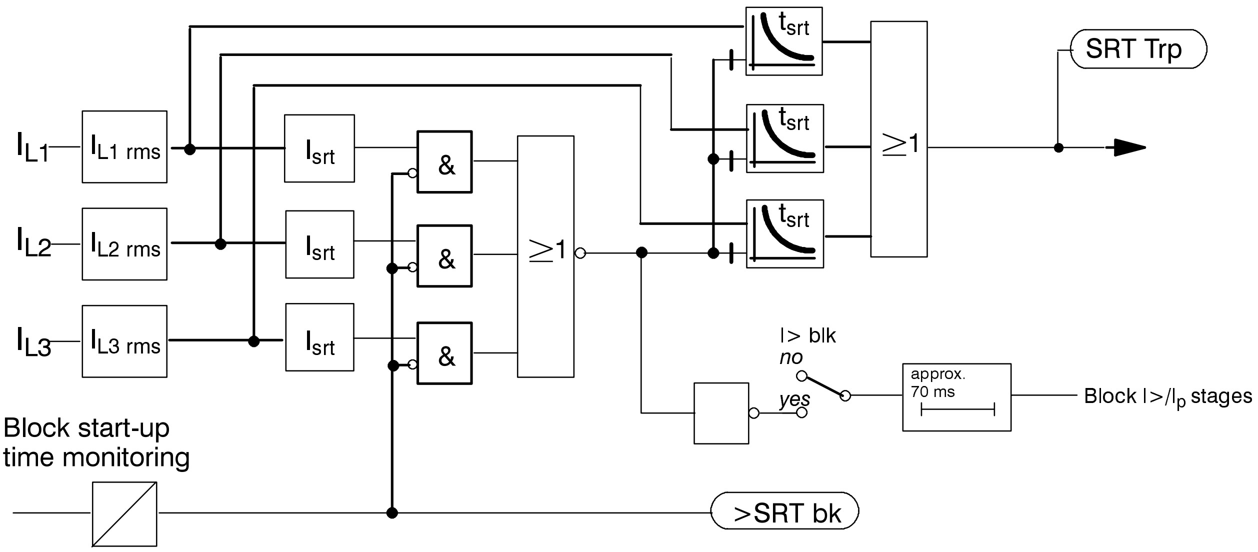



Figure 4.10 Logic diagram of start-up time monitoring

## 4.6 **Automatic reclosure** (optional)

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

If the short circuit is still present after the auto-reclosure (arc not quenched or metallic short circuit), then the protective relay finally disconnects the power. Multiple auto-reclosure attempts are possible in some networks.

7SJ600 allows automatic three-pole as well as single- and multi-shot reclosure.

It can be freely arranged which protection function should initiate the auto-reclosure function (refer also to Section 5.5.6). Normally, the auto-reclosure function will be started by the trip command of the short-circuit protection functions, but not by other tripping functions like overload protection or unbalanced load protection. Initiation can also be achieved from an external device via a binary input of the relay provided this input is accordingly allocated (refer also to Section 5.5.2).

For the auto-reclosure sequence to be successful, faults on any part of the line should be cleared from the feeding line ends within the same – shortest possible – time. The time overcurrent protection is, therefore, programmed as to trip with the instantaneous or short-time delayed stages I>>, I>>>, and $I_E$>>, only before the first reclosure, in order to achieve fast tripping. Thereafter, these stages are blocked in order to allow selective delayed tripping in accordance with the time-grading plan of the system.

Initiation of the auto-reclosure function can be blocked by signals which can be freely assigned to internal signals or to a binary input. This is meaningful for such tripping functions which shall block reclosure, e.g for an external bus-bar protection. Reclosure is blocked when the blocking signal appears at any time instant while the start signal is present.

Furthermore, the reclosure command can be blocked by conditions which can equally freely arranged or input via a binary input. This blocking of reclosure operates statically, i.e. as long as it is present. But, if this blocking signal is active at the instant that reclosure command is generated, auto-reclosure is completely aborted. This can be used to ensure that the circuit breaker is ready to reclose and trip at the moment where reclosure command is output. Once a reclosure command is present, it is, of course, retained.

Normally, the sequence of auto-reclosure is as follows:

The time overcurrent protection clears a short-circuit in one of the rapid stages I>>, I>>>, or $I_E$>>. The AR-function is initiated. With fault clearance (i.e. drop off of the trip command), the (settable) dead time "AR T1" for the first AR-cycle commences. After the dead time, the circuit breaker receives a closing command, the duration of which is settable. Simultaneously, the (settable) reclaim time "T–REC" is started.

If the fault is cleared (successful AR), the reclaim time "T–REC" 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 reclaim time is aborted by the renewed trip; the next AR-cycle is initiated provided further AR-cycles are allowed. After fault clearance, the dead time "AR T*n*" of the *n*-th AR-cycle starts. At the end of this, the circuit breaker is given a new closing command. Simultaneously, the reclaim time "T–REC" is re-started. Also, any fault during the reclaim time will result in initiation of the next AR-cycle if allowed.

If one of the cycles is successful, that is, after reclosure the fault is no longer present, the reclaim time "T–REC" 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. The lock-out time "T–LOC" is started. For this time the close command locked. Since no further AR cycle is permitted, AR has been unsuccessful.

A special blocking time "T–BLM" is provided for manual closing. During this time after manual closure, reclosure is blocked; any trip command will be a final trip. Precondition is that the manual close command is connected to an accordingly allocated binary input. Note that the manual close signal given to the relay does not energize the close command output but must be wired to the closing coil of the breaker by a different contact.

# 4.7 Trip circuit supervision

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. 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.

Figure 4.13 shows the logic diagram of the annunciations generated by the trip circuit supervision.

## 4.7.1 Supervision using two binary inputs

When two binary inputs are used, they are connected according to Figure 4.11: 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.

## 4.7.2 Supervision using one binary input

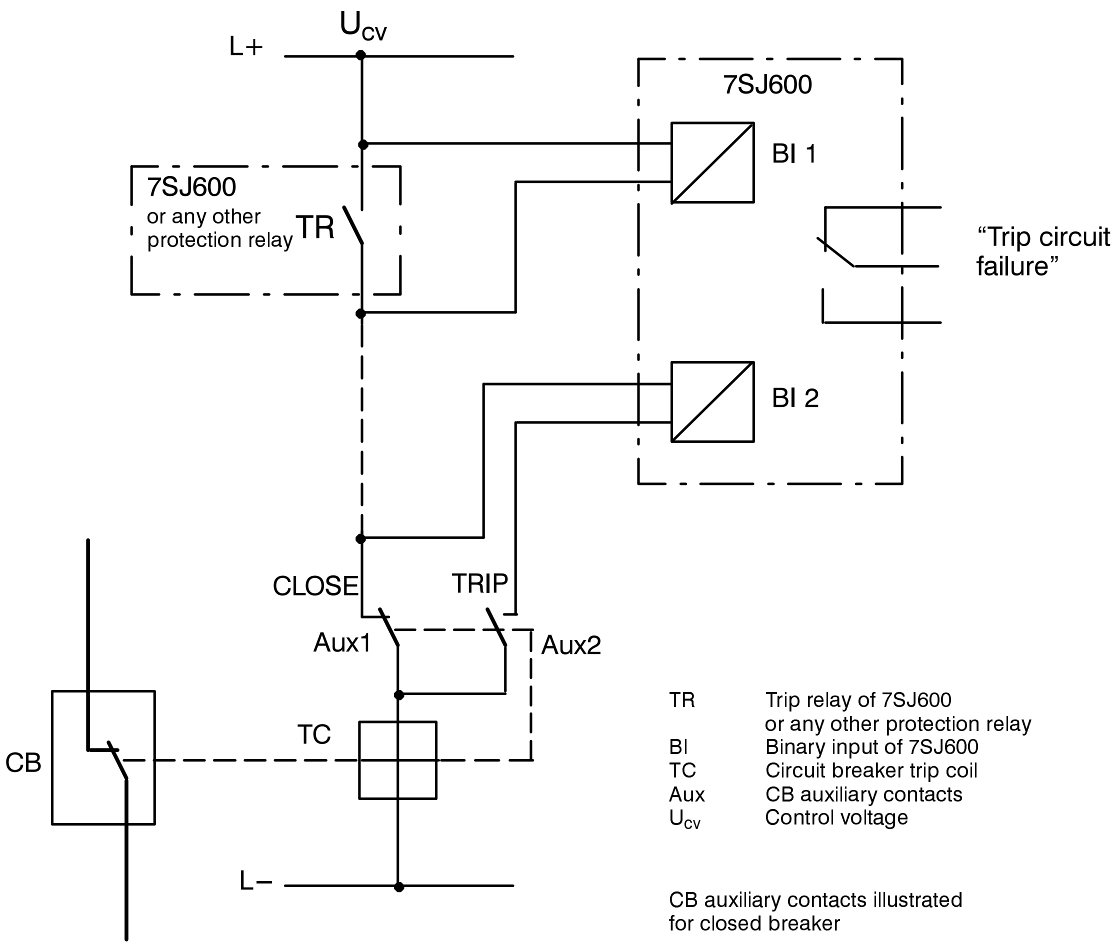
When one binary input is used, this is connected according to Figure 4.12: in parallel to the trip relay the circuit of which is to be supervised.

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, the status of the binary input is checked in relatively long periods (30 s). 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 4.12, compare with Figure 4.11). 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 5.2.3.




| 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 |

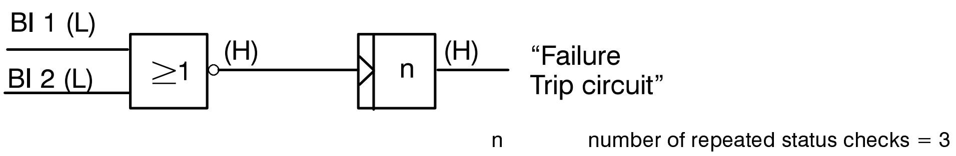



Figure 4.11 Principle of trip circuit supervision with two binary inputs

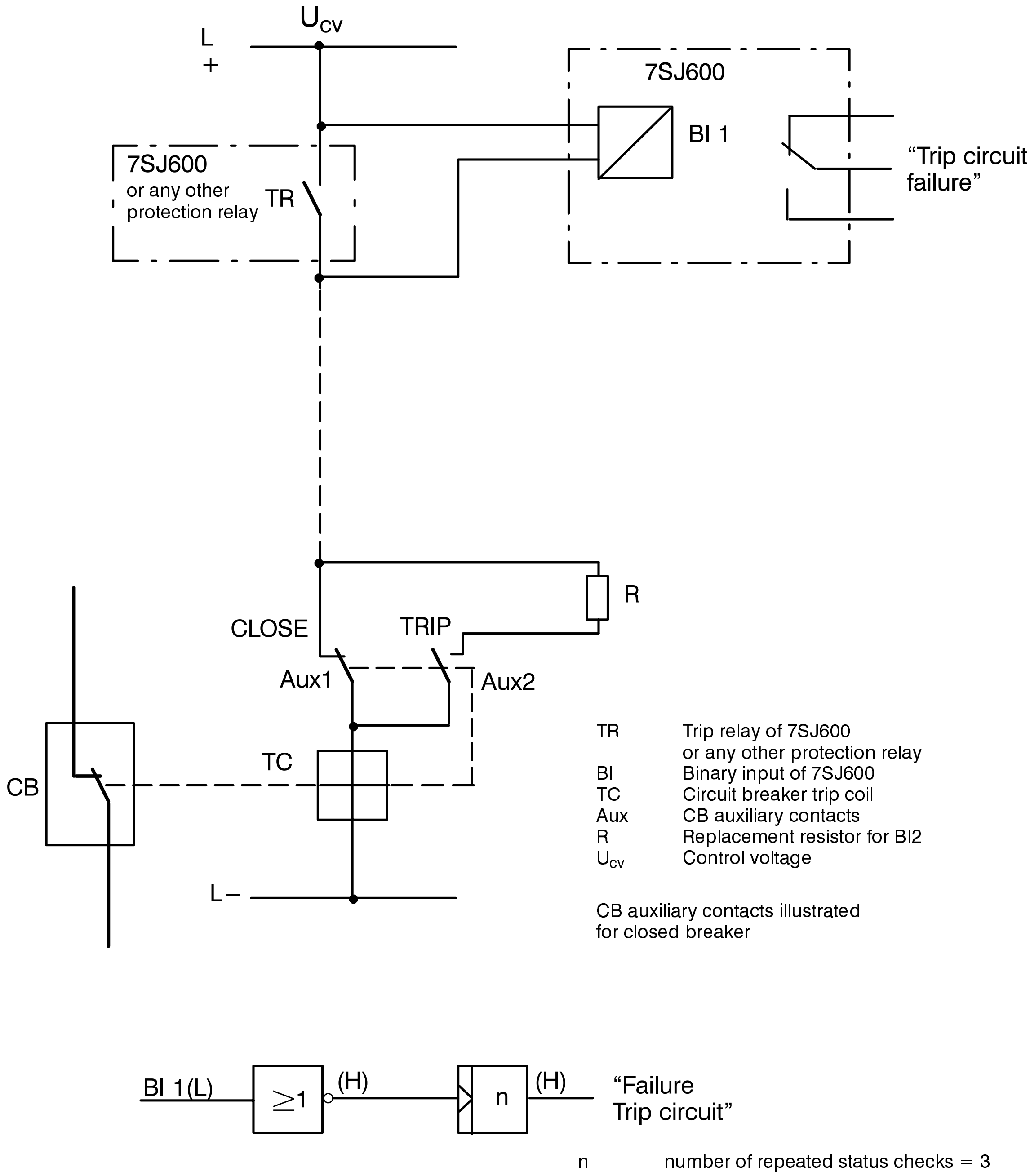



Figure 4.12 Principle of trip circuit supervision with one binary input

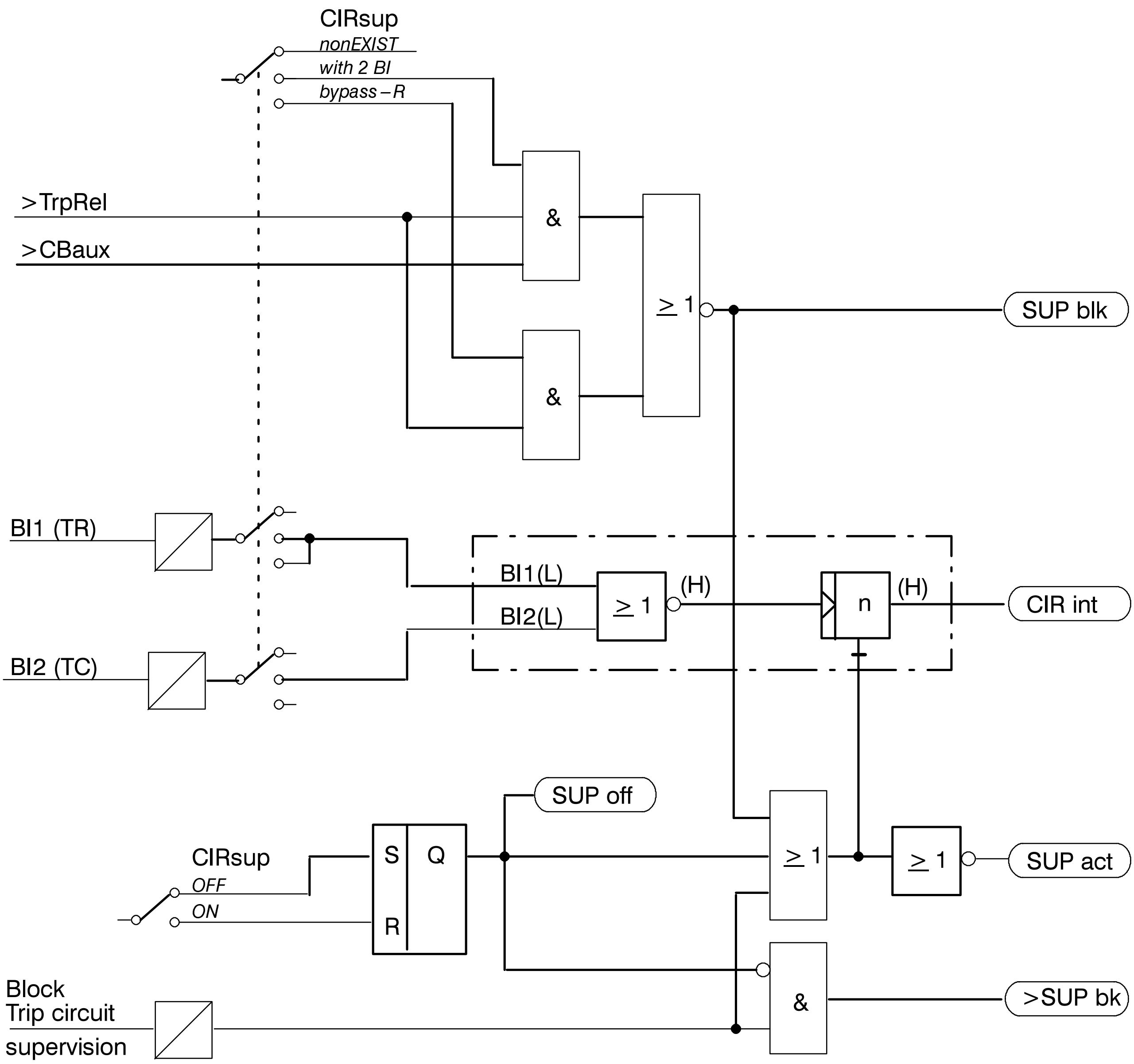



Figure 4.13 Logic diagram of trip circuit supervision

# 4.8 Ancillary functions

The ancillary functions of the numerical time overcurrent protection 7SJ600 include:

– processing of annunciations,

– storage of short-circuit data for fault recording,

– operational measurements,

– test routines,

– monitoring functions.

## 4.8.1 Processing of annunciations

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

### 4.8.1.1 Indicators and binary outputs (signal relays)

Important events and conditions are indicated by optical indicators (LED) on the front plate. The relay also contains signal relays for remote signalling. All 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 reset:

– locally, by operation of the reset button (“**N**”) on the relay,

– remotely by energization of the remote reset input,

– via the operating interface,

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

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

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

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

### 4.8.1.2 Information on the display panel or to a personal computer

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

In the quiescent state, i.e. as long as no network faults are present, the display outputs the operational measured values of the phase currents $I_{L1}$ and $I_{L2}$. In the event of a network fault, information on the fault appears instead of the operating information. The first line of the display indicates the phase(s) in which the fault has been detected. The second line displays the trip annunciation of the time overcurrent protection provided trip has occurred. If the relay picks up without trip (e.g. since an external fault has been cleared on a different power line), the second line does not change: the measured value remains standing. In the event of two successive pick-up occurrences it is possible that both display lines show pick-up information of the two successive pick-ups.

The quiescent information is displayed again once the fault annunciations have been acknowledged. The acknowledgement is identical to resetting of the stored LED displays as in Section 4.8.1.1.

The device also has several event buffers, e.g. for operating messages or fault annunciations (refer to Section 6.4). These messages, as well as the 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.

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 information 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 sequences so that non-successful auto-reclose attempts will also be stored as part of one network fault (if auto-reclosure is carried out). Thus, one network fault can include different fault events (from pick-up until drop-off). This is particularly advantageous for allocation of time data.

### 4.8.2 Data storage and transmission for fault recording

The instantaneous values of the measured values

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

are sampled at 1 ms intervals (for 50 Hz) or 0.83 ms intervals (for 60 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. 3 seconds are power-fail safe, i.e., after completion of the storing procedure, they are protected against voltage outage.

These data are then available for fault analysis. For each renewed fault event, the actual new fault data are stored without acknowledgement of the old data.

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

### 4.8.3 Operating measurements and conversion

For local recall or transmission of data, the true r.m.s. values of the phase currents are available as long as the relay is not dealing with a fault. When the overload protection with total memory is in operation the calculated temperature rise can be read out. When the warning threshold has been exceeded, the time to trip (steady-state current assumed), after an overload trip the time until the warning temperature rise is fallen below, can be read out.

The following is valid:

– $I_{L1}$, $I_{L2}$, $I_{L3}$ Phase currents in % of rated current and in A or kA primary,

– $\Theta/\Theta_{trip}$ calculated temperature rise referred to trip temperature rise.

### 4.8.4 Control functions

7SJ600 is – dependent on the ordered version – capable to control of a circuit breaker. That means that trip and close commands can be issued to the breaker via the integrated keypad on the front of the device, or via a serial interface from a personal computer or a localized switchgear automation system (LSA).

Breaker control can be blocked via a binary input.

The CLOSE command generates the annunciation "`Q0 Clo.`" which must be allocated to the binary output for breaker close (if applicable together with the AR close command) during configuration.

The annunciation remains until the general close command duration T–CL has expired. The close command is disrupted as soon as a trip command occurs.

The TRIP command generates the annunciation "`Q0 Trp`" which must be allocated to the binary output for breaker trip (together with the protection trip signal(s)) during configuration.

The annunciation remains until the general trip command duration T–TRP has expired. The close command of this control function does not initiate the auto-reclose function (if available).

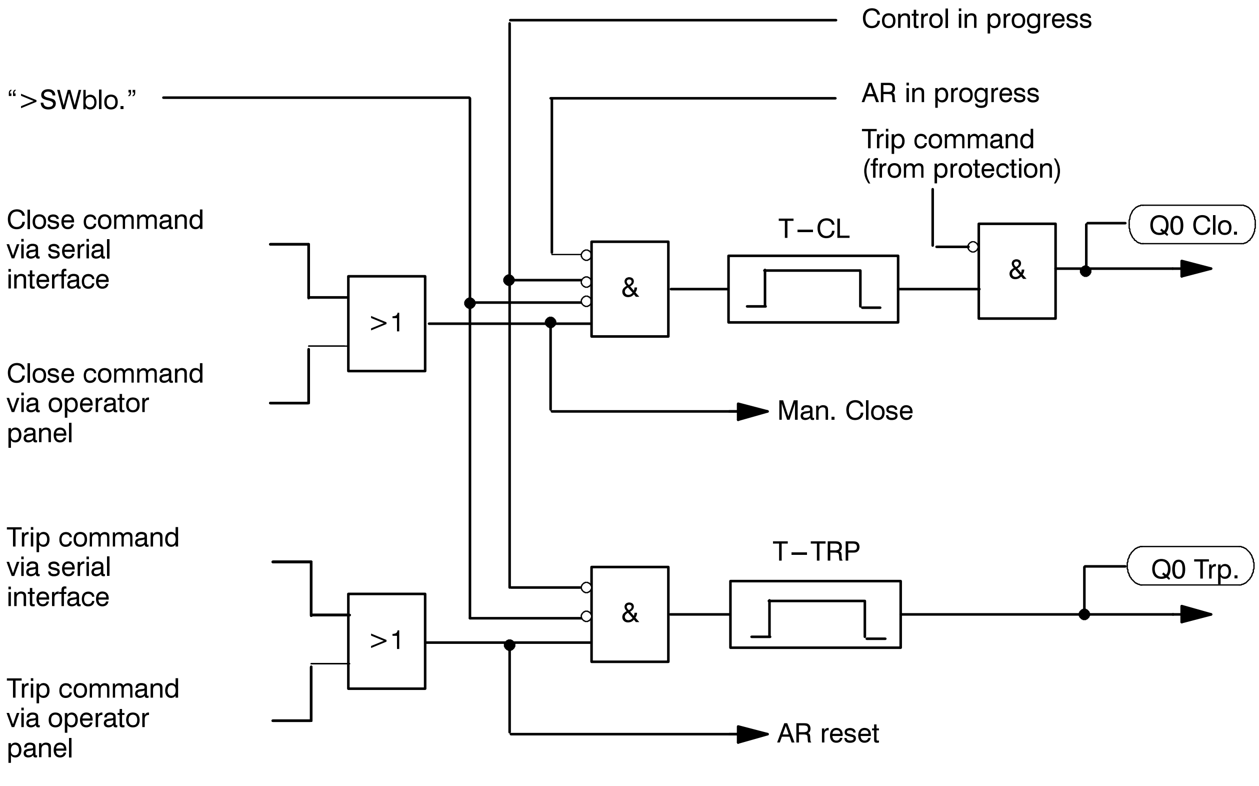



Figure 4.14 Logic of circuit breaker control

### 4.8.5 Test facilities

Numerical time overcurrent protection 7SJ600 allows simple checking of the tripping circuit and the circuit breaker as well as interrogation of the state of all binary inputs and outputs. Initiation of the test can be given from the operator keyboard or via the operator interface (refer to Section 6.7.3 and 6.7.4).

#### 4.8.5.1 Circuit breaker trip test

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

The relay issues a three-pole trip command. Before start of the procedure and during the test procedure, the relay indicates the test sequence in the display. If the relay is equipped with the auto-reclosure option, a TRIP/RECLOSE cycle can be initiated.

#### 4.8.5.2 Interrogation of binary states

The momentary condition of all binary inputs and binary outputs (signal relays, trip relays, LED indicators) can be displayed on request by the operator.

### 4.8.6 Monitoring functions

The device incorporates comprehensive monitoring functions which cover both hardware and software.

#### 4.8.6.1 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

  Failure or switch-off of the auxiliary voltage automatically puts the system out of operation; this status is indicated by the breaking contact of an availability relay provided it is accordingly allocated. Transient dips in supply voltage of less than 50 ms will not disturb the function of the relay (rated d.c. auxiliary voltage $\geq$ 110 V).

– Command output channels:

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

– Memory modules:

  After the relay has been connected to the auxiliary supply voltage, the working memory (RAM) is checked by writing a data bit pattern and reading it.

  The further memory modules are periodically checked for fault by

  - formation of the modulus for the program memory (EPROM) and comparison of it with a reference program modulus stored there,

  - Formation of the modulus of the values stored in the parameter store (EEPROM) then comparing it with the newly determined modulus after each parameter assignment process.

#### 4.8.6.2 Software monitoring

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

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

# 5 Installation instructions

## ⚠ Warning

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

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

## 5.1 Unpacking and repacking

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

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

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

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

## 5.2 Preparations

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

### ⚠ Caution!

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

In installed conditions, the modules are in no danger.

## 5.2.1 Mounting and connections

### 5.2.1.1 Model 7SJ600⋆–⋆B⋆⋆⋆ or –⋆D⋆⋆⋆ for panel surface mounting

– Secure the unit with four screws to the panel. Verify sufficient space to adjacent relays in case of model –⋆B⋆⋆⋆. For dimensions refer to Figure 2.1 or 2.2.

– Make a solid low-ohmic and low-inductive operational earth connection between the earthing surface at the bottom 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; observe labelling of the individual terminals; observe the maximum permissible cross sections and torque (see Section 2.2). Use copper conductors only!

– If the RS485 interface is used, the cable screen must be earthed.

### 5.2.1.2 Model 7SJ600⋆–⋆E⋆⋆⋆ for panel flush mounting or cubicle installation

– Slip away the covers at top and bottom of the housing in order to gain access to the four holes in the fixing angle.

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

– 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 connectors of the housing. Observe labelling of the individual connector modules to ensure correct location; observe the max. permissible conductor cross-sections and torque (see Section 2.2). Use copper conductors only! The use of the screwed terminals is recommended; snap-in connection requires special tools and must not be used for field wiring unless proper strain relief and the permissible bending radius are observed.

– Earth the screen of the serial RS485 interface when it is used.

## 5.2.2 Checking the rated data

The rated data of the unit must be checked against the plant data. This applies in particular to the auxiliary voltage and the rated current of the current transformers.

### 5.2.2.1 Auxiliary voltage

Four different ranges of auxiliary voltage can be delivered (cf. Section 2.3 and 3.1). If, for exceptional reason, the rated voltage of the supply input is to be changed, it must be taken into account that the models for rated auxiliary voltage 60/110/125 Vdc and 220/250 Vdc differ from each other by different plug jumpers. The assignment of these jumpers and their location on the p.c.b. are shown in Figure 5.1. The model for 220/250 Vdc is suitable for 115 Vac, too. A different model is suited for 230 Vac. When the relay is delivered, all theses plugs are correctly located and matched to the specification given on the name plate of the relay, so that, normally, none of the bridges need to be altered.

### 5.2.2.2 Rated currents

The current inputs of the relay are matched to the rated current as given on the name plate of the relay according to the order designation. The rated current is considered by correct location of plug jumpers on the p.c.b. The assignment of these jumpers and their location on the p.c.b. are shown in Figure 5.2. When the relay is delivered, all theses plugs are correctly located and matched to the specification given on the name plate of the relay, so that, normally, none of the bridges need to be altered.

### 5.2.2.3 Control d.c. voltage of binary inputs

When delivered from factory, the binary inputs are designed to operate in the total control voltage range from 17 V to 288 V d.c. If the rated control voltage for binary inputs is 110 V or higher, it is advisable to fit a higher pick-up threshold to these inputs in order to increase stability against stray voltages in the d.c. circuits.

To fit a higher pick-up threshold of approximately 74 V to a binary input a solder bridge must be removed. Figure 5.3 shows the assignment of these solder bridges and their location on the p.c.b.

*Note:* If binary inputs are used for trip circuit supervision, it must be considered that two binary inputs (or one input and a replacement resistor) are connected in series. Therefore, the pick-up threshold must be clearly smaller than half the control voltage.

– Slip away the covers at top and bottom of the housing in order to gain access to the two fixing screws of the module. Unscrew these screws.

– Pull out the module by taking it at the front cover and place it on a surface which is suited to electrostatically endangered components (EEC);

## ⚠ Caution!

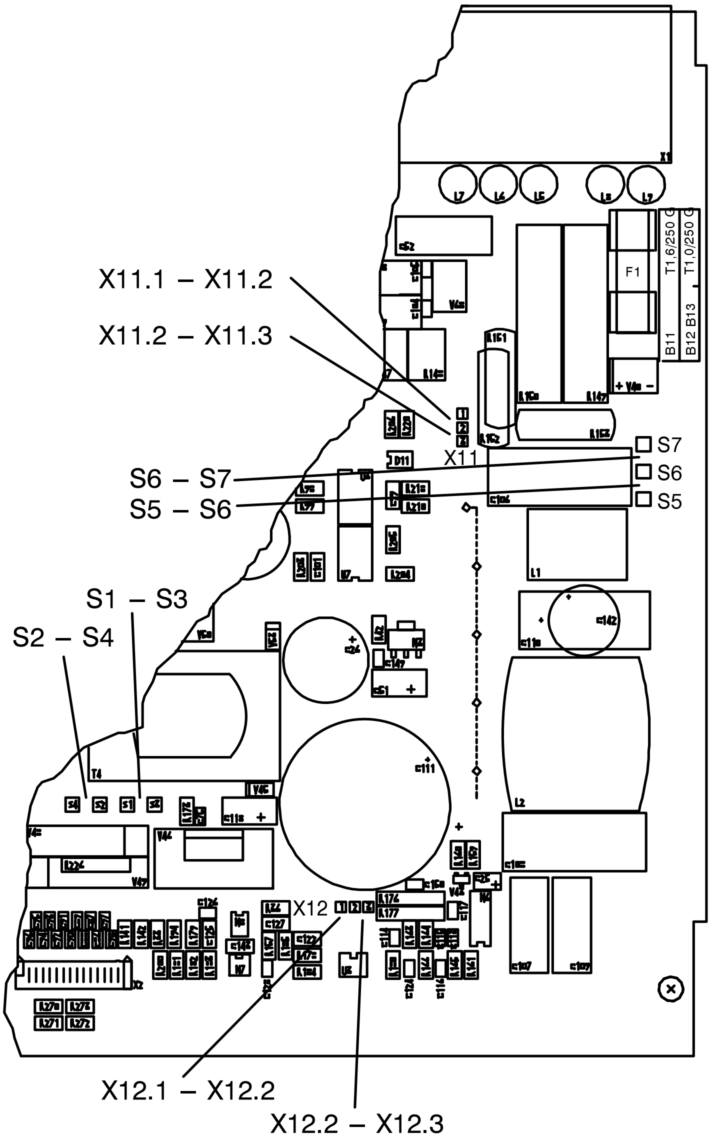
Electrostatic discharges via the component connections, the PCB tracks or the connecting pins of the modules must be avoided under all circumstances by previously touching an earthed metal surface.

– Check the solder bridges according to Figure 5.1 to 5.3.

– Insert module into the housing;

– Fix the module into the housing by tightening the two fixing screws.

– Re-insert covers.




| Bridges | Rated auxiliary voltage | |
|---|---|---|
| | 60 $V_{dc}$<br>110 $V_{dc}$<br>125 $V_{dc}$ | 220 $V_{dc}$<br>250 $V_{dc}$<br>115 $V_{ac}$ |
| X11.1 – X11.2 | x | |
| X11.2 – X11.3 | | x |
| X12.1 – X12.2 | | x |
| X12.2 – X12.3 | x | |
| S1 – S3 | x | |
| S1 – S2 | | x |
| S2 – S4 | x | |
| S5 – S6 | | x |
| S6 – S7 | x | |

Figure 5.1 Checking for auxiliary voltage of the integrated dc-dc-converter

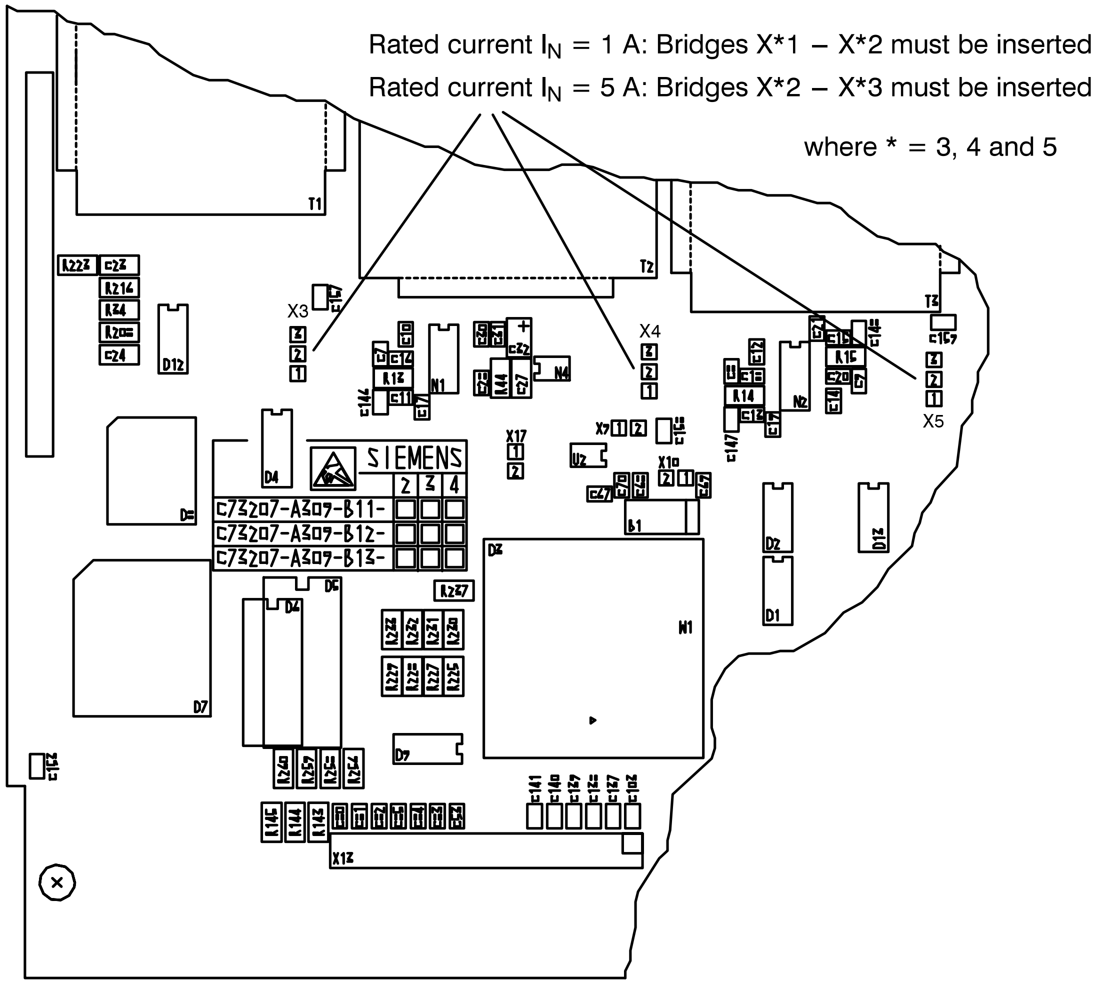
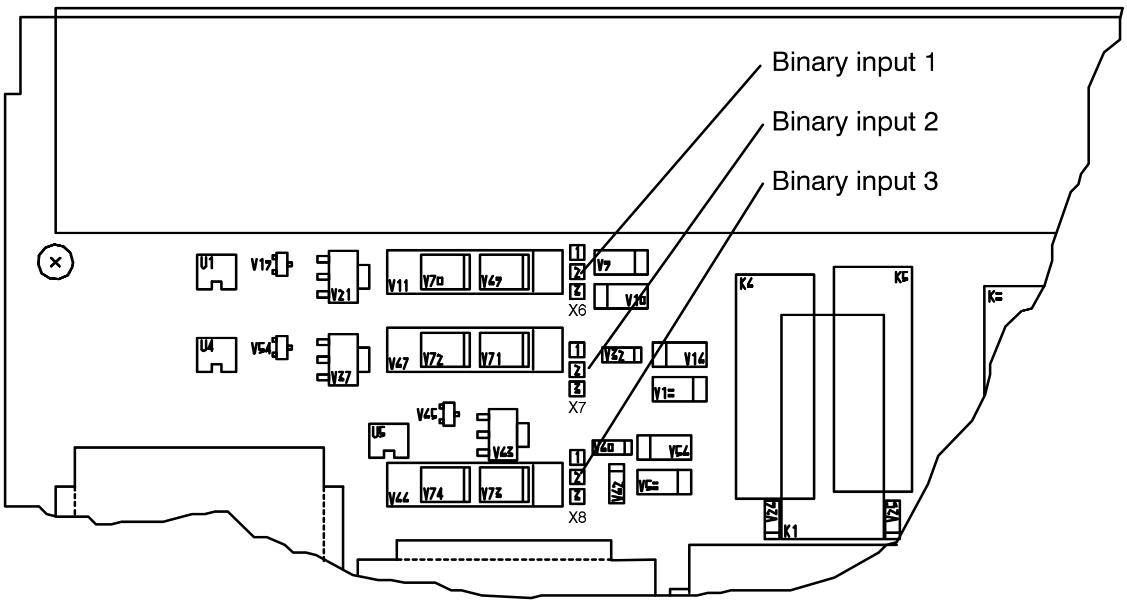



Figure 5.2 Checking for the rated current 1 A/5 A




For rated voltages 24/48/60 Vdc: Bridges X*2 – X*3 must be inserted! (pick-up threshold approx. 17 Vdc)

For rated voltages 110/125/220/250 Vdc: Bridges X*1 – X*2 may be inserted. (pick-up threshold approx. 74 Vdc)

where * = 6, 7 and 8

Figure 5.3 Checking for control voltages for binary inputs

### 5.2.3 Connections

General and connection diagrams are shown in Appendix A and B. The marshalling possibilities of the binary inputs and outputs are described in Section 5.5.

If 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 4.7, where also the principle connections are given.

*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.

If one single binary input is available (Figure 5.4), 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 4.7.2). Thus, 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 5.4).

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:

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

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

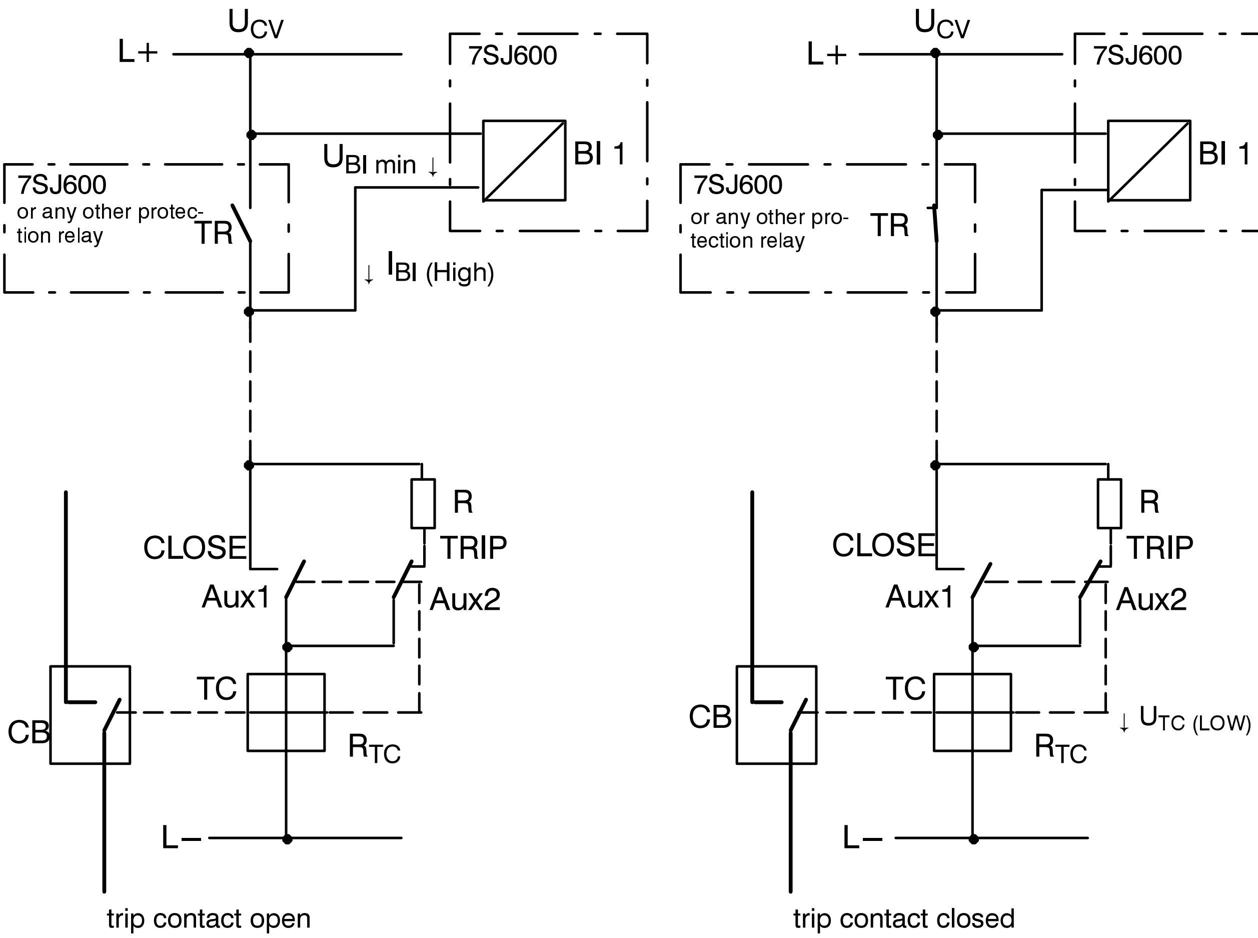



Figure 5.4 Dimensioning the external resistor R when one single binary input is used

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

$I_{BI\,(High)}$ constant current which operates the binary input (approx. 2 mA)

$U_{BI\,min}$ minimum control voltage for the binary input (approx. 17 V at delivery, approx. 75 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

Example:

$I_{BI\,(High)}$ 2 mA (protection relay data)

$U_{BI\,min}$ 17 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)

$$R_{max} = \frac{110\text{ V} - 17\text{ V}}{2\text{ mA}} - 500\ \Omega$$

$$R_{max} = 46\text{ k}\Omega$$

$$R_{min} = 500\ \Omega \cdot \frac{110\text{ V} - 2\text{ V}}{2\text{ V}}$$

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

$$R = \frac{R_{max} + R_{min}}{2} = 36.5\text{ k}\Omega$$

The nearest standard value is selected: 33 kΩ.

### 5.2.4 Checking the connections

**⚠ Warning**

Some of the following test steps are carrie out in presence of hazardous voltages They shall be performed by qualified per sonnel only which is thoroughly familiar witl all safety regulations and precautionar measures and pay due attention to them. Non-observance can result in severe per sonal injury.

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

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

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

- Are the current transformers correctly earthed?

- Is the phase relationship of the current transformers correct? The relay may be connected to L1 – L2 – L3 or L1 – E – L3 (E = residual current). This must be in accordance with parameter “CT 2” (address block 01, refer to Section 6.3.3).

- Are the polarities of the current transformer connections consistent?

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

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

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

– The measured current consumption should correspond to the quiescent power consumption of approximately 2 W/VA. Transient movement of the ammeter pointer only indicates the charging current of the storage capacitors.

– Open the circuit breaker for the power supply.

– Remove the ammeter; reconnect the auxiliary voltage leads.

– Close the power supply circuit breaker. The unit starts up and, on completion of the run-up period, the green LED on the front comes on, the red LED gets off after at most 7 sec.

– Open the circuit breaker for the power supply.

– Check through the tripping circuits to the circuit breaker.

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

– Check the signal circuits.

# 5.3 Configuration of operation and memory functions

## 5.3.1 Operational preconditions and general

For most operational functions, the input of a codeword is necessary. The “codeword” is a predefined key sequence which must be entered via the membrane keyboard or operating interface which concern the operation on the relay, for example

- configuration parameters for operation language, interface configuration, and device configuration,
- allocation or marshalling of annunciation signals, binary inputs, optical indications,
- setting of functional parameters (thresholds, functions).
- starting of test procedures.

In order to indicate authorized operation and to prevent from unintended alteration, the codeword must be entered before any alteration can be performed.

When an operation object is selected which requires codeword input, press one of the keys ⊞ or ⊟ in order to inform the relay about the intended alteration. The display then shows the line “CW :” which indicates that the codeword is required. The 'codeword' itself consists of the key sequence ⊟ ⊞ ⊟. Press these keys in the indicated sequence and confirm with the enter key **E**. If the codeword is correct the display shows “CW OK_”. By pressing the enter key **E** one more time the operation item is displayed again. Use the keys ⊞ or ⊟ in order to change the presented text or numerical value. A flashing cursor indicates that the relay operates now in alteration mode, starting with the first alteration and ending after confirmation of the altered item with the enter key **E**. The alteration mode is equally ended when the setting menu is left or after an internal waiting time.

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

```
C W :
@ @ @
```

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

```
C W   O K _
```

```
C W   W R O N G
```

If the codeword is not correct the display shows **CW WRONG**. Pressing the keys ⊞ or ⊟ allows another attempt at codeword entry.

The operating interface is built up by a hierarchically structured menu tree, which can be passed through by means of the scrolling keys ◁ , ▷ , △, and ▽. Thus, each operation object can be reached. A complete overview is listed in Appendix C. Figure 5.5 illustrates the way to get to the configuration items.

After the relay has been switched on, the display shows the type designation and the version of the implemented firmware. Pressing the key ▽ leads to the first main menu item “PARAME.” (parameters) in the first operation level of the menu tree. Press key ▷ to reach the second operation menu level, which starts with the first parameter block “00 CONF.” (configuration). Press the key ▽ repeatedly until address block 71 appears. You may scroll back with the key △ or page to the previous operation menu level with ◁ .

Next to the address block number (71), the heading of the address block appears in abbreviated form: “INT. OP” (integrated operation).


[7100]
Beginning of the block “Integrated operation”

Address blocks 71 to 74 are provided for configuration of the software operating system. These settings concern the operation of the relay, communication with external operating and processing devices via the serial interface, and the interaction of the device functions.

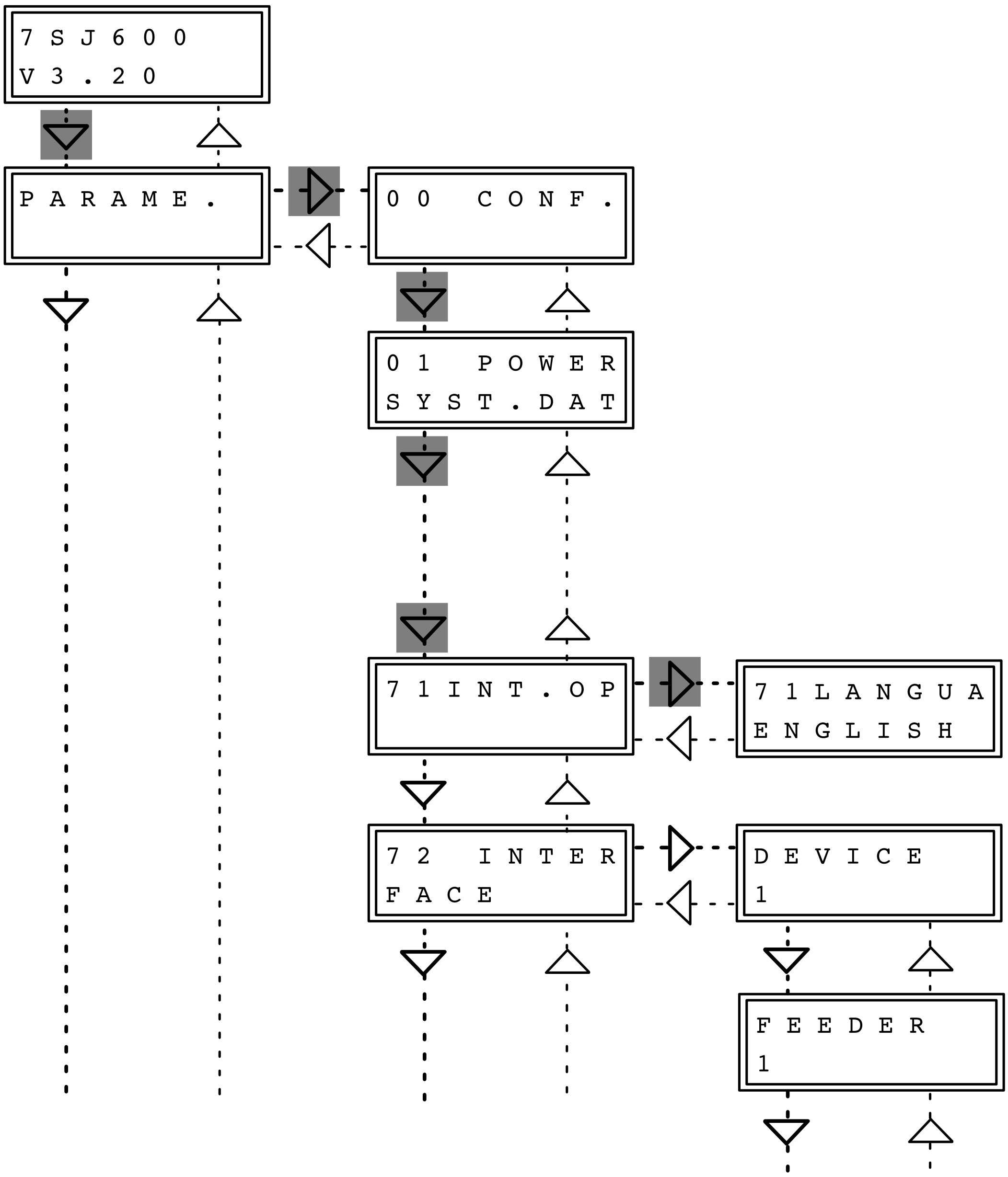



Figure 5.5 Extract from the operation structure and illustration of selection of the configuration blocks

You may, for example, change with the key ▷ to the third operation menu level, then with key ◁ back to the second operation menu level, as shown in Figure 5.5. Press the key ▽ to change to address block 72, etc.

The display shows the two-figure address block number and the meaning of the requested parameter (Figure 5.5). In the second display line follows the text or number which is presently applicable. The preset text or number can be altered by pressing the keys ⊞ or ⊟.

When the relay is operated from a personal computer by means of the protection data processing program DIGSI®, each configuration parameter is identified by a four-digit address number. In the following clarifications, this number is indicated at the beginning of the explanations in brackets.

For text parameters, an alternative text appears which is illustrated in the explanations below. Multiple alternatives may be possible. The alternative which is chosen, **is confirmed with the enter key E.** When the last possible alternative is reached, no further changing with the key ⊞ is possible. The same is valid when one tries to change the first alternative with the key ⊟.

If a numerical value of the parameter is required, the preset number can equally be changed with the keys ⊞ or ⊟ in order to get a higher or lower number. The desired value **must be confirmed with the enter key E!**

When one of the keys, ⊞ or ⊟, is pressed continuously, the numbers will change with an accelerating sequence. Thus, a fast and fine adjustment is possible within a wide setting range.

If one tries to leave an operating item or operating level by pressing one of the arrow keys without having confirmed an alteration with the enter key **E**, the display will show the question “SAVE NEW SETTING?”. Confirm with the “Yes”-key **Y/J** that the new settings shall become valid now. If you press the “No”-key **N** instead, codeword operation will be aborted, and the alteration which has been changed since the last entry is lost. Thus, erroneous alterations can be made ineffective. Press the arrow key once again in order to change really the operating item or level.

When the configuration or setting process is terminated by pressing the enter key **E**, the altered parameters are permanently secured in EEPROMs and protected against power outage.

## 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 to be selected.

When the relay is delivered from the factory, the device is programmed to give function names and outputs in the English language. This can be changed under address block 71. This item is reached from the second operation level, address block 71 (as described above) by changing with the key ▷ to the third operation level where the operation language may be changed. The operator languages available at present are shown in the boxes below.

```
◁  7 1 L A N G U A
   E N G L I S H
+  D E U T S C H
   F R A N C A I S
   E S P A N O L
```

[7101]
The available languages can be called up by repeatedly pressing the key ⊞ or ⊟ Each language is spelled in the corresponding national language. If you don’t understand a language, you should find your own language, nevertheless.

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

### 5.3.3 Configuration of the serial interface − address block 72

The device provides one serial interface (operating or PC interface). Communication via this interface requires some data prearrangements: identification of the relay, transmission format, transmission speed.

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

The setting of the GAPS is relevant only when the relay is intended to communicate via a modem. The setting is 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.

---

```
72 INTER
FACE
```

[7200]
Beginning of the block “Interface for personal computer”

```
DEVICE
1
```

[7201]
Identification number of the relay within the substation; 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**

```
FEEDER
1
```

[7202]
Number of the feeder within the substation;
Smallest permissible number: **1**
Largest permissible number: **254**

```
SUBSTA.
1
```

[7203]
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**

```
FUN.TYPE
160
```

[7208]
Function type in accordance with IEC 60870−5−103; for overcurrent time protection no. 160.
This address is mainly for information, it should not be changed.

| Display | Description |
|---|---|
| PC INTER<br>DIGSI V3 | [7211]<br>Data format for the PC (operating) interface:<br>format for Siemens protection data processing program *DIGSI*® Version *V3* |
| + ASCII | *ASCII* format |
| IEC com. | *IEC com*patible format (acc. IEC 60870–5–103) |
| IEC ext. | compatible with *IEC* 60870–3–105 and *ext*ended |

| Display | Description |
|---|---|
| 72 GAPS<br>1.0 s | [7214]<br>Maximum time period of data gaps which may occur during data transmission via modem<br>Smallest setting value: **0.0** s<br>Largest setting value: **5.0** s |

| Display | Description |
|---|---|
| PC BAUD<br>9600BAUD | [7215]<br>The transmission Baud-rate for communication via the PC (operating) interface 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 key **+** or **–**. Confirm the desired Baud-rate with the entry key **E**. |
| + 19200 BD | |
| 1200BAUD | |
| 2400BAUD | |
| 4800BAUD | |

| Display | Description |
|---|---|
| PARITY<br>DIGSI V3 | [7216]<br>Parity and stop-bits for the PC (operating) interface:<br>format for Siemens protection data processing program *DIGSI*® Version *V3* with even parity and 1 stop-bit |
| + 8 0 1 | transmission with *O*dd parity and *1* stop-bit |
| 8 N 2 | transmission with *N*o parity and *2* stop-bits |
| 8 N 1 | transmission with *N*o parity and *1* stop-bit |

### 5.3.4 Settings for fault recording – address block 74

The time overcurrent protection relay is equipped with a fault data store (see Section 4.8.2). Distinction must be made between the reference instant and the storage criterion. Normally, the general fault detection signal of the protection is the reference instant. The storage criterion can be the general fault detection, too (*RECbyFT*), or the trip command (*RECbyTP*). Alternatively, the trip command can be selected as reference instant (*SRT witTP*), 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.

The actual recording time starts with the pre-trigger time T–PRE before the reference instant and ends with the post-fault time T–POS after the recording criterion has disappeared. The permissible recording time (incl. pre-trigger and post-fault time) for each record (incl. pre-trigger and post-fault time) is set as T–MAX. Altogether 5 s are available for fault recording. Within this time range, up to 8 fault records can be stored. 3 s of the total time are saved against power failure.

*Note:* The set times are related on a system frequency of 50 Hz. They are to be matched, accordingly, for different frequencies.

| Display | Description |
|---|---|
| 74 FAULT<br>RECORDER | [7400]<br>Beginning of block “Fault recordings” |
| 74 RECini<br>RECbyFT | [7402]<br>Data storage is initiated:<br>– fault detection is reference instant<br>fault detection is storage criterion |
| + RECbyTP | – fault detection is reference instant<br>trip command is storage criterion |
| SRTwitTP | – trip command is reference instant<br>trip command is storage criterion |
| 74 T-MAX<br>1.00 s | [7410]<br>Maximum time period of one fault record<br>Smallest setting value: **0.30** s<br>Largest setting value: **5.00** s |
| 74 T-PRE<br>0.10 s | [7411]<br>Pre-trigger time before the reference instant<br>Smallest setting value: **0.05** s<br>Largest setting value: **0.50** s |
| 74 T-POS<br>0.10 s | [7412]<br>Post-fault time after the storage criterion disappears<br>Smallest setting value: **0.05** s<br>Largest setting value: **0.50** s |

# 5.4 Configuration of the protective functions

## 5.4.1 Introduction

The device 7SJ600 provides a series of protection and additional functions. The scope of the hard- and firm-ware is matched to these functions. Furthermore, individual functions can be set (configured) to be effective or non-effective by configuration parameters. A preselection of the characteristics of the overcurrent time protection can be made, additionally.

Example for configuration of the scope of functions: Assume a network comprising overhead lines and cable sections. Overload protection is only reasonable for the cable sections, this function will be "de-configured" for the devices protecting the overhead line sections.

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

For the purpose of configuration, address block 00 is provided. This block is reached from the initial display in operation level 1 with the key ▽ ("PARAME.") and changing with key ▷ to the second operation level. Address block 00 CONFiguration appears (Figure 5.6).

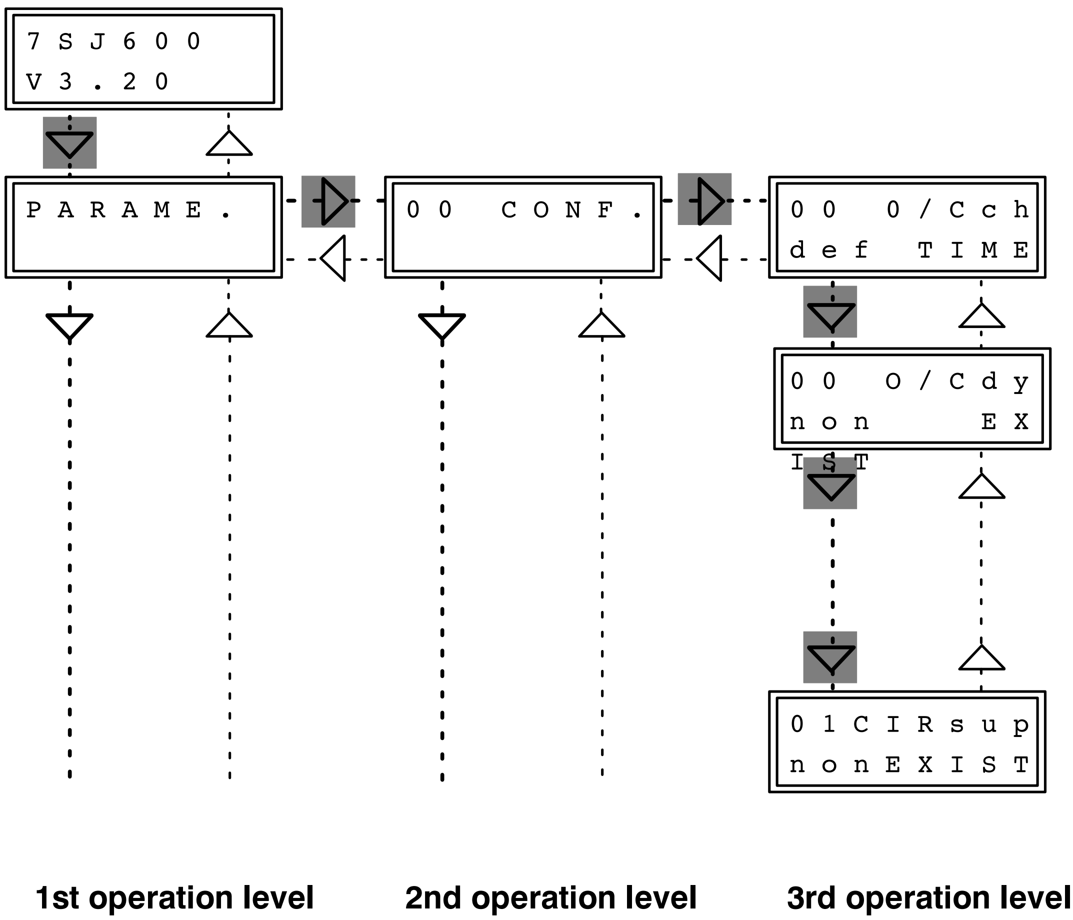



Figure 5.6 Extract from the operation structure and illustration of selection of the configuration block

Within the block 00 one can page with key ▷ to the third operation level and scroll on with key ∇ or scroll back with key Δ. Each paging action leads to a further operation object for the input of a configuration parameter. In the following sections, each operating object is shown in a box and explained. In the upper line of the display, behind the block 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 Δ can be used to page the next or previous operating item. If the text should be altered, press the keys ⊞ or ⊟, after having input the codeword; an alternative text then appears (e.g. "*nonEXIST*"). There may be other alternatives which can then be displayed by repeated depression of the keys ⊞ or ⊟. When the last possible alternative is reached, no further changing with the key ⊞ is possible. The same is valid when one tries to change the first alternative with the key ⊟. The required alternative **must be confirmed with the key E!**

When the relay is operated from a personal computer by means of the protection data processing program DIGSI®, each configuration parameter is identified by a four-digit address number. In the following clarifications, this number is indicated at the beginning of the explanations in brackets.

If one tries to leave an operating item or operating level by pressing one of the arrow keys without having confirmed an alteration with the enter key **E**, the display will show the question "SAVE NEW SETTING?". Confirm with the "Yes"-key **Y**/**J** that the new settings shall become valid now. If you press the "No"-key **N** instead, codeword operation will be aborted, and the alteration which has been changed since the last entry is lost. Thus, erroneous alterations can be made ineffective. Press the arrow key once again in order to change really the operating item or level.

When the configuration or setting process is terminated by pressing the enter key **E**, the altered parameters are permanently secured in EEPROMs and protected against power outage.

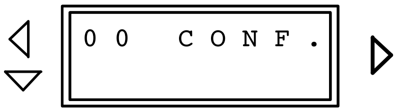
With the arrow key ◁ (one level back), the second operation level can be reached where you may scroll with key ∇ to the next address block. If you press the arrow key ◁ once again, the first operation level is reached.

## 5.4.2 Programming the scope of functions – address block 00

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 *nonEXIST* will not be processed in 7SJ600: There will be no annunciations and the associated setting parameters (functions, limit values) will not be requested during setting (Section 6.3). In contrast, **switch-off** of a function means that the function will be processed, that indication will appear (e.g. "`... switched off`") but that the function will have no effect on the result of the protective process (e.g. no tripping command).

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




[7800]
Beginning of block "Configuration of the scope of functions"

Overcurrent time protection:
Preselection of tripping characteristic

[7801]

```
00  O/Cch
def  TIME
```

Only definite time characteristics (for phase and earth currents) are available

```
+ I>>>  I>>
```

Only the high current stage I>> and the instantaneous very high current stage I>>> (for phase currents) and the high current stage $I_E$>> (for earth current) are available
**Attention!** This option must only be used without auto-reclosure, as these stages will be blocked after the first auto-reclose cycle!

```
IEC  inv.
```

The four inverse time characteristics according IEC are available (refer to Figures 3.1 and 3.2, Section 3.3), besides the high-current and very high current stages

```
ANSI  inv
```

The eight inverse time characteristics according ANSI are available (refer to Figures 3.3 and 3.4, Section 3.3), besides the high-current and very high current stages

```
IEC  O/C
```

The definite time stages as well as the four inverse time characteristics according IEC are available (refer to Figures 3.1 and 3.2, Section 3.3), besides the high-current and very high current stages

```
ANSI  O/C
```

The definite time stages as well as the eight inverse time characteristics according ANSI are available (refer to Figures 3.3 and 3.4, Section 3.3), besides the high-current and very high current stages

```
nonEXIST
```

No overcurrent time protection is available

---

[7802] Dynamic switch-over of pick-up values

```
00  O/Cdy
nonEXIST
+ EXIST
```

[7805] Start-up time supervision:

```
01  STRT
nonEXIST
+ EXIST
```

[7803] Unbalanced load protection:

```
01  UNB.L
nonEXIST
+ EXIST
```

[7834] Automatic reclosure:

```
01  AR
nonEXIST
+ EXIST
```

[7804] Thermal overload protection:

```
01  O/L
nonEXIST
+ preLOAD
no  preLD
```

preLOAD: with total memory (preload considered)

no preLD: without memory (no preload)

[7839] Trip circuit supervision:

```
01CIRsup
nonEXIST
+ with  2BI
bypass-R
```

## 5.5 Marshalling of binary inputs, binary outputs and LED indicators

### 5.5.1 Introduction

The functions of the binary inputs and outputs represented in the general diagrams (Appendix A) relate to the factory settings. The assignment of the inputs and outputs of most of the internal functions can be rearranged and thus adapted to the on-site conditions.

Marshalling of the inputs, outputs and LEDs is performed by means of the integrated operator panel or via the operating interface. The operation of the operator panel is described in detail in Section 6.2. Marshalling begins at the address block 60.

The input of the codeword is required for marshalling (refer to Section 5.3.1). Without codeword entry, parameters can be read out but not be changed. A flashing cursor indicates that the relay operates now in alteration mode, starting with the first alteration and ending after confirmation of the altered item with the enter key **E**. The alteration mode is equally ended when the setting menu is left or after an internal waiting time.

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

**Example:** A fault is registered from any of the integrated protection functions. This event is generated in the device as an “Annunciation” (logical function) and should be available at certain terminals of the unit as a N.O. contact. Since specific unit terminals are hard-wired to a specific (physical) signal relay, e.g. to the signal relay 2, the processor must be advised that the logical signal “`FT det`” (fault detected) should be transmitted to the signal relay 2. Thus, when marshalling is performed two statements of the operator are important: **Which** (logical) annunciation generated in the protection unit program should trigger **which** (physical) signal relay? Up to 20 logical annunciations can trigger one (physical) signal relay.

A similar situation applies to binary inputs. In this case external information (e.g. blocking of I>> stage) is connected to the unit via a (physical) input module and should initiate a (logical) function, namely blocking. The corresponding question to the operator is then: **Which** signal from a (physical) input relay should initiate **which** reaction in the device? One physical input signal can initiate up to 10 logical functions.

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

The logical annunciation functions can be used in multiple manner. E.g. one annunciation function can trigger several signal relays, several trip relays, additionally be indicated by LEDs, and be controlled by a binary input unit.

The 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) functions should be allocated.

The offered logical functions are tabulated for the binary inputs, outputs and LEDs in the following sections.

The marshalling block is reached with the keys ▽ (scrolling forwards) or △ (scrolling backwards), ▷ (next operation level) or ◁ (previous operation level), i.e. from the initial display (Figure 5.7):

– key ▽ (forwards),

– key ▷ (second operation level),

– key ▽ (forwards) until address block 60 appears in the display.

```
6 0   M A R S H
```

[6000]
Beginning of marshalling blocks

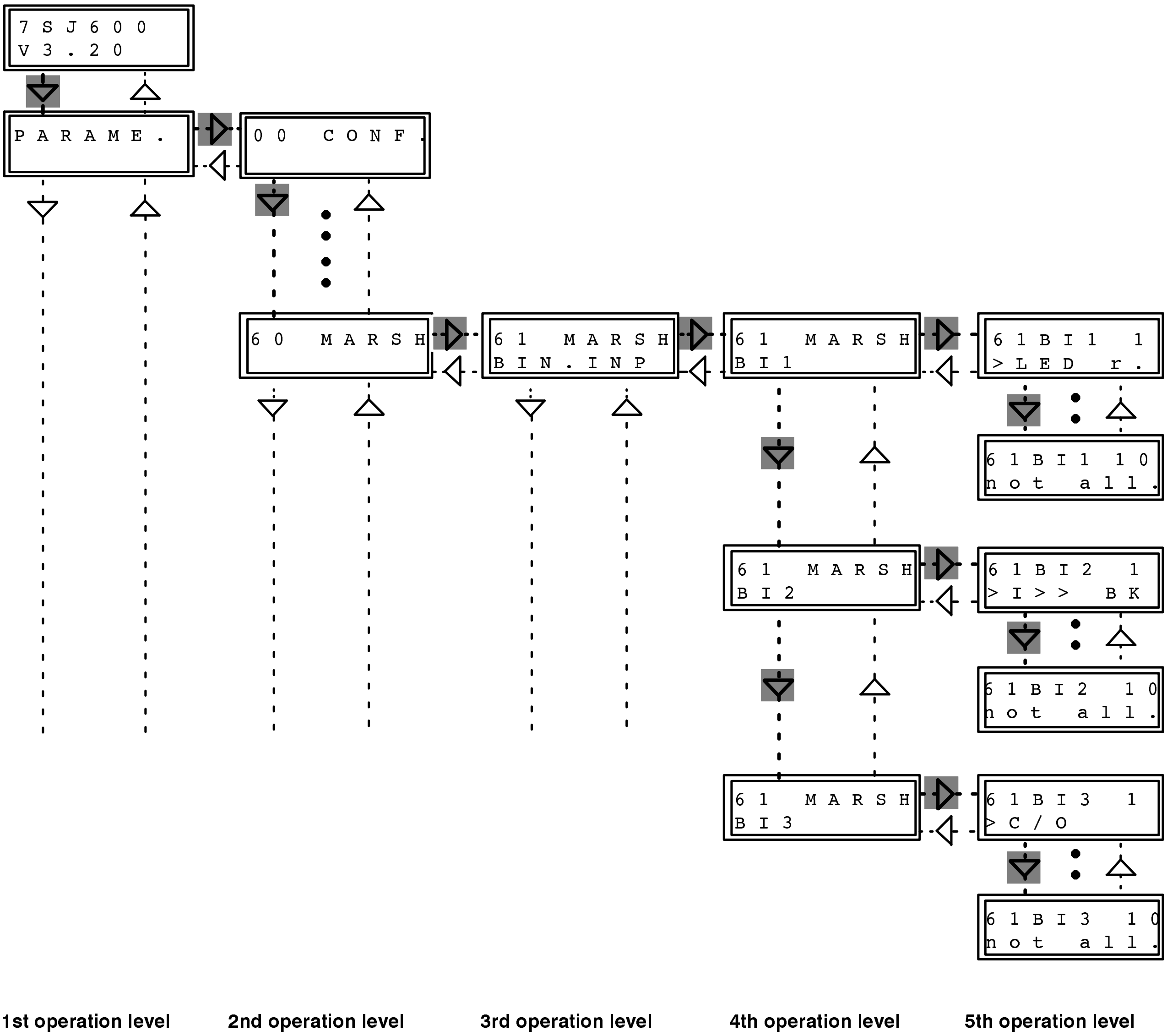



Figure 5.7 Extract from the operation structure and illustration of selection of the marshalling blocks

You may, for example, change with the key ▷ to the next operation menu level, then with key ◁ back to the previous operation menu level, as shown in Figure 5.7. Within a menu level, key ▽ is used to scroll forwards or △ to scroll backwards. Each forward or backward step in the fourth operation level leads to display of the next input, output or LED position. In the display the physical input/output unit forms the heading.

Key ▷ leads to the selection level of an individual input/output module. The display shows, in the upper line, the physical input/output unit, this time with a one to two digit index number. The second display line shows the logical function which is presently allocated.

On this selection level the allocated function can be changed after codeword input by pressing the key ⊞. By repeated use of the key ⊞ all marshallable functions can be paged through the display. Backpaging is possible with the key ⊟. When the required function appears press the execute key **E**. After this, further functions can be assigned to the same physical input or output module (with further index numbers) by using the key ▽. **Each selection must be confirmed by pressing the key E!** If a selection place shall not be assigned to a function, selection is made with the function “`not all.`” (not allocated).

You can leave the selection level by pressing the key ◁. The display shows again the previous selection level. Now you can page with key ▽ to the next input/output module or with △ to the previous to repeat selection procedure, as above.

In the following paragraphs, allocation possibilities for binary inputs, binary outputs and LED indicators are given. The arrows ▽ △ or ▷ ◁ at the left hand side of the display box indicate paging from operation level to another operation level, within the operation level or selection level. Those arrows which lead to the next operating step in a logical sequence are indicated in bold figures.

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

When the relay is operated from a personal computer by means of the protection data processing program DIGSI®, each configuration parameter is identified by a four-digit address number. In the following clarifications, this number is indicated at the beginning of the explanations in brackets.

If one tries to leave an item or operating level by pressing one of the arrow keys without having confirmed the allocation with the enter key **E**, the display will show the question “SAVE NEW SETTING?”. Confirm with the “Yes”-key **Y/J** that the new settings shall become valid now. The new text is displayed now. If you press the “No”-key **N** instead, all alterations which has been changed since the last entry of the key **E** are lost and the old text is displayed. Thus, erroneous alterations can be made ineffective. Press the arrow key once again in order to change really the operating item or level.

When the marshalling process is terminated by pressing the enter key **E**, the allocations are permanently secured in EEPROMs and protected against power outage.

## 5.5.2 Marshalling of the binary inputs – address block 61

The unit contains 3 binary inputs which are designated INPUT 1 to INPUT 3. They can be marshalled in address block 61. The block is reached from the initial display by pressing the key ▽ to the first main menu item “PARAME.” (parameters) in the first operation level of the menu tree. Press key ▷ to reach the second operation menu level, which starts with the first parameter block “00 CONF.” (configuration). Press the key ▽ repeatedly until address block “60 MARSH” (marshalling) appears. Key ▷ leads to operation level 3 with address block “61 MARSH BIN INP” (marshalling of binary inputs) (refer also to Figure 5.7).

The selection procedure is carried out as described in Section 5.5.1.

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

– (no index) “normally open” mode: the input acts as a NO contact, i.e. the control voltage at the input terminals activates the function;

c – “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 with ⊞ or ⊟, each input function is displayed without any index which indicates the “normally open” mode and with the index “c” which indicates the “normally closed” mode, as above. The changed function then must be re-confirmed by the entry key **E**.

Table 5.1 shows a complete list of all the binary input functions with their associated function number **FNo**. Input functions naturally have no effect if the corresponding protection function has been programmed out (“de-configured”, refer Section 5.4.2).

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

◁ ▽ | 61 MARSH BIN.INP | ▷

[6100]
Beginning of block “Marshalling binary inputs”

The first binary input is reached with the key ▷ :

```
6 1   M A R S H
B I   1
```

[6101]
Allocations for binary input 1

Change over to the selection level with ▷ :

```
6 1 B I 1   1
> L E D   r .
```

[6102]
Reset of stored LED indications, FNo `5`;
“normally open” operation:
LEDs are reset when control voltage present

```
6 1 B I 1   2
n o t   a l l .
```

[6103]
No further functions are initiated by binary input 1

Following codeword input, all marshallable functions can be paged through the display by repeated use of the key [+]. Back-paging is possible with the key [−]. 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 1 to 10) by using the key ▽. **Each selection must be confirmed by pressing the key E!** If a selection place shall not be assigned to a function, selection is made with the function “`not all.`” (not allocated).

Leave the selection level with key ◁ . You can go then to the next binary input with the arrow key ▽.

| FNo | Abbreviation | Description |
|---|---|---|
| 1 | `not all.` | Binary input is not allocated to any input function |
| 3 | `>TimeSy` | Time synchronization |
| 5 | `>LED r.` | Reset LED indicators |
| 11 | `>Annu.1` | User defined annunciation 1 |
| 12 | `>Annu.2` | User defined annunciation 2 |
| 13 | `>Annu.3` | User defined annunciation 3 |
| 14 | `>Annu.4` | User defined annunciation 4 |
| 356 | `>mCLOSE` | Circuit breaker is manually closed (from discrepancy switch) |
| 1157 | `>CBclo` | Circuit breaker closed (from CB auxiliary contact) |
| 1501 | `>O/L on` | Switch on thermal overload protection |
| 1502 | `>O/Loff` | Switch off thermal overload protection |
| 1503 | `>O/L bk` | Block thermal overload protection |
| 1701 | `>O/Cpon` | Switch on time overcurrent protection for phase currents |
| 1702 | `>O/Cpof` | Switch off time overcurrent protection for phase currents |
| 1704 | `>O/Cpbk` | Block time overcurrent protection for phase currents |
| 1711 | `>O/Ceon` | Switch on time overcurrent protection for earth current |
| 1712 | `>O/Ceof` | Switch off time overcurrent protection for earth current |
| 1714 | `>O/Cebk` | Block time overcurrent protection for earth current |

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

| FNo | Abbreviation | Description |
|---|---|---|
| 1721 | >I>> bk | Block I>> stage of time overcurrent protection (phase faults) |
| 1722 | >I> blk | Block I> stage of definite time overcurrent protection (phase faults) |
| 1723 | >Ip blk | Block $I_p$ stage of inverse time overcurrent protection (phase faults) |
| 1724 | >IE>>bk | Block $I_E$>> stage of time overcurrent protection (earth faults) |
| 1725 | >IE> bk | Block $I_E$> stage of definite time overcurrent protection (earth faults) |
| 1726 | >IEp bk | Block $I_{Ep}$ stage of inverse time overcurrent protection (earth faults) |
| 1727 | >C/O | Change over of overcurrent fault detection level |
| 2701 | >AR on | Switch on internal auto-reclosure function |
| 2702 | >AR off | Switch off internal auto-reclosure function |
| 2732 | >AR St. | Start internal auto-reclosure function (initiation) |
| 2733 | >ARblSt | Block initiation of internal auto-reclosure function |
| 2734 | >ARblCl | Block reclose command of internal auto-reclosure function |
| 4632 | >SWblo. | Block control facility |
| 5143 | >I2 blk | Block unbalanced load protection |
| 5144 | >revPhR | Reversed phase rotation |
| 6758 | >I>>>bk | Block I>>> stage (inst.. very high stage) of time overcurrent protection |
| 6801 | >SRT bk | Block start-up time supervision |
| 6851 | >SUP bk | Blocking trip circuit supervision |
| 6852 | >TrpRel | Trip circuit supervision: Trip relay |
| 6853 | >CBaux | Trip circuit supervision: CB auxiliary |

Table 5.1 Marshalling possibilities for binary inputs

The complete pre-settings are listed in Table 5.2.

| 4th selection level | 5th selection level | FNo | Remarks |
|---|---|---|---|
| MARSHALLING | BINARY INPUTS | | Heading of the address block |
| 61 MARSH<br>BI 1 | 61BI1 1<br>>LED r. | 5 | Acknowledge and reset of stored LED and displayed fault indications, LED-test |
| 61 MARSH<br>BI 2 | 61BI2 1<br>>I>> bk | 1721 | Block I>> stage of overcurrent time protection for phase faults |
| 61 MARSH<br>BI 3 | 61BI3 1<br>>mCLOSE | 356 | Circuit breaker is manually closed (from discrepancy switch) |

Table 5.2 Preset binary inputs

### 5.5.3 Marshalling of the signal output relays – address block 62

The unit contains 2 signal outputs (alarm relays). These signal relays are designated SIG.RE 1 and SIG.RE 2 and can be marshalled in address block 62. The block is reached from the initial display by pressing the key ▽ to the first main menu item "PARAME." (parameters) in the first operation level of the menu tree. Press key ▷ to achieve the second operation menu level, which starts with the first parameter block "00 CONF." (configuration). Press the key ▽ repeatedly until address block "60 MARSH" (marshalling) appears. Key ▷ leads to operation level 3 with address block "61 MARSH BIN INP" (marshalling of binary inputs); key ▽ leads to address block "62 MARSH SIG REL" (marshalling signal relays) (refer also to Figure 5.7).

The selection procedure is carried out as described in Section 5.5.1. Multiple annunciations are possible, i.e. one logical annunciation function can be routed to several physical signal relays (see also Section 5.5.1).

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

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

*Note* as to Table 5.3: Annunciations which are indicated by a leading ">" sign, represent the direct confirmation of the binary inputs and are available as long as the corresponding binary input is energized.

Further information about annunciations see Section 6.4.

---

```
◁  | 6 2   M A R S H |  ▷
▽  | S I G . R E L   |
```

[6200]
Beginning of the block "Marshalling of the output signal relays"

The first signal relay is reached with the key ▷ :

```
◁  | 6 2   M A R S H |  ▷
▽  | S I G . R E   1 |
```

[6201]
Allocations for signal relay 1

Change over to the selection level with ▷ :

```
◁  | 6 2 S I G 1   1 |  ▽
   | o p e r a t .   |
```

[6202]
Signal relay 1 has been preset for:
At least one protection function is operative, FNo `52`;

```
◁  | 6 2 S I G 1   2 |  △
   | n o t   a l l . |  ▽
```

[6203]
no further functions are preset for signal relay 1

Following codeword input, all marshallable functions can be paged through the display by repeated use of the key [+]. Back-paging is possible with the key [−]. When the required function appears press the execute key **E**. After this, further functions can be allocated to the same signal relay (with further index numbers 1 to 20) by using the key ▽. **Each selection must be confirmed by pressing the key E!** If a selection place shall not be assigned to a function, selection is made with the function "`not all.`" (not allocated).

Leave the selection level with key ◁ . You can go then to the next signal relay with the arrow key ▽.

| FNo | Abbreviation | Description |
|---|---|---|
| 1 | not all. | No annunciation allocated |
| 3 | >TimeSy | Time synchronization |
| 5 | >LED r. | Reset LED indicators |
| 11 | >Annu.1 | User defined annunciation 1 (delayed with address 3801) |
| 12 | >Annu.2 | User defined annunciation 2 (delayed with address 3802) |
| 13 | >Annu.3 | User defined annunciation 3 (delayed with address 3803) |
| 14 | >Annu.4 | User defined annunciation 4 (delayed with address 3804) |
| 52 | operat. | At least one protection function is operative |
| 301 | Sys.Flt | Fault in the power system |
| 302 | FAULT | Fault event with consecutive number |
| 356 | >mCLOSE | Circuit breaker is manually closed (from discrepancy switch) |
| 501 | FT det | General fault detection of device |
| 511 | DEV.Trp | General trip of device |
| 563 | CBA sup | CB alarm suppressed |
| 1157 | >CBclo | Circuit breaker closed |
| 1174 | CBtest | Circuit breaker test in progress |
| 1185 | CBtpTST | Circuit breaker test: Trip 3pole |
| 1188 | CBTwAR | Circuit breaker test: Trip 3pole with auto-reclosure |
| 1501 | >O/L on | Switch on thermal overload protection |
| 1502 | >O/Loff | Switch off thermal overload protection |
| 1503 | >O/Lblk | Block thermal overload protection |
| 1511 | O/L off | Thermal overload protection is switched off |
| 1512 | O/L blk | Thermal overload protection is blocked |
| 1513 | O/L act | Thermal overload protection is active |
| 1516 | O/L wrn | Thermal overload protection: Thermal warning stage |
| 1518 | O/L p/u | Thermal overload protection: Pick-up |
| 1521 | O/L Trp | Thermal overload protection: Trip |
| 1701 | >O/Cpon | Switch on overcurrent time protection for phase currents |
| 1702 | >O/Cpof | Switch off overcurrent time protection for phase currents |
| 1704 | >O/Cpbk | Block overcurrent time protection for phase currents |
| 1711 | >O/Ceon | Switch on overcurrent time protection for earth current |
| 1712 | >O/Ceof | Switch off overcurrent time protection for earth current |
| 1714 | >O/Cebk | Block overcurrent protection for earth current |
| 1721 | >I>> bk | Block I>> stage of overcurrent time protection (phase currents) |
| 1722 | >I> blk | Block I> stage of definite time overcurrent protection (phase currents) |
| 1723 | >Ip blk | Block $I_p$ stage of inverse time overcurrent protection (phase currents) |
| 1724 | >IE>>bk | Block $I_E$>> stage of overcurrent time protection (earth current) |
| 1725 | >IE> bk | Block $I_E$> stage of definite time overcurrent protection (earth current) |
| 1726 | >IEp bk | Block $I_{Ep}$ stage of inverse time overcurrent protection (earth current) |
| 1727 | >C/O | Dynamic change-over of overcurrent fault detection pick-up values |
| 1751 | O/Cpoff | Overcurrent time protection phase is switched off |
| 1752 | O/Cpblk | Overcurrent time protection phase is blocked |
| 1753 | O/Cpact | Overcurrent time protection phase is active |
| 1756 | O/Ceoff | Overcurrent time protection earth is switched off |
| 1757 | O/Ceblk | Overcurrent time protection earth is blocked |
| 1758 | O/Ceact | Overcurrent time protection earth is active |
| 1762 | O/C L1 | Fault detection of overcurrent time protection phase L1 |
| 1763 | O/C L2 | Fault detection of overcurrent time protection phase L2 |
| 1764 | O/C L3 | Fault detection of overcurrent time protection phase L3 |
| 1765 | O/C E | Fault detection of overcurrent time protection earth fault |
| 1800 | FD I>> | Fault detection of overcurrent time protection stage I>> phase currents |
| 1805 | Trp I>> | Trip by high-set I>>stages for phase currents |
| 1810 | FD I> | Fault detection of overcurrent time protection stage I> phase currents |
| 1815 | Trip I> | Trip by overcurrent I> stage for phase currents |

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

| FNo | Abbreviation | Description |
|---|---|---|
| 1820 | FD Ip | Fault detection of overcurrent stage $I_p$ for phase currents |
| 1825 | Trip Ip | Trip by overcurrent $I_p$ stage for phase currents |
| 1831 | FD IE>> | Fault detection of high-set stage I>> for phase currents |
| 1833 | TrpIE>> | Trip by overcurrent $I_E$>> stage for earth currents |
| 1834 | FD IE> | Fault detection of overcurrent $I_E$> stage for earth current |
| 1836 | Trp IE> | Trip by overcurrent $I_E$> stage for earth current |
| 1837 | FD IEp | Fault detection of overcurrent $I_{Ep}$ stage for earth current |
| 1839 | Trp IEp | Trip by overcurrent $I_{Ep}$ stage for earth current |
| 1850 | FD dyn | Dynamic switch-over of overcurrent pick-up values |
| 2701 | >AR on | Switch on internal auto-reclosure function |
| 2702 | >AR off | Switch off internal auto-reclosure function |
| 2732 | >AR St. | Start internal auto-reclosure function (initiation) |
| 2733 | >ARblSt | Block initiation of internal auto-reclosure function |
| 2734 | >ARblCl | Block reclose command of internal auto-reclosure function |
| 2736 | AR act. | Internal auto-reclose function is active |
| 2781 | AR off | Internal auto-reclose function is switched off or blocked |
| 2801 | AR i pg | Internal auto-reclose cycle in progress |
| 2851 | AR ClCm | Internal auto-reclose function close command |
| 2863 | AR dTrp | Internal auto-reclose function definitive (final) trip |
| 2872 | AR Strt | Internal auto-reclosure function started |
| 2873 | AR blSt | Internal auto-reclosure function initiation is blocked |
| 2874 | AR blCl | Internal auto-reclosure function close command is blocked |
| 2875 | ARblMCl | Internal auto-reclosure function is blocked by manual closure |
| 2876 | AR DT | Internal auto-reclosure function dead time is running |
| 4632 | >SWblo. | Block control facility |
| 4640 | Q0 Clo. | Control-Close-Command CB–Q0 |
| 4641 | Q0 Trp. | Control-Trip-Command CB–Q0 |
| 5143 | >I2 blk | Block unbalanced load protection |
| 5144 | >revPhR | Reversed phase rotation |
| 5151 | I2 off | Unbalanced load protection is switched off |
| 5152 | I2 blk | Unbalanced load protection is blocked |
| 5153 | I2 act | Unbalanced load protection is active |
| 5159 | FD I2>> | Fault detection of unbalanced load protection stage $I_2$>> |
| 5165 | FD I2> | Fault detection of unbalanced load protection stage $I_2$> |
| 5170 | Trp I2 | Trip by unbalanced load protection stage $I_2$> |
| 6757 | TrpI>>> | Trip by very high overcurrent stage I>>>, phases |
| 6758 | >I>>>bk | Instantaneous very high stage of overcurrent time protection is blocked |
| 6801 | >SRT bk | Block start-up time supervision |
| 6811 | SRT off | Start-up time supervision is switched off |
| 6812 | SRT blk | Start-up time supervision is blocked |
| 6813 | SRT act | Start-up time supervision is active |
| 6821 | SRT Trp | Trip by start-up time supervision |
| 6851 | >SUP bk | Block trip circuit supervision |
| 6852 | >TrpRel | Trip circuit supervision: binary input in parallel to trip relay |
| 6853 | >CBaux | Trip circuit supervision: binary input in parallel to CB auxiliary contact |
| 6861 | SUP off | Trip circuit supervision is switched off |
| 6862 | SUP blk | Trip circuit supervision is blocked |
| 6863 | SUP act | Trip circuit supervision is active |
| 6864 | SUPnoBI | Trip circuit supervision is inactive, binary input is not marshalled |
| 6865 | CIR int | Trip circuit is interrupted |

Table 5.3 Marshalling possibilities for signal relays and LEDs

| 4th selection level | 5th selection level | FNo | Remarks |
|---|---|---|---|
| MARSHALLING | SIGNAL RELAYS | | Heading of the address block |
| 62 MARSH SIG.RE 1 | 62SIG1 1 operat. | 52 | At least one protection function is operative |
| 62 MARSH SIG.RE 2 | 62SIG2 1 FT det | 501 | General fault detection of device |

Table 5.4 Preset annunciations for signal relays

## 5.5.4 Marshalling of the LED indicators – address block 63

The unit contains 6 LEDs for optical indications, 4 of which can be marshalled. They are designated LED 1 to LED 4 and can be marshalled in address block 63. The block is reached from the initial display by pressing the key ▽ to the first main menu item "PARAME." (parameters) in the first operation level of the menu tree. Press key ▷ to reach the second operation menu level, which starts with the first parameter block "00 CONF." (configuration). Press the key ▽ repeatedly until address block "60 MARSH" (marshalling) appears. Key ▷ leads to operation level 3 with address block "61 MARSH BIN INP" (marshalling of binary inputs); key ▽ (twice) leads to address block "63 MARSH LED IND" (marshalling LED indicators) (refer also to Figure 5.7).

The selection procedure is carried out as described in Section 5.5.1. Multiple annunciations are possible, i.e. one logical annunciation function can be routed to several LEDs (see also Section 5.5.1).

Apart from the logical function, each LED can be marshalled to operate either in the stored mode or unstored mode. Each annunciation function is displayed with the index `m` (for **m**emorized) or without index (for not memorized) when proceeding with the 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).

The changed function must be re-confirmed by the enter-key **E**.

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

```
◁  63 MARSH   ▷
▽  LED IND
```

[6300]
Beginning of the block "Marshalling of the LED indicators"

The first marshallable LED is reached with the key ▷:

```
◁  63 MARSH   ▷
▽  LED 1
```

[6301]
"Allocations for LED 1"

Change over to the selection level with ▷ :

```
◁  6 3 L E D 1    1   ▽
   O / C   L 1    M
```

[6302]
LED 1 has been preset for:
1st: Fault detection of overcurrent time protection phase L1, memorized, FNo 1762

```
◁  6 3 L E D 1    2   △
   n o t   a l l .    ▽
```

[6303]
No further functions are preset for LED 1

Following codeword input, all marshallable functions can be paged through the display by repeated use of the key +. Back-paging is possible with the key −. When the required function appears press the execute key **E.** After this, further functions can be allocated to the same LED indicator (with further index numbers 1 to 20) by using the key ▽. **Each selection must be confirmed by pressing the key E!** If a selection place shall not be assigned to a function, selection is made with the function "not all." (not allocated).

Leave the selection level with key ◁ . You can go then to the next LED indicator with the arrow key ▽.

| 4th selection level | 5th selection level | FNo | Remarks |
|---|---|---|---|
| MARSHALLING | LEDs | | Heading of the address block |
| 6 3 M A R S H<br>L E D 1 | 6 3 L E D 1 1<br>O / C L 1 M | 1762 | Fault detection of overcurrent time protection phase L1; memorized |
| 6 3 M A R S H<br>L E D 2 | 6 3 L E D 2 1<br>O / C L 2 M | 1763 | Fault detection of overcurrent time protection phase L2; memorized |
| 6 3 M A R S H<br>L E D 3 | 6 3 L E D 3 1<br>O / C L 3 M | 1764 | Fault detection of overcurrent time protection phase L3; memorized |
| 6 3 M A R S H<br>L E D 4 | 6 3 L E D 4 1<br>D E V . T r p M | 511 | General trip of device; memorized |

Table 5.5 Preset LED indicators

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

The unit contains 2 trip relays which are designated CMD.RE 1 and CMD.RE 2. 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 from the initial display by pressing the key ▽ to the first main menu item "PARAME." (parameters) in the first operation level of the menu tree. Press key ▷ to reach the second operation menu level, which starts with the first parameter block "00 CONF." (configuration). Press the key ▽ repeatedly until address block "60 MARSH" (marshalling) appears. Key ▷ leads to operation level 3 with address block "61 MARSH BIN INP" (marshalling of binary inputs); repeated pressing of the key ▽ leads to address block "64 MARSH CMD.REL" (marshalling command relays).

The selection procedure is carried out as described in Section 5.5.1. Multiple commands are possible, i.e. one logical command function can be routed to several trip relays (see also Section 5.5.1).

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

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

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

---

```
◁  64 MARSH   ▷
▽  CMD.REL
```

[6400]
Beginning of the block "Marshalling of the trip relays"

The first trip relay is reached with the key ▷:

```
◁  64 MARSH   ▷
▽  CMD.RE  1
```

[6401]
Allocations for trip relay 1

Change over to the selection level with ▷:

```
◁  64CMD1  1  ▽
   Trp I>>
```

[6402]
Trip relay 1 has been preset for:
1st: Trip signal given by the overcurrent time protection high-set I>> stage, phases, FNo 1805

```
◁  64CMD1  2  △
   Trip I>    ▽
```

[6403]
Trip relay 1 has been preset for:
2nd: Trip signal given by the overcurrent time protection I> stage, phases, FNo 1815

```
◁  64CMD1  3  △
   not all.   ▽
```

[6404]
no further functions are preset for trip relay 1

Following codeword input, all marshallable functions can be paged through the display by repeated use of the key [+]. Back-paging is possible with the key [−]. When the required function appears press the execute key **E**. After this, further functions can be allocated to the same trip relay (with further index numbers 1 to 20) by using the key ▽. **Each selection must be confirmed by pressing the key E!** If a selection place shall not be assigned to a function, selection is made with the function "`not all.`" (not allocated).

Leave the selection level with key ◁. You can go then to the next command relay with the arrow key ▽.

| FNo | Abbreviation | Logical command function |
|---|---|---|
| 1 | `not all.` | No function allocated |
| 501 | `FT det` | General fault detection of the device |
| 511 | `DEV.Trp` | General trip command of the device |
| 1185 | `CBtpTST` | Circuit breaker test: live trip [1]) |
| 1188 | `CBTwAR` | Circuit breaker test: trip with auto-reclosure [2]) |
| 1521 | `O/L Trp` | Thermal overload protection: trip |
| 1800 | `FD I>>` | Phase overcurrent time protection: I>> stage picked up |
| 1805 | `Trp I>>` | Phase overcurrent time protection: trip by I>> stage |
| 1810 | `FD I>` | Phase overcurrent time protection: I> stage (definite) picked up |
| 1815 | `Trip I>` | Phase overcurrent time protection: trip by I> stage (definite time) |
| 1820 | `FD Ip` | Phase overcurrent time protection: $I_p$ stage (inverse) picked up |
| 1825 | `Trip Ip` | Phase overcurrent time protection: trip by $I_p$ stage (inverse time) |
| 1831 | `FD IE>>` | Earth overcurrent time protection: $I_E$>> stage picked up |
| 1833 | `TrpIE>>` | Earth overcurrent time protection: trip by $I_E$>> stage |
| 1834 | `FD IE>` | Earth overcurrent time protection: $I_E$> stage (definite) picked up |
| 1836 | `Trp IE>` | Earth overcurrent time protection: trip by $I_E$> stage (definite time) |
| 1837 | `FD IEp` | Earth overcurrent time protection: $I_{Ep}$ stage (inverse) picked up |
| 1839 | `Trp IEp` | Earth overcurrent time protection: trip by $I_{Ep}$ stage (inverse time) |
| 2851 | `AR ClCm` | Close command of internal auto-reclose function |
| 4640 | `Q0 Clo.` | Control-Close-Command CB−Q0 |
| 4641 | `Q0 Trp.` | Control-Trip-Command CB−Q0 |
| 5159 | `FD I2>>` | Unbalanced load protection: $I_2$>> stage picked up |
| 5165 | `FD I2>` | Unbalanced load protection: $I_2$> stage picked up |
| 5170 | `Trp I2` | Unbalanced load protection: trip by $I_2$> stage |
| 6757 | `TrpI>>>` | Phase overcurrent time protection: trip by I>>> stage |
| 6821 | `SRT Trp` | Start-up time supervision: Trip |

[1]) Trip command for live trip test [2]) Trip command for TRIP/RECLOSE test

Table 5.6 Command functions

| 4th selection level | 5th selection level | FNo | Remarks |
|---|---|---|---|
| `MARSHALLING` | `TRIP RELAYS` | | Heading of the address block |
| `64 MARSH`<br>`CMD.RE 1`<br>`CMD.RE 1` | `64 CMD1 1`<br>`Trp I>>`<br>`Trip I>` | <br>1805<br>1815 | <br>Trip by I>> stage of O/C (phases, definite)<br>Trip by I> stage of O/C (phases, definite) |
| `64 MARSH`<br>`CMD.RE 2` | `64 CMD2 1`<br>`Trp IE>` | <br>1836 | <br>Trip by IE> stage of O/C (earth, definite) |

Table 5.7 Preset command functions for trip relays

### 5.5.6 Marshalling of the auto-reclosure conditions – address block 65

The conditions of initiation and blocking of the internal auto-reclosure function can be freely assigned in address block 65. These are the input signals:

– Initiation (start) of the auto-reclosure function with the designation "AR MAR START",

– blocking of initiation of the auto-reclosure function with the designation "AR MAR ST.BLOCK",

– blocking of the auto-reclose command (statically) with the designation "AR MAR CL. BLOCK".

With these marshalling possibilities, it is, for example, possible to initiate the auto-reclose function by trip of the I>> stage of the overcurrent time protection but not to initiate it by trip of the I> stage or $I_p$ stage. Each of the AR input signals may be controlled by up to 20 conditions. Additionally, external conditions can be included via binary inputs (refer to Section 5.5.2). If, for example, a binary input has been assigned to an AR input signal in address block 61, e.g. the function ">AR St" (FNo 2732) for AR initiation, this allocation need not be repeated here. All conditions which have been assigned to an AR input signal, are combined in *OR* mode.

Principally, the manual closing signal for the circuit breaker, if repeated to the relay via a binary input to the function "manual close" (">mCLOSE", FNo 356), blocks auto-reclosure. This need not be considered here.

If readiness of the circuit breaker should be a condition for auto-reclosure, this condition can be entered to the relay via the binary input ">ARblCl" (FNo 2734), which must then have been allocated to a physical input module in accordance with Section 5.5.2. Use the "normally closed" contact mode to release AR when the breaker is ready. This signal prevents from reclosing when it is present at the moment where reclosure command should be given. The blocking of start of the auto-reclose function ">ARblSt." (FNo 2733) is interrogated by the AR function only before and as long as initiation signal is present.

The block 65 is reached from the initial display by pressing the key ▽ to the first main menu item "PARAME." (parameters) in the first operation level of the menu tree. Press key ▷ to reach the second operation menu level, which starts with the first parameter block "00 CONF." (configuration). Press the key ▽ repeatedly until address block "60 MARSH" (marshalling) appears. Key ▷ leads to operation level 3 with address block "65 AR MARSHALL" (marshalling of auto-reclosure input signals, refer also to Figure 5.7).

In principle, all annunciation functions according to Table 5.3 can be assigned as condition for any AR input signal, but not all are meaningful. Conditions are naturally not effective when the corresponding protection function is not available in the actual model or has been programmed out (de-configured).

The following boxes show an example for marshalling of the "Start" signal (initiation of the auto-reclosure function).

---

◁ ▽ | 6 5 A R<br>M A R S H A L L | ▷

[6500]
Beginning of the block "Marshalling of auto-reclosure input signals"

The first AR input signal is reached with the key ▷:

◁ ▽ | 6 5 A R M A R<br>S T A R T | ▷

[6501]
Allocations for the starting conditions of the auto-reclose function

Change over to the selection level with ▷ :

| | | | |
|---|---|---|---|
| ◁ | `65 ARS01`<br>`Trp I>>` | ▽ | Conditions for start of the AR may be for example:<br>[6502]<br>1st: Trip signal given by the phase overcurrent time protection high-set I>> stage |
| ◁ | `65 ARS01`<br>`TrpIE>>` | ▽ | [6503]<br>2nd: Trip signal given by the earth overcurrent time protection high-set I>> stage |
| ◁ | `65 ARS01`<br>`TrpI>>>` | ▽ | [6504]<br>3rd: Trip signal given by the phase overcurrent time protection instantaneous I>>> stage |
| ◁ | `64 ARS01`<br>`not all.` | △ ▽ | [6501]<br>no further functions are preset for AR initiation |

---

Following codeword input, all marshallable functions can be paged through the display by repeated use of the key ⊞. Back-paging is possible with the key ⊟. When the required function appears press the execute key **E**. After this, further functions can be allocated to the same AR input (with further index numbers 1 to 20) by using the key ▽. **Each selection must be confirmed by pressing the key E!** If a selection place shall not be assigned to a function, selection is made with the function "`not all.`" (not allocated).

Leave the selection level with key ◁. You can go then to the next AR input with the arrow key ▽.

# 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

Figure 6.1 illustrates the front view.

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

During dialog, the upper line gives a two figure number. This number presents the **setting address block**.

The keyboard comprises 9 keys with paging, Yes/No and control buttons. The significance of the keys is explained in detail in the following:

Keys for alteration of numerical values and alternative texts:

| | |
|---|---|
| + | increasing a value or text item |
| - | decreasing a value or text item |

In order to set the value "∞", press the ⊞ key until the maximum value appears, then press ⊞ again.

Yes/No keys:

| | |
|---|---|
| Y/J | Yes key: operator affirms the displayed question |
| N | No key: operator denies the displayed question; this key serves either as reset key for stored LED indicators and fault annunciations |

Keys for scrolling and paging:

| | |
|---|---|
| ▽ | Scrolling forwards: the next display line or menu item is displayed |
| △ | Scrolling backwards: the previous display line or menu item is displayed |
| ▷ | Paging to the next operation level: the operation object of the next operating level is displayed |
| ◁ | Paging to the previous operation level: the operation object of the previous operating level is displayed |

Confirmation key:

| | |
|---|---|
| E | Enter or confirmation key: each change via the "Yes"/"No"-keys or the + or − 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. |

Stored LED indications on the front and the fault annunciation buffer can be erased via the "No"-key **N**. During reset operation the assigned LEDs on the front will be illuminated thus performing a LED test. With this reset, additionally, the fault event indications in the display on the front panel of the device are acknowledged; the display shows then the operational values of the quiescent state.

### 6.2.2 Operation with a personal computer

A personal computer (with operating system MS WINDOWS) 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. The PC program DIGSI® is available for setting and processing of all digital protection data.

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.

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. A survey of the suitable operating programs and further accessories is shown in Section 2.3 Ordering data.

### 6.2.3 Operational preconditions

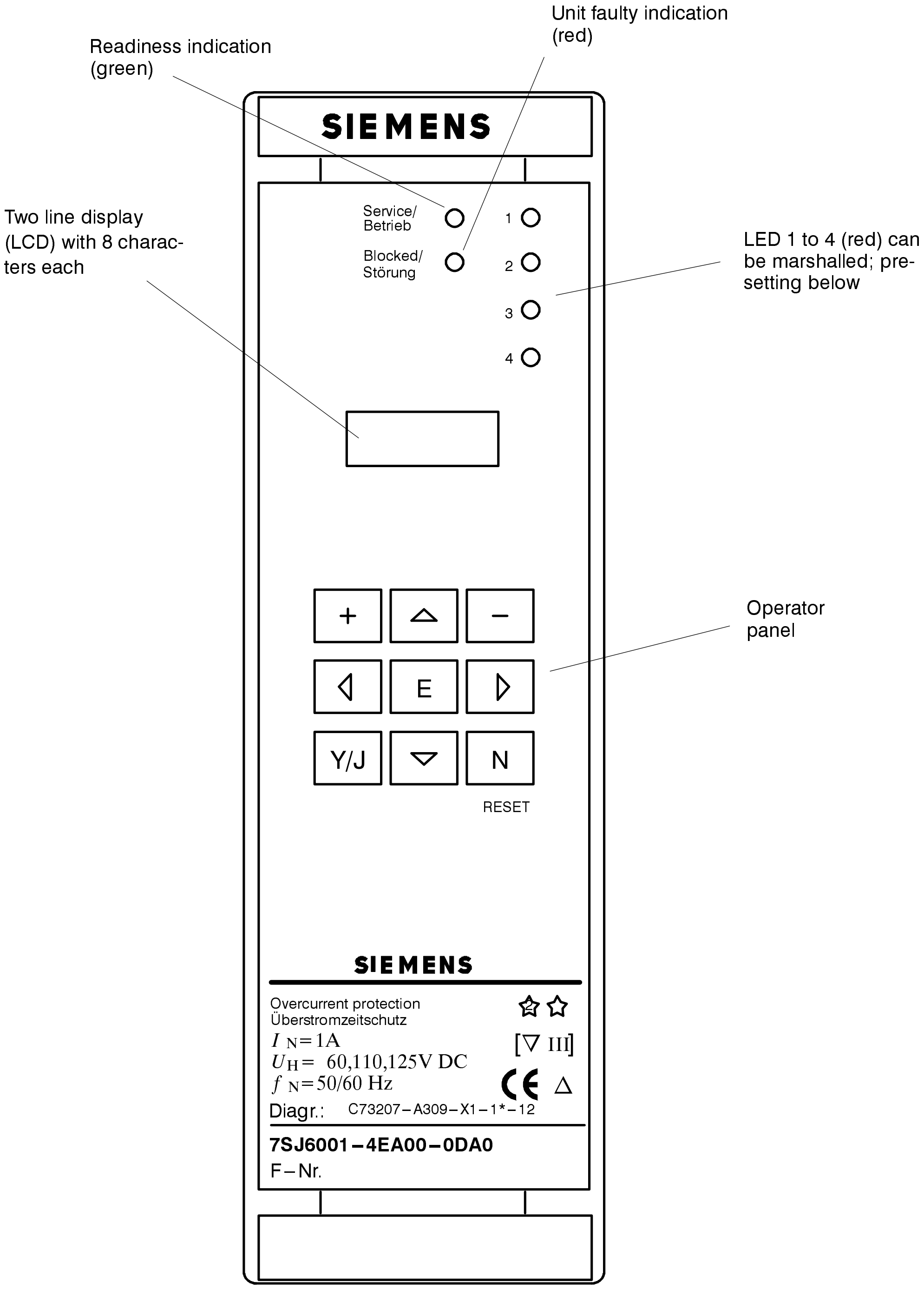
For most operational functions, the input of a codeword is necessary. This applies for all entries via the membrane keyboard or interface which concern the operation on the relay, for example

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

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

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

### 6.2.4 Representation of the relay (front view)




Factory presetting LEDs:

1 Fault L1
2 Fault L2
3 Fault L3
4 General trip

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 operating surface is built up by a hierarchically structured menu tree, which can be passed through by means of the scrolling keys ▷ , ◁ , ▽, and △. Thus, each operation object can be reached. A complete overview is listed in Appendix C.

From the initial display, the key ▽ is used to switch to the first operation item "PARAME." (parameters) which contains all setting and configuration blocks of the device (see Figure 6.2). Key ▷ is pressed to change to the next operation level. The display shows the first item "CONF." (configuration), which is described in Section 5.3 and 5.4.

Pressing the key ▽ leads to the first parameter block "01 POWER SYST.DAT" (power system data). Further parameter blocks can be called up with the scrolling keys ▽ or △.

The key ▷ changes to the third operation level where the individual functions and values are set; refer to Figure 6.2. They are explained in detail in the following sections.

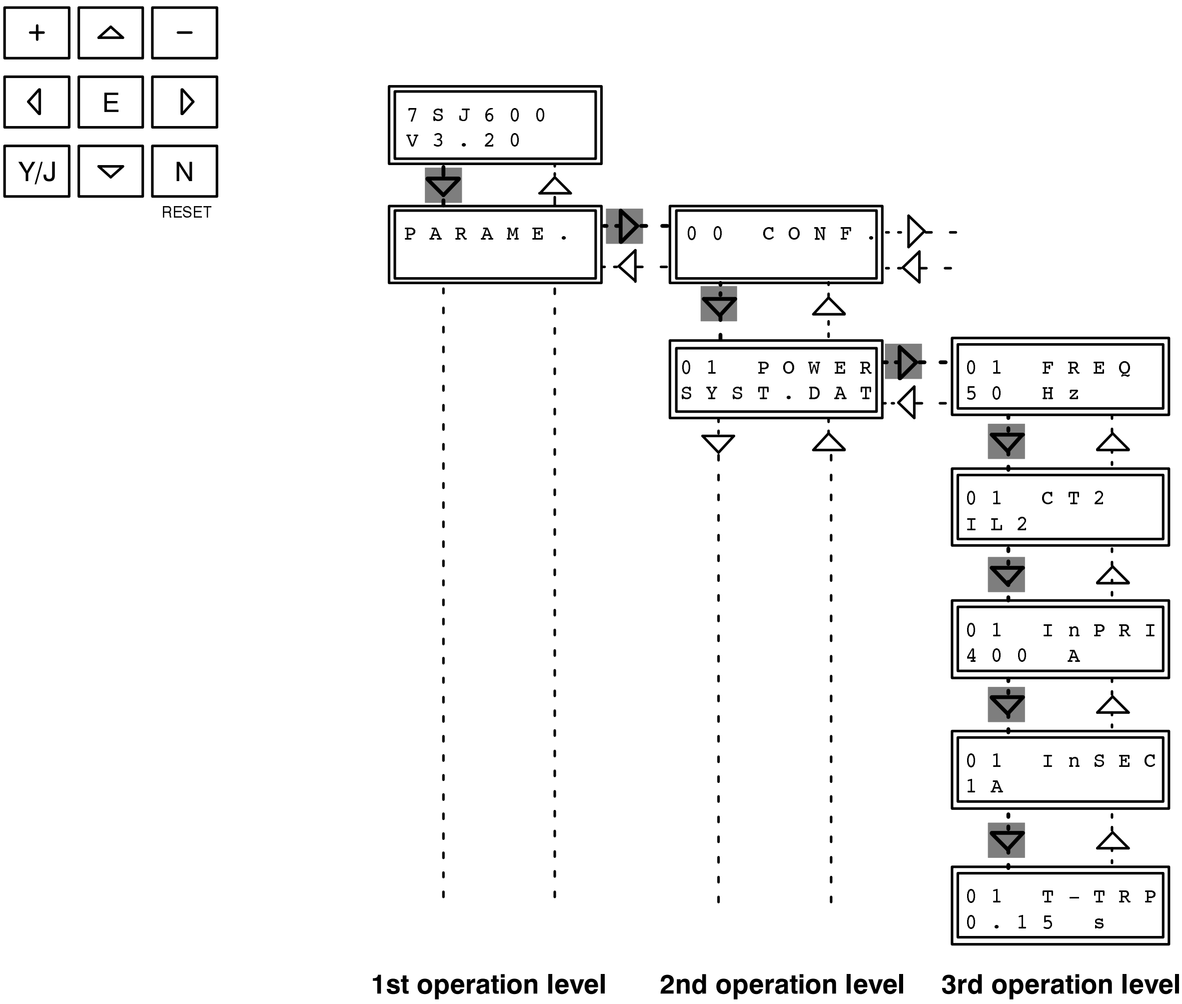



Figure 6.2 Selection of the power system data

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

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

– Addresses without request for operator input

  Displayed text forms the heading of this address block. The address block is identified by the block number (two digit number). No input is expected. By using keys ▽ or △ the next or the previous block can be selected. By using the key ▷ the next operation level can be reached.

– Addresses which require numerical input

  The display shows the two-digit block number in the first line. Behind the block number appears the meaning of the required parameter in abbreviated form, in the second display line, the value of the parameter. When the relay is delivered a value has been preset. In the following sections, this value is shown. If this value is to be retained, no other input is necessary. One can page forwards or backwards within the block or to the next (or previous) operation level. If the value needs to be altered, it can – after codeword input – be increased with the keys ⊞ or decreased with the key ⊟. When one of the keys, ⊞ or ⊟, is pressed continuously, the numbers will change with an accelerating sequence. Thus, a fast and fine adjustment is possible within a wide setting range. The permissible setting range is given in the following text, next to the associated box. When the highest possible value is reached, the next changing with ⊞ leads to $\infty$ if permissible; otherwise no further changing with the key ⊞ is possible. If the minimum value is reached with ⊟, no further changing with the key ⊟ is possible. **The selected value must be confirmed with the entry key E!** The display then confirms the accepted value. The changed parameter is effective after this confirmation.

– Addresses which require text input

  The display shows the two-digit block number and the meaning of the required parameter and in the second display line, the applicable text. When the relay is delivered, a text has been preset. In the following sections, this text is shown. If it is to be retained, no other input is necessary. One can page forwards or backwards within the block or to the next (or previous) operation level. If the text needs to be altered, press – after codeword input – the key ⊞ (or ⊟). The next (or previous) alternative text, also printed in the display boxes illustrated in the following sections, then appears. If the alternative text is not desired, then the key ⊞ (or ⊟) is pressed again, etc. The alternative which is chosen, **is confirmed with the entry key E.** When the last possible alternative is reached, no further changing with the key ⊞ is possible. The same is valid when one tries to change the first alternative with the key ⊟.

For each of the addresses, the possible parameters and text are given in the following sections. If the meaning of a parameter is not clear, it is usually best to leave it at the factory setting. The arrows ▽ △ or ▷ ◁ besides the illustrated display boxes indicate the method of moving from block to block or within the block. Unused addresses are automatically passed over.

When the relay is operated from a personal computer by means of the protection data processing program DIGSI®, each functional parameter is identified by a four-digit address number. In the following clarifications, this number is indicated at the beginning of the explanations in brackets.

If one tries to leave an operating item or operating level by pressing one of the arrow keys without having confirmed an alteration with the enter key **E**, the display will show the question “SAVE NEW SETTING?”. Confirm with the “Yes”-key **Y/J** that the new settings shall become valid now. If you press the “No”-key **N** instead, codeword operation will be aborted, and the alteration which has been changed since the last entry is lost. Thus, erroneous alterations can be made ineffective. Press the arrow key once again in order to change really the operating item or level.

When the setting process is terminated by pressing the enter key **E**, the altered parameters are permanently secured in EEPROMs and protected against power outage.

#### 6.3.1.2 Setting of date and time

The date and time should be set when the relay is finally installed and connected to the supply voltage.

From the initial display, the key ▽ is pressed (three times) until the menu item “ADDITION FUNCTION” (“additional functions”) is displayed. Key ▷ is pressed to change to the next operation level. The display shows the first item “TIME SETTING”. Change to the third operation level with key ▷. The actual date and time is displayed now. Scroll on with key ▽ to find the setting items for date and time, as illustrated below.

After the relay has been switched on, first the date “01.01.95” appears and the time since the start-up of the processor system.

The next two addresses allow to set date and time. Codeword entry is not required. Day, month, and year can be altered using the keys ⊞ and ⊟. Each time a value is changed, the enter key **E** must be pressed, before the next number can be changed. Proceed in analog manner to change the time.

*Note:* When the day is changed, the display firstly allows 31 days. Only when the month and year is changed, the relay can check plausibility of the complete date. After confirmation with the enter key **E**, the day may be reduced to an existing number.

---

◁
```
TIME
SETTING
```
▷

[8100]
Beginning of the block “Setting the real time clock”

◁
```
01.01.95
01:15:06
```
▽

[8101]
At first, the “actual” date (**DD.MM.YY**) and the “actual” time (**HH.MM.SS**) are displayed.
Continue with ▽.

◁
```
DATE
27.10.02
```

[8102]
Enter the new date: 2 digits for day, 2 digits for month and 2 digits for year: **DD**▷ **MM** ▷ **YY**

Use key ⊞ to increase the day or ⊟ to decrease;
use key ▷ to change over to the month;
use key ⊞ to increase the month or ⊟ to decrease;
use key ▷ to change over to the year;
use key ⊞ to increase the year or ⊟ to decrease;
confirm with enter key **E**.

◁
```
TIME
13:44:27
```

[8103]
Key ▽ is used to come to the time setting. Enter the new time: 2 digits for hour, 2 digits for minute: **HH** ▷ **MM**

Use key ⊞ to increase the hour or ⊟ to decrease;
use key ▷ to change over to the minute;
use key ⊞ to increase the minute or ⊟ to decrease;

the seconds are not changed. They are automatically set to “00” when the enter key **E** is pressed.

---

### 6.3.2 Initial display

When the relay is switched on, firstly the type identification of the relay and the version of the implemented firmware appears. All Siemens relays have an MLFB (machine readable order number). Approximately 30 s after the relay has been switched on, the display shows the quiescent messages, i.e. the measured values of the currents $I_{L1}$ and $I_{L2}$. When the keys ▽ and subsequently △ is pressed, the initial display is shown again.

```
7 S J 6 0 0
V 3 . 2 *
```

The relay introduces itself by giving its type number. The second display line shows the version of firmware with which it is equipped.

The setting parameters start at address block 01. This block is reached by pressing the key ▽ (refer also to Figure 6.2), with ▷ to the second operation level (“00 CONFIG.”), with ▽ to block “01 POWER SYST.DAT” (power system data). Further address possibilities are listed under “Annunciations” and “Tests”.

### 6.3.3 Power system data – address block 01

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

```
◁  0 1   P O W E R  ▷
   S Y S T . D A T
```

[1100]
Beginning of the block “Power system data”

Firstly, the rated system frequency can be changed. It must comply with the setting. If the system frequency is not 50 Hz, the address must be changed.

```
◁  0 1   F R E Q    ▽
   5 0   H z
+  6 0   H z
```

[1101]
Rated system frequency *50 Hz* or *60 Hz*

The device must be instructed as to how the second current input (terminals 3 and 4) is connected. It can be connected to the current transformer $I_{L2}$ or to the residual current path $I_E$. In the first case the relay calculates the residual current from the three phase currents, in the latter case the current $I_{L2}$ is calculated from the phase currents $I_{L1}$, $I_{L3}$, and the residual current $I_E$. In each case, all four current are evaluated.

```
◁  0 1   C T 2      △▽
   I L 2
+  I E
```

[1102]
Connection mode of the second measured current input: can be
$I_{L2}$ or $I_E$

The following rated currents do not affect the protection functions but are used only for scaling of the fault recording data:

```
0 1   I n P R I
4 0 0   A
```

[1105]
Current transformer primary rated current
Smallest setting value: **10** A
Largest setting value: **50000** A

```
0 1   I n S E C
1 A
+ 5 A
```

[1106]
Current transformer secondary rated current

*1 A* or *5 A*

The minimum trip command duration T−TRP can be set. This is then valid for all protection functions of the device which can issue a trip signal. The close command duration T−CL is relevant if the relay is equipped with auto-reclosure. It must be long enough to ensure reliable closure of the circuit breaker. An excessively long time does not present any danger, since the closing command will be interrupted at once on renewed trip of any of the protection functions.

```
0 1   T - T R P
0 . 1 5   s
```

[1134]
Minimum duration of the **trip** command
Smallest setting value: **0.01** s
Largest setting value: **32.00** s

```
0 1   T - C L
1 . 0 0   s
```

[1135]
Maximum duration of the **close** command
Smallest setting value: **0.01** s
Largest setting value: **60.00** s

In order to come to the next address block, key ◁ is pressed to return to the previous operation level, and subsequently ▽ is pressed which will lead to the next address block 10. The individual parameters are listed in the next operation level.

## 6.3.4 Settings for phase fault overcurrent time protection − address block 10

```
1 0   O / C
P H A S E
```

[1300]
Beginning of the block “Overcurrent time protection for phase faults”

```
1 0   O / C p h
O N
+ O F F
```

[1301]
Switching *ON* of the phase fault overcurrent time protection

Switching *OFF* of the phase fault overcurrent time protection

Dependent on the scope of functions of the relay (refer to Section 5.4.2), only those parameters are available which have a meaning for the selected functions. The settings for dynamic switch-over of pick-up values are only accessible when the dynamic switch-over had been configured as EXIST (Section 5.4.2).

If the dynamic switch-over facility is used and an adequate binary input has been assigned to this function, the duration Tdyn of this dynamic switch-over is set.

Then, the very high set and the high set overcurrent stages I>>> and I>>, and – if appropriate – their dynamic thresholds I>>>dy and I>>dy, are set. These stages are often used for current grading before high impedances, e.g. transformers.

They are set such that they pick up on short-circuits into the protected impedance, e.g. for transformers to 1.5 times of the value

$$\frac{I>>>}{I_N} \approx \frac{I>>}{I_N} \approx 1.5 \cdot \frac{1}{u_{K\,transf}} \cdot \frac{I_{N\,transf}}{I_{N\,c.t.}}$$

In order to bridge out high inrush currents it may be advisable to set a short delay time for the I>> stage. Normally, 30 ms to 100 ms are sufficient.

For use on motors, it must be considered, that the high-set overcurrent element must not be exceeded by the motor start-up current, so that this stage does not trip the motor during start-up.

The very high instantaneous stage I>>> picks up on few instantaneous values of the current amplitude (converted to r.m.s. value). With short-circuit currents of more than 2 times setting value this stage operates immediately. Thus it should be set equal or higher than the high set stage I>>. The I>>> stage is always instantaneous, the I>> stage is always a definite time (or instantaneous) stage, independent on which characteristic is set for the overcurrent stage.

If the relay is intended to operate with auto-reclosure then the I>> and I>>> stage are used as rapid tripping stage before auto-reclosure: Before the first auto-reclosure, the I>> stage is valid without delay or with short-time delay, or the instantaneous I>>> stage, for the auto-reclosure sequence to be successful. After unsuccessful auto-reclosure, the I>> and I>>> stages are blocked. The delayed overcurrent stage I> (definite time) or $I_p$ (inverse time) remains effective and, for reasons of selectivity, will clear the fault in accordance with the time grading plan of the network. The pick-up values of the I>> and I>>> stages need not be different from the overcurrent stage because it is the short tripping time of these stages which is of interest in this case. Note that these stages are blocked, in relays with auto-reclose function, after the first auto-reclosure. They can either be blocked via a binary input, together with blocking of the AR function (refer also to Section 5.5.2 Marshalling of the binary inputs).

A further application of the I>> stage is in conjunction with the reverse interlocking principle (as described in Section 4.2.4). The different tripping time is of interest in this case, too. The I>> stage is used for rapid tripping in case of a bus-bar fault, with only a short safety time. The overcurrent stage is the back-up for fault on an outgoing feeder.

The set times are pure delay times which do not include the operating time of the protection. If the high-set overcurrent stage I>>> or I>> are not used then set the pick-up values to ∞. This is accomplished by pressing the key ⊞ beyond the highest setting value.

---

```
10  Tdyn
600.0 s
```

[1302]
Duration of the dynamic switch-over of pick-up values; valid for phase as well as for earth currents
Setting range: **0.1** s to **10000.0** s

```
10  I>>>
∞
```

[1303]
Pick-up value of the very high set instantaneous stage I>>> for phase faults
Setting range: **0.3** to **12.5** · $I_N$
and ∞ (no trip with I>>> for phase faults)

```
1 0 I > > > d y
∞   I n
```

[1304]
Dynamic pick-up value of the very high set instantaneous stage I>>> (dyn)
Setting range: **0.3** to **12.5** $\cdot I_N$
and ∞ (no trip with I>>>dyn)

```
1 0   I > >
2 . 0   I / I n
```

[1305]
Pick-up value of the high set stage I>> for phase faults
Setting range: **0.1** to **25.0** $\cdot I_N$
and ∞ (no trip with I>> for phase faults)

```
1 0   I > > d y
3 . 0   I n
```

[1306]
Dynamic pick-up value of the high-set stage I>> (dyn)
Setting range: **0.1** to **25.0** $\cdot I_N$
and ∞ (no trip with I>>dyn)

```
1 0   T I > >
0 . 0 3   s
```

[1307]
Trip time delay of the high-set stage I>>
Setting range: **0.00** s to **60.00** s

---

The overcurrent stage can be used as definite time overcurrent protection or inverse time overcurrent protection or both at the same time. A choice can be made whether the inverse time characteristics meet the IEC standards or the ANSI standards. This function mode has been preselected during configuration in Section 5.4.2. In this block 10, only those parameters are available which are associated with the preselected function mode.

If a definite time the function mode is chosen, i.e. "*def TIME*" or "*IEC O/C*" or "*ANSI O/C*", the following setting parameters are presented. 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.

For use on motors, it must be considered, that the motor takes increased start-up current. Either the overcurrent stage must be set accordingly high, or the dynamic stage I>dy must be used during start-up. This stage must then be set above the start-up current; furthermore, the relay must be switched over to the dynamic stage via a binary input as long as the motor is starting.

The time delay TI> depends on the grading plan for the network. If the overcurrent stage I> is not used then set the pick-up value I> to ∞.

---

```
1 0   I >
1 . 0   I n
```

[1308]
**For definite time overcurrent protection only (def TIME, IEC O/C, ANSI O/C)**:

Pick-up value of the overcurrent stage I> for phase faults
Setting range: **0.1** to **25.0** $\cdot I_N$
and ∞ (no trip with I> for phase faults)

```
1 0   I > d y
2 . 0   I n
```

[1309]
**For definite time overcurrent protection only (def TIME, IEC O/C, ANSI O/C):**
Dynamic pick-up value of the overcurrent stage I> (dyn)
Setting range: **0.1** to **25.0** $\cdot I_N$
and ∞ (no trip with I>dyn)

```
10  TI>
0.50  s
```

[1310]
**For definite time overcurrent protection only (def TIME, IEC O/C, ANSI O/C)**:
Trip time delay for the overcurrent stage I>
Setting range: **0.00** s to **60.00** s

```
10  REPph
NO
+ YES
```

[1311]
Measurement repetition for all phase current stages except the I>>> and I>>>dyn stage; normal setting: *NO*

With setting *YES* the operating time is increased by approx. 10 ms

---

If the function mode is “*IECinv*” or “*IEC O/C*”, one of four inverse time characteristics defined in IEC 60255−3 can be selected. It must be considered that, according to IEC 60255−3, the protection picks up only when at least 1.1 times the set value is exceeded.

If the overcurrent stage $I_p$ is not used then set “*never*” as characteristic for phase currents.

For use on motors, it must be considered, that the motor takes increased start-up current. Either the overcurrent stage must be set accordingly high, or the dynamic stage Ip dy must be used during start-up. This stage must then be set above the start-up current; furthermore, the relay must be switched over to the dynamic stage via a binary input as long as the motor is starting.

---

```
10  CHAph
inverse
+ very  inv
extr.inv
long  inv
never
```

[1312]
**For “IEC inv.” or “IEC O/C” only**: Characteristic of the overcurrent stage $I_p$ for phase faults, can be

normal *inverse* time lag (IEC 60255−3 type A)

*very inv*erse time lag (IEC 60255−3 type B)

*extr*emely *inv*erse time lag (IEC 60255−3 type C)

*long inv*erse time lag (IEC 60255−3 type B)

$I_p$ stages for phase currents operate *never*

```
10  Tp
0.50  s
```

[1313]
**For “IEC inv.“ or “IEC O/C” only**:
Time multiplier for the inverse time overcurrent stage $I_p$ for phase currents
Setting range: **0.05** s to **3.20** s

```
10  Ip
1.0  I/In
```

[1316]
**For “IEC inv.” or “IEC O/C” only**:
Pick-up value of the inverse time overcurrent stage $I_p$ for phase currents
Setting range: **0.1** to **4.0** · $I_N$

```
1 0   I p   d y
2 . 0   I n
```

[1317]
**For “IEC inv.” or “IEC O/C” only**:
Dynamic pick-up value of inverse time O/C stage $I_p$ (dyn)
Setting range: **0.1** to **4.0** · $I_N$

---

If the function mode is *“ANSIinv”* or *“ANSI O/C”*, one of the following eight inverse time characteristics can be selected.

It must be considered that, according to ANSI/IEEE, the protection picks up only when at least 1.06 times the set value is exceeded.

If the overcurrent stage $I_p$ is not used then set “*never*” as characteristic for phase currents.

For use on motors, it must be considered, that the motor takes increased start-up current. Either the overcurrent stage must be set accordingly high, or the dynamic stage I>dy must be used during start-up. This stage must then be set above the start-up current; furthermore, the relay must be switched over to the dynamic stage via a binary input as long as the motor is starting.

---

```
1 0 C H A   p h
i n v e r s e
```

[1314]
**For “ANSI O/C” or “ANSI inv”**:
Characteristic for phase faults, can be

| | | |
|---|---|---|
| `inverse` | normal *inverse* | time lag acc. ANSI/IEEE |
| + `short in` | *short in*verse | time lag acc. ANSI/IEEE |
| `long inv` | *long inv*erse | time lag acc. ANSI/IEEE |
| `mode inv` | *mode*rately *inv*erse | time lag acc. ANSI/IEEE |
| `very inv` | *very inv*erse | time lag acc. ANSI/IEEE |
| `extr inv` | *extr*emely *inv*erse | time lag acc. ANSI/IEEE |
| `def inv` | *def*inite *inv*erse | time lag acc. ANSI/IEEE |
| `IsqaredT` | *I−squared−T* | |
| `never` | $I_p$ stages for phase currents operate *never* | |

```
1 0   D
0 . 5   s
```

[1315]
**For “ANSI O/C” or “ANSI inv”**:
Time multiplier for the inverse time overcurrent stage $I_p$ for phase currents
Setting range: **0.5** s to **15.0** s

```
1 0   I p
1 . 0   I / I n
```

[1316]
**For “ANSI O/C” or “ANSI inv”**:
Pick-up value of the inverse time overcurrent stage $I_p$ for phase currents
Setting range: **0.1** to **4.0** · $I_N$

```
1 0   I p   d y
2 . 0   I n
```

[1317]
**For “ANSI O/C” or “ANSI inv”**:
Dynamic pick-up value of inverse time O/C stage $I_p$ (dyn)
Setting range: **0.1** to **4.0** · $I_N$

When the definite time characteristic is chosen, the fundamental waves of the measured currents are evaluated for pick-up. When one of the **inverse time** characteristic is chosen, a choice can be made whether the fundamental waves of the measured currents are evaluated, or if the true r.m.s. values including harmonics and d.c. component are calculated for evaluation. 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 the evaluation with harmonics and d.c. component may be advantageous.

---

```
10CALCph
noHARMON

HARMONIC
```

[1318]
**For inverse time overcurrent protection only**:

The fundamental waves of the measured currents are evaluated

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

---

The next parameter in address block 10 determines which stage is effective when the circuit breaker is manually closed. A pre-requisite is, that the manual close command for the breaker is repeated via a binary input to the relay 7SJ600 so that it is informed about manual closing of the breaker. *INEFFECTI*VE means that the stages operate according to the settings.

---

```
10M.CLph
I>>undel

+ I>undela

Ip  undel

INEFFECT
```

[1319]
Phase overcurrent stage which is effective during manual closing of the circuit breaker:

*I>>* i.e. I>> stage but *undel*ayed

*I>* i.e. I> stage (definite time), but *undel*ayed

*Ip* i.e. $I_p$ stage (inverse time), but *undel*ayed

*INEFFECTI*VE, i.e. stages operate as parameterized

---

### 6.3.5 Settings for earth fault overcurrent time protection – address block 11

```
11  O/C
EARTH
```

[1400]
Beginning of the block "Overcurrent time protection for earth faults"

```
11  O/C   e
ON
```

```
+ OFF
```

[1401]
Switching *ON* of the earth fault overcurrent time protection

Switching *OFF* of the earth fault overcurrent time protection

---

Dependent on the scope of functions of the relay (refer to Section 5.4.2), only those parameters are available which have a meaning for the selected functions. The settings for dynamic switch-over of pick-up values are only accessible when the dynamic switch-over had been configured as *EXIST* (Section 5.4.2).

If the dynamic switch-over facility is used and an adequate binary input has been assigned to this function, the appropriate threshold values are set. The duration of the dynamic switch-over is the same as set for phase currents (Section 6.3.4).

The high-set overcurrent stage $I_E$>> is set, if used; if not used, set $I_E$>> to $\infty$. For determination of the setting values similar considerations are valid as for the phase fault stage I>> (refer Section 6.3.4). Blocking of the $I_E$>> stage after unsuccessful AR is valid as with the I>> stage.

---

```
11  IE>>
0.5  I/In
```

[1402]
Pick-up value of the high-set stage $I_E$>> for earth faults
Setting range: **0.05** to **25.00** · $I_N$
and $\infty$ (no trip with $I_E$>> for earth faults)

```
11IE>>dy
0.5  I/In
```

[1403]
Dynamic pick-up value of the high-set stage $I_E$>> (dyn) for earth current
Setting range: **0.05** to **25.00** · $I_N$
and $\infty$ (no trip with $I_E$>>dyn)

```
11  TIE>>
0.10  s
```

[1404]
Trip time delay of the high-set stage $I_E$>>
Setting range: **0.00** s to **60.00** s

---

The earth current stage can be used as definite time overcurrent protection or inverse time overcurrent protection or both at the same time, independent on the phase current stage.

If a definite time the function mode is chosen, i.e. "*def TIME*" or "*IEC O/C*" or "*ANSI O/C*", the following setting parameters are presented. 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. The minimum earth fault current determines the setting of the overcurrent stage $I_E$>.

The time delay TIE> depends on the grading plan for the network.

If the overcurrent stage $I_E$> is not used then set the pick-up value IE> to $\infty$.

---

```
1 1   I E >
0 . 2   I / I n
```

[1405]
**For definite time overcurrent protection only (def TIME, IEC O/C, ANSI O/C)**:
Pick-up value of the overcurrent stage $I_E$> for earth faults
Setting range: **0.05** to **25.00** · $I_N$
and $\infty$ (no trip with $I_E$> for earth faults)

```
1 1   I E > d y
0 . 2   I / I n
```

[1406]
**For definite time overcurrent protection only (def TIME, IEC O/C, ANSI O/C)**:
Dynamic pick-up value of the stage $I_E$> (dyn)
Setting range: **0.05** to **25.00** · $I_N$
and $\infty$ (no trip with $I_E$>dyn)

```
1 1   T I E >
0 . 5 0   s
```

[1407]
**For definite time overcurrent protection only (def TIME, IEC O/C, ANSI O/C)**:
Trip time delay for the overcurrent stage $I_E$>
Setting range: **0.00** s to **60.00** s

```
1 1   M . C L e
N O
+ Y E S
```

[1408]
Measurement repetition for all earth current stages; normal setting: *NO*

With setting *YES* the operating time is increased by approx. 10 ms

---

If the function mode is "*IECinv*" or "*IEC O/C*", one of four inverse time characteristics defined in IEC 60255−3 can be selected. It must be considered that, according to IEC 60255−3, the protection picks up only when at least 1.1 times the set value is exceeded.

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. The minimum earth fault current determines the setting of the overcurrent stage $I_{Ep}$.

If the overcurrent stage $I_{Ep}$ is not used then set "*never*" as characteristic for earth current.

---

```
1 1   C H A   e
i n v e r s e
+ s h o r t   i n
e x t r . i n v
l o n g   i n v
n e v e r
```

[1409]
**For inverse time overcurrent protection "IEC O/C" or "IEC inv" only**: Characteristic of the overcurrent stage $I_{Ep}$ for earth faults, can be

normal *inverse* time lag (IEC 60255−3 type A)

*short in*verse time lag (IEC 60255−3 type B)

*extr*emely *inv*erse time lag (IEC 60255−3 type C)

*long inv*erse time lag (IEC 60255−3 type B)

$I_{Ep}$ stage for earth current operates *never*

```
10 TEp
0.50 s
```

[1410]
**For inverse time overcurrent protection "IEC O/C" or "IEC inv" only**:
Time multiplier for the inverse time overcurrent stage $I_{Ep}$ for earth current
Setting range: **0.05** s to **3.20** s

```
10 IEp
1.0 I/In
```

[1413]
**For inverse time overcurrent protection "IEC O/C" or "IEC inv" only**:
Pick-up value of the inverse time overcurrent stage $I_{Ep}$ for earth current
Setting range: **0.05** to **4.00** · $I_N$

```
11IEpdy
0.1 I/In
```

[1414]
**For inverse time overcurrent protection "IEC O/C" or "IEC inv" only**:
Dynamic pick-up value of inverse time O/C stage $I_{Ep}$ (dyn)
Setting range: **0.05** to **4.00** · $I_N$

---

If the function mode is *"ANSIinv"* or *"ANSI O/C"*, one of the following eight inverse time characteristics can be selected. It must be considered that, according to ANSI/IEEE, the protection picks up only when at least 1.06 times the set value is exceeded.

If the overcurrent stage $I_{Ep}$ is not used then set *"never"* as inverse time characteristic for earth current.

---

```
11 CHA e
inverse
+
short in
long inv
mode inv
very inv
extr inv
def inv
IsqaredT
never
```

[1411]
**For inverse time overcurrent protection "ANSI O/C" or "ANSI inv" only**:
Characteristic for earth faults, can be

| | |
|---|---|
| normal *inverse* | time lag acc. ANSI/IEEE |
| *short in*verse | time lag acc. ANSI/IEEE |
| *long inv*erse | time lag acc. ANSI/IEEE |
| *mode*rately *inv*erse | time lag acc. ANSI/IEEE |
| *very inv*erse | time lag acc. ANSI/IEEE |
| *extr*emely *inv*erse | time lag acc. ANSI/IEEE |
| *def*inite *inv*erse | time lag acc. ANSI/IEEE |
| *I−squared−T* | |

$I_{Ep}$ stage for earth current operates *never*

```
11 DE
0.5 s
```

[1412]
**For inverse time overcurrent protection "ANSI O/C" or "ANSI inv" only**:
Time multiplier for the inverse time overcurrent stage $I_{Ep}$
Setting range: **0.5** s to **15.0** s

```
11  IEp
0.1  I/In
```

[1413]
**For inverse time overcurrent protection "ANSI O/C" or "ANSI inv" only**:
Pick-up value of the inverse time overcurrent stage $I_{Ep}$ for earth faults
Setting range: **0.05** to **4.00** · $I_N$

```
11IEpdy
0.1  I/In
```

[1414]
**For inverse time overcurrent protection "ANSI O/C" or "ANSI inv" only**:
Dynamic pick-up value of inverse time O/C stage $I_{Ep}$ (dyn)
Setting range: **0.05** to **4.00** · $I_N$

---

When the definite time characteristic is chosen, the fundamental waves of the measured currents are evaluated for pick-up. When one of the **inverse time** characteristic is chosen, a choice can be made whether the fundamental waves of the measured currents are evaluated, or if the true r.m.s. values including harmonics and d.c. component are calculated for evaluation. 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 the evaluation with harmonics and d.c. component may be advantageous.

---

```
11CALC  e
noHARMON
```

[1415]
**For inverse time overcurrent protection only**:

`noHARMON` The fundamental waves of the measured currents are evaluated

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

---

The next parameter in address block 11 determines which stage is effective if the circuit breaker is manually closed. A pre-requisite is, that the manual close command for the breaker is repeated via a binary input to the relay 7SJ600 so that it is informed about manual closing of the breaker. *INEFFECTIVE* means that the stages operate according to the settings.

---

```
11  M.CLe
IE>>unde
```

[1416]
Earth overcurrent stage which is effective during manual closing of the circuit breaker:

`IE>>unde` *IE>>* i.e. $I_E$>> stage but undelayed

`IE>undel` *E>* i.e. $I_E$> stage (definite time), but undelayed

`IEp  unde` *IEp* i.e. $I_{Ep}$ stage (inverse time), but *unde*layed

`INEFFECT` *INEFFECTIVE*, i.e. stages operate as parameterized

### 6.3.6 Settings for unbalanced load protection – address block 24

The relay includes an unbalanced load protection (refer to Section 4.3). This can operate only when it is configured to UNB. L = *EXIST* under address block 00 during configuration of the device functions (refer to Section 5.4.2).

The unbalanced load protection can be set to be inoperative or operative.

The preset values are adequate for most motors. If limit values have been stated by the manufacturer, theses should be preferred.

---

```
24 UNBA
L LOAD
```

[1500]
Beginning of the block "Unbalanced load protection"

```
24 UNB.L
ON
```

[1501]
Switch *ON* of unbalanced load protection

```
+ OFF
```

Switch *OFF* of unbalanced load protection

---

```
24 I2>
10 %
```

[1502]
Pick-up value for stage $I_2$>
Setting range: **8** % to **80** %
(referred to rated current of the relay $I_N$)

```
24 TI2>
5.00 s
```

[1503]
Time delay for stage $I_2$>
Setting range : **0.00** s to **60.00** s

```
24 I2>>
50 %
```

[1504]
Pick-up value for stage $I_2$>>
Setting range: **8** % to **80** %
(referred to rated current of the relay $I_N$)

```
24 TI2>>
1.00 s
```

[1505]
Time delay for stage $I_2$>>
Setting range : **0.00** s to **60.00** s

---

### 6.3.7 Settings for thermal overload protection – address block 27

The relay includes a thermal overload protection (refer to Section 4.4). This can operate only when it is configured (refer Section 5.4.2) either as overload protection with total memory (“preLOAD”) or without memory (“no preLD”), and when it is switched “*ON*”. Dependent on the configuration, only the parameters associated with the corresponding function are available.

When the thermal overload function with total memory is selected, all load cycles of the protected object are evaluated in a thermal replica. Thus, the relay can be adapted optimally to the protected object. When the overload function without memory is selected, then only those currents are evaluated, which exceed 1.1 times the set threshold value. Currents below this value are ignored.

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.

This function is usually not required for overhead lines as the current carrying capacity of overhead lines is generally not defined.

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

```
27 THERM
OVERLOAD
```

[2700]
Beginning of block “Thermal overload protection”

```
27 O/L
ON
```

```
+ OFF
```

[2701]
Thermal overload protection can be set to

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

be switched *OFF*

#### 6.3.7.1 Overload protection with total memory

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:

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

where k = factor acc. IEC 60255–8 or VDE 0435 part 303

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.

Since the rated current of the protected object (e.g. motor) is rarely identical with the rated current of the current transformers, the ratio

$$\frac{I_{N\,mach}}{I_{Npri}}$$

must be considered when the maximum current $I_{max}$ is determined:

$$k = \frac{I_{max\,mach}}{I_{N\,mach}} \cdot \frac{I_{N\,mach}}{I_{Npri}} = \frac{I_{max\,mach}}{I_{Npri}}$$

The heating-up time constant $\tau$ depends on the cable data and the cable surroundings or the motor data. If the time constant is not readily available, it can be calculated from the short-term overload capacity. 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 $\tau$ [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.

For motors, often the $t_6$-time is given instead of the thermal time constant; that is the time for which a current of 6 times rated current of the motor is permissible. The time constant can then be approximated by the equation:

$$\text{Setting value } \tau \text{ [min]} = \frac{\mathbf{t_6/s}}{60} \cdot 36 = 0.6 \cdot t_6/s$$

---

```
27  k-FAC
1.10
```

[2702]
Setting value of k-factor = $I_{max}/I_N$
Setting range: **0.40** to **2.00**

```
27  T-CON
10.0  min
```

[2703]
Time constant $\tau$
Setting range: **1.0** to **999.9** min

---

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 into account by the following parameter, which represents the factor how much times the cooling-down time constant exceeds the heating-up time constant, i.e.

$$\text{Setting value f-Tco} = \frac{\tau_{\text{cooling down}}}{\tau_{\text{heating up}}}$$

The criterion that the motor is at stand-still is that all currents are smaller than 0.1 times rated current.

---

```
27  f-Tc
o2.00
```

[2704]
Prolongation factor of the time constant at stand-still referred to the time constant during running
Setting range: **1.00** to **10.00**

---

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

---

```
27  T-ALM
90  %
```

[2702]
Thermal warning stage, in % of trip temperature rise $\Theta_{warn}/\Theta_{trip}$
Setting range: **50** % to **99** %

#### 6.3.7.2 Overload protection without memory

The criterion for overload for overload protection without memory is that an adjustable limit value is exceeded. This threshold is 1.1 times the set value $I_L$ where $I_L$ is the permissible load current, normally the rated current of the protected object. The applied formula, as given in Section 3.5.2 is, nevertheless, based on one times the current $I_L$. Thus, as the safety factor 1.1 for pick-up is already considered in the relay, the recommended setting value for $I_L$ is:

$$\text{Setting value} \quad \frac{I_L}{I_{N\ Device}} = \frac{I_{N\ mach}}{I_{Npri}}$$

The time multiplier $t_L$ must be set in accordance with the thermal capability of the protected object. It represents the so-called $t_6$-time, i.e. the tripping time when 6 times the base current $I_L$ is flowing; this is often stated by the motor manufacturer. If the heating-up time constant is stated instead of the $t_6$-time, then the latter (and thus the setting value $t_L$) can be approximated by the following equation:

$$\frac{t_6}{s} = \frac{1}{36} \cdot \frac{\tau}{s}$$

```
2 7   t L
2 0 . 0   s
```

[2706]
Time multiplier $t_L$ for overload stage without memory
Setting range: **1.0** s to **120.0** s

```
2 7   I L
1 . 0   I / I n
```

[2707]
Base value $I_L$ for overload stage without memory (pick-up at 1.1 times $I_L$)
Setting range: **0.4** to **4.0** · $I_N$

### 6.3.8 Settings for start-up time monitoring – address block 28

The device incorporates a start-up time monitor (refer to Section 4.5), 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*" in address block 28.

The start-up criterion is the increased current that the motor takes during start-up. Consequently, the critical current value $I_{strt}$ must be set such that it is exceeded by the start-up current under all load and voltage conditions. On the other hand, this value must not be exceeded by permissible short-term overloads.

The tripping time $T_{strt}$ must be coordinated with the motor such, that the motor is not thermally endangered during this time. On the other hand, it must be long enough that the motor has terminated the start-up period under normal, healthy conditions. When this time is exceeded, it is assumed that the rotor is locked, so that ventilation may be reduced.

<u>Calculation example</u>:

| | | |
|---|---|---|
| Motor | rated current | $I_N$ = 115 A |
| | start-up current | $I_{start}$ = 575 A |
| | start-up time | $T_{start}$ = 10 s |
| Current transformers | | 150 A /5 A |

For safety reasons, the start-up time monitor is set to approximately half the start-up current, i.e. 288 A. In secondary referred value:

$$\text{Setting } I_{strt} = \left(\frac{288\ A}{150\ A}\right) = 1.92$$

The parameter Tstrt is calculated according the following equation which is derived from the protection characteristic:

$$\text{Setting Tstrt} = t_{start} \cdot \left(\frac{I_{rms}}{Istrt}\right)^2$$

For the given example results:

$$\text{Setting Tstrt} = 10\ \text{s} \cdot \left(\frac{575}{288}\right)^2 = 40\ \text{s}$$

Thus, tripping at rated start-up current will occur after approximately 10 s.

*Note:* The thermal characteristics of the overload protection (with or without memory) are effective even during start-up of the motor.

Address 2804 determines whether the overcurrent stage of the time overcurrent protection (I> stage and/or Ip stage, dependent on configuration) should be blocked during start-up of a motor, after 70 ms.

---

| Display | Description |
|---|---|
| 28 START<br>TIME SUP | [2800]<br>Beginning of the block “Supervision of start-up time” |
| 28 STRT<br>ON | [2801]<br>Switching *ON* the supervision of start-up time |
| + OFF | Switching *OFF* the supervision of start-up time |
| 28 Tstrt<br>10.0 s | [2802]<br>Setting value of the permissible start-up time $T_{strt}$ at $I_{strt}$<br>Setting range: **1.0** s to **360.0** s |
| 28 Istrt<br>4.0 I/In | [2803]<br>Base value $I_{strt}$ of the permissible start-up current<br>Setting range: **0.4** · $I_N$ to **20.0** · $I_N$ |
| 28I> blk<br>NO | [2804]<br>Blocking of the I>/Ip stages during motor start-up |
| + YES | |

---

### 6.3.9 Settings for auto-reclosure − address block 34

Auto-reclose function is effective only if it is incorporated in the relay and configured as *EXIST* (refer to Section 5.4.2).

If no auto-reclosure is to be carried out on the feeder which is protected by the time overcurrent protection relay (e.g. cables, transformers, motors, etc.), then the internal AR function must be configured as *nonEXIST* (refer to Section 5.4.2). The AR function is then not effective at all, i.e. 7SJ600 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.

If auto-reclosure is to be carried out on the feeder which is protected by the time overcurrent protection relay, then the stages I>>, I>>>, and $I_E$>> are used for rapid trip before the first reclosure. Thereafter, these stages are blocked in order to allow selective delayed tripping in accordance with the time-grading plan of the system.

7SJ600 allows up to nine auto-reclose attempts to be carried out. The number of desired auto-reclosure attempts is set as ARcnt.

The dead times can be separately and individually set for the first three auto-reclosure cycles (AR T1, AR T2, and AR T3). If further auto-reclosure attempts are required, they operate with the dead time AR T4. The duration of the dead times is determined by the application philosophy. For longer 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. (0.6 s to 1.0 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, longer dead times can be tolerated.

The reclaim time T−REC is the time period after which the network fault is supposed to be terminated after a <u>successful</u> auto-reclose cycle. A renewed AR initiation 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 reclaim time must be set longer than the expected time for a renewed initiation condition of a persistent fault, i.e. normally longer than the maximum trip time of the overcurrent time protection.

The lock-out time T−LOC is the time period during which after an <u>unsuccessful</u> auto-reclosure further reclosures by 7SJ600 are locked. This time must be longer than the renewed readiness for operation of the circuit breaker.

The blocking time after manual closure of the breaker T−BLM must cover the time for safe closing and opening of the circuit breaker (0.5 s to 1 s). If a renewed initiation condition appears within this time, definitive trip command is issued and reclosure is blocked.

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

---

```
34  AR
```

[3400]
Beginning of the block “internal auto-reclosure function”

```
34  AR
ON
```

[3401]
Switch *ON* of internal auto-reclosure

```
+  OFF
```

Switch *OFF* of internal auto-reclosure

| Display | Description |
| --- | --- |
| 34 ARcnt<br>1 | [3472]<br>Number of permissible auto-reclosure shots<br>Setting range: **1** to **9** |
| 34 AR T1<br>0.10 s | [3465]<br>Dead time for the first auto-reclose cycle<br>Setting range: **0.05** s to **1800.00** s |
| 34 AR T2<br>0.10 s | [3466]<br>Dead time for the second auto-reclose cycle, if used<br>Setting range: **0.05** s to **1800.00** s |
| 34 AR T3<br>0.10 s | [3467]<br>Dead time for the third auto-reclose cycle, if used<br>Setting range: **0.05** s to **1800.00** s |
| 34 AR T4<br>0.10 s | [3468]<br>Dead time for the fourth and any further auto-reclose cycle, if used<br>Setting range: **0.05** s to **1800.00** s |
| 34 T-REC<br>10.00 s | [3469]<br>Reclaim time after successful auto-reclosure<br>Setting range: **0.05** s to **320.00** s |
| 34 T-LOC<br>3.00 s | [3470]<br>Lock-out time after unsuccessful AR<br>Setting range: **0.05** s to **320.00** s |
| 34 T-BLM<br>1.00 s | [3471]<br>Blocking time after manual closing of circuit breaker<br>Setting range: **0.50** s to **320.00** s |

### 6.3.10 Settings for user definable annunciations – address block 38

Four user definable logical functions are available. Each function can be triggered by binary inputs and marshalled to binary outputs (LEDs, signal relays, trip relays). For pick-up, delay times can be set in address block 38.

The binary inputs are the following:
- ">Annu.1" (FNo 11),
- ">Annu.2" (FNo 12),
- ">Annu.3" (FNo 13),
- ">Annu.4" (FNo 14),

For the binary outputs, the identical annunciations must be allocated. Nevertheless, between the inputs and the outputs, the associated time delay is effective as parameterized in these addresses.

Note that the set times are pure delay times which do not include the inherent operating times of the binary inputs and outputs.

---

```
38 DELAY
ANNUNC.
```

[3800]
Beginning of block
"User definable logical functions"

```
38T-Anc1
0.01 s
```

[3801]
Pick-up time delay for the first user definable logical function
Smallest setting value: **0.00** s
Largest setting value: **10.00** s
and ∞, i.e. no start

```
38T-Anc2
0.01 s
```

[3802]
Pick-up time delay for the second user definable logical function
Smallest setting value: **0.00** s
Largest setting value: **10.00** s
and ∞, i.e. no start

```
38T-Anc3
0.01 s
```

[3803]
Pick-up time delay for the third user definable logical function
Smallest setting value: **0.00** s
Largest setting value: **10.00** s
and ∞, i.e. no start

```
38T-Anc4
0.01 s
```

[3804]
Pick-up time delay for the fourth user definable logical function
Smallest setting value: **0.00** s
Largest setting value: **10.00** s
and ∞, i.e. no start

### 6.3.11 Settings for trip circuit supervision – address block 39

The relay includes a trip circuit supervision function (refer to Section 4.7), which requires one or two binary inputs. This can operate only when it is configured (refer to Section 5.4.2) using one ("*by-pass – R*") or two ("*with 2 BI*") binary inputs. Furthermore, the adequate number of binary inputs must be allocated to this function and the external wiring must be correct.

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. But if the trip command lasts more than 60 s to 90 s, then the trip circuit supervision will give alarm even without any other fault.

Details about the function of this supervision are given in Section 4.7. Section 5.2.3 contains information about connection and dimensioning hints as to the resistor in case of supervision with one single binary input.

---

```
39 CIRsup
```

[3900]
Beginning of the block "Trip circuit supervision"

```
39 CIRsup
ON
```

[3901]
Switch *ON* the trip circuit supervision

```
+ OFF
```

Switch *OFF* the trip circuit supervision

---

# 6.4 Annunciations

## 6.4.1 Introduction

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

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

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

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

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

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

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

To call up annunciations on the operator panel scroll with the key ∇ to the item "ANNUNC." (annunciations), refer to Figure 6.3. The key ▷ changes over to the second operation level, where you can reach the different groups of annunciations with the scrolling keys ∇ and △.

When the relay is operated from a personal computer by means of the protection data processing program DIGSI®, the annunciation groups are identified by a four-digit address number. In the following clarifications, this number is indicated at the beginning of the explanations in brackets.

The annunciations are arranged as follows:

Block 81 Operational annunciations; these are messages which may appear during the operation of the relay: information about condition of relay functions, measurement data etc.

Block 82 Event annunciations for the last eight network faults: pick-up, trip, AR (if fitted and used), expired times, or similar. As defined, a network fault begins with pick-up of any fault detector and ends after drop-off of the last protection function. If autoreclosure is carried out, the network fault ends after expiry of the last reclaim or lock-out 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 of the latest protection function.

Block 84 Indication of operational measured values (current magnitudes, values of the thermal overload protection).

The annunciations and measured values are arranged in lists. After paging to a certain annunciation block, an extract (two lines) of a list is shown in the display; the list can be scrolled by the keys ∇ and △, as illustrated in Figure 6.4.

When you have read out annunciations from the display you may revert to the normal display state by pushing the reset-key ("**N**"). The display will then show the quiescent information, i.e. the measured currents of phases L1 and L2. When you now operate one of the scrolling keys ∇ or △ the display automatically restores the last information before reset.

If you have failed to reset to the normal state after read-out of annunciations, the display continues to show the last annunciations. After approximately 10 minutes the display is able to give new spontaneous messages on occurrence of a fault, i.e. the pick-up indication overwrites the 1st display line and (if applicable) the trip information overwrites the 2nd line. If a pick-up is not followed by a trip, the 2nd line does not change.

A comprehensive list of the possible annunciations and output functions with the associated function number FNo is given in Appendix C. It is also indicated to which device each annunciation can be routed.

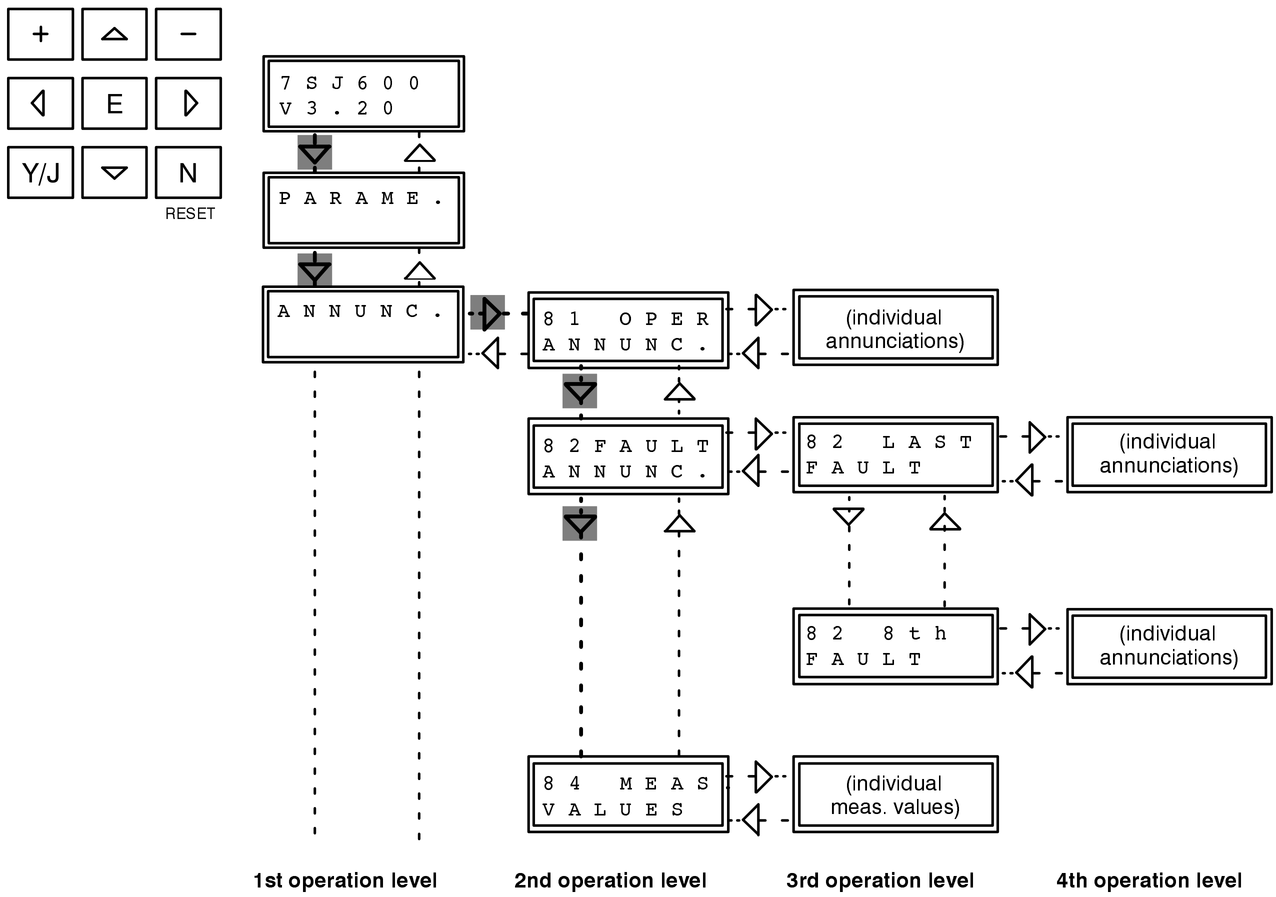



Figure 6.3 Selection of annunciation blocks

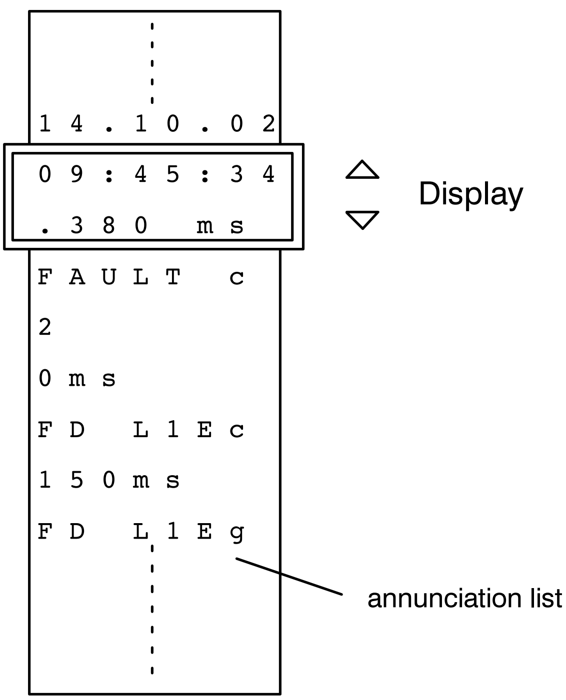



Figure 6.4 Display of an annunciation list – example

## 6.4.2 Operational annunciations – address block 81

Operational and status annunciations contain information which the unit provides during operation and about the operation. They begin at address block 81. Important events and status changes are chronologically listed, starting with the most recent message. Time information is shown in hours, minutes and seconds. Up to 30 operational indications can be stored. If more occur, the oldest are erased in sequence.

Faults in the network are only indicated as "FAULT" together with the sequence number of the fault. Detailed information about the history of the fault is contained in the block "Fault annunciations"; refer to Section 6.4.3.

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.

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 two lines; the third line shows the beginning of a condition with the character **c** to indicate that this condition occurred at the displayed time.

```
8 1   O P E R .
A N N U N C .
```

[5100]
Beginning of the block "Operational annunciations"

```
1 4 . 1 0 . 0 2
0 9 : 4 5 : 3 4
```

1st line: Date of the event or status change
2nd line: Time of the event or status change

Use the arrow keys to scroll through the displayed annunciation list.

```
0 9 : 4 5 : 3 4
L E D   r e s c
```

1st line: Time of the event or status change
2nd line: Annunciation text, in the example **c**oming

When date and time have not yet been set (refer also to Section 6.5.1), the date is shown as 01.01.95, the time is given as relative time from the last re-start of the processor system.

**Direct response from binary inputs:**

| | |
|---|---|
| `>Annu.1` | User defined annunciation 1 (c/g) |
| `>Annu.2` | User defined annunciation 2 (c/g) |
| `>Annu.3` | User defined annunciation 3 (c/g) |
| `>Annu.4` | User defined annunciation 4 (c/g) |
| `>mCLOSE` | Manual close command (c/g) |

| | |
|---|---|
| >CBclo | Circuit breaker closed (from CB auxiliary contact) (c/g) |
| >I>> bk | Block I>> stage of phase overcurrent protection from an external device (c/g) |
| >I> blk | Block I> stage of definite time phase overcurrent protection from an external device (c/g) |
| >Ip blk | Block $I_p$ stage of inverse time phase overcurrent protection from an external device (c/g) |
| >IE>>bk | Block $I_E$>> stage of earth overcurrent protection from an external device (c/g) |
| >IE> bk | Block $I_E$> stage of definite time earth overcurrent protection from an external device (c/g) |
| >IEp bk | Block $I_{Ep}$ stage of inverse time earth overcurrent protection from an external device (c/g) |
| >AR St. | Start internal auto-reclosure (initiation) (c/g) |
| >ARblSt | Block initiation of internal auto-reclosure (c/g) |
| >ARblCl | Block reclose command of internal auto-reclosure (statically) (c/g) |
| >revPhR | Reversed phase rotation (c/g) |
| >I>>>bk | Block instantaneous very high set stage I>>> of the phase overcurrent time protection via binary input (c/g) |
| >TrpRel | Trip circuit supervision: binary input in parallel to trip contact (c/g) |
| >CBaux | Trip circuit supervision: binary input in parallel to CB auxiliary contact (c/g) |

**General operational annunciations of the protection device:**

| | |
|---|---|
| operat. | At least one protection function operative (c/g) |
| LED res | Stored LED indications reset (c) |
| REC del | Fault recording data deleted (c) |
| Sys.Flt | Network system fault (c), detailed information in the fault annunciations |
| FAULT | Fault with associated sequence number (c) |
| >mCLOSE | Manual close command (c/g) |
| >CBclo | Circuit breaker is closed (c/g) |

**Annunciations of monitoring functions:**

| | |
|---|---|
| `ANNlost` | Annunciations lost (buffer overflow) (c) |
| `PCannLT` | Annunciations for operating (PC) interface lost (c) |

**Operational annunciations of time overcurrent protection:**

| | |
|---|---|
| `O/Cpoff` | Phase overcurrent time protection is switched off (c/g) |
| `O/Cpblk` | Phase overcurrent time protection is blocked (c/g) |
| `O/Cpact` | Phase overcurrent time protection is active (c/g) |
| `O/Ceoff` | Earth overcurrent time protection is switched off (c/g) |
| `O/Ceblk` | Earth overcurrent time protection is blocked (c/g) |
| `O/Ceact` | Earth overcurrent time protection is active (c/g) |
| `FD dyn` | Dynamic change over of current fault detection level (c/g) |
| `>I>> bk` | Block I>> stage of phase overcurrent protection via binary input (c/g) |
| `>I> blk` | Block I> stage of definite time phase overcurrent protection via binary input (c/g) |
| `>Ip blk` | Block $I_p$ stage of inverse time phase overcurrent protection via binary input (c/g) |
| `>IE>>bk` | $I_E$>> stage of earth overcurrent protection blocked via binary input (c/g) |
| `>IE> bk` | $I_E$> stage of definite time earth overcurrent protection blocked via binary input (c/g) |
| `>IEp bk` | $I_{Ep}$ stage of inverse time earth overcurrent protection blocked via binary input (c/g) |
| `>I>>>bk` | Block instantaneous very high set stage I>>> of the phase overcurrent protection via binary input (c/g) |

**Operational annunciations of thermal overload protection:**

| | |
|---|---|
| `O/L off` | Overload protection is switched off (c/g) |
| `O/L blk` | Overload protection is blocked (c/g) |
| `O/L act` | Overload protection is active (c/g) |

| | |
|---|---|
| O/L wrn | Overload protection with memory thermal warning stage (c/g) |
| O/L p/u | Overload protection without memory pick-up (c/g) |

**Operational annunciations of unbalanced load protection:**

| | |
|---|---|
| I2 off | Unbalanced load protection is switched off (c/g) |
| I2 blk | Unbalanced load protection is blocked (c/g) |
| I2 act | Unbalanced load protection is active (c/g) |

**Operational annunciations of start-up time supervision:**

| | |
|---|---|
| SRT off | Start-up time supervision is switched off (c/g) |
| SRT blk | Start-up time supervision is blocked (c/g) |
| SRT act | Start-up time supervision is active (c/g) |
| SRT Trp | Start-up time supervision trip (c/g) |

**Operational annunciations of the internal auto-reclose function:**

| | |
|---|---|
| AR off | Auto-reclosure is switched off or blocked (c/g) |
| AR act. | Auto-reclosure is active (c/g) |
| ARblMCl | Auto-reclosure is blocked by manual close command (c/g) |
| AR DT | Auto-reclosure: dead time started with number of AR cycle (c) |
| >AR St. | Internal auto-reclosure started via binary input (initiation) (c/g) |
| >ARblSt | Initiation of internal auto-reclosure blocked via binary input (c/g) |
| >AR blC | Close command of internal auto-reclosure blocked via binary input (statically) (c/g) |

**Operational annunciations of trip circuit supervision:**

| | |
|---|---|
| SUP off | Trip circuit supervision is switched off (c/g) |
| SUP blk | Trip circuit supervision is blocked (c/g) |
| SUP act | Trip circuit supervision is active (c/g) |
| SUPnoBI | Trip circuit supervision is blocked, because binary input is not marshalled (c/g) |
| CIR int | Trip circuit is interrupted (c/g) |
| >TrpRel | Trip circuit supervision: binary input in parallel to trip contact (c/g) |
| >CBaux | Trip circuit supervision: binary input in parallel to CB auxiliary contact (c/g) |

**Operational annunciations of the circuit breaker control:**

| | |
|---|---|
| Q0 clo. | Circuit breaker close command (c) |
| Q0 trp. | Circuit breaker open (trip) command (c) |

**Operational annunciations of the circuit breaker test function:**

| | |
|---|---|
| CBtest | Circuit breaker test in progress (c/g) |
| CBtpTst | Trip by internal circuit breaker test function (c/g) |
| CBTwAR | Internal circuit breaker trip test with auto-reclosure (c/g) |

**Operational annunciations of the user defined annunciations:**

| | |
|---|---|
| >Annu.1 | User defined annunciation 1 (c/g) |
| >Annu.2 | User defined annunciation 2 (c/g) |
| >Annu.3 | User defined annunciation 3 (c/g) |
| >Annu.4 | User defined annunciation 4 (c/g) |

### 6.4.3 Fault annunciations – address block 82

The annunciations which occurred during the last eight network faults can be read off on the front panel or via the operating interface. The indications are recorded in the sequence from the youngest to the oldest. When a ninth fault occurs, the data relating to the oldest are erased. Each of the eight fault data buffer can contain up to 30 annunciations. When more occur, the last message signals "buffer overflow".

Input of the codeword is not required.

When the relay is operative and the initial display or the quiescent messages are displayed, press the key ▽ to reach the item "ANNUNC." Key ▷ is used to change over to the second operation level, where one can go with the key ▽ to the address block 82 which forms the heading of the fault annunciations. The third operation level, with key ▷ contains the eight system faults. The individual annunciations can be found in the fourth operation level (key ▷), see Figure 6.3. Use the keys ▽ and △ to scroll through the annunciation list (Figure 6.4).

For these purposes, the term "system fault" means the period from short-circuit inception up to final clearance. If auto-reclosure is carried out, the network fault ends after expiry of the last reclaim or lock-out time. Within a network fault, several fault events can occur, from pick-up of any fault detection until drop-off of the latest protection function.

When date and time have not yet been set (refer also to Section 6.5.1), the date is shown as 01.01.95, the time is given as relative time from the last re-start of the processor system. Thereafter, the fault annunciations are listed in chronological sequence with the relative time referred to the first fault detection.

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

◁ ▽
```
82 FAULT
ANNUNC.
```
▷

[5200]
Beginning of the block "Fault annunciations"

```
82 LAST
FAULT
```
▷

[5210]
Beginning of the block "Fault annunciations of the last system fault"

Use the arrow keys to scroll through the displayed annunciation list.

```
03.11.02
22:09:46
```

[5211]
1st line: Date of the last system fault
2nd line: Time of the last system fault (hours, minutes, seconds

```
.810 ms
FAULT c
```

and ms)
System fault, **c**oming

```
2
0 ms
```

1st line: Consecutive number of the system fault
2nd line: Beginning of the relative time; time resolution is 1 ms

```
0 ms
FD L1E c
```

1st line: Beginning of the relative time
2nd line: Event that has started the relative time

etc.

**General fault annunciations of the device:**

| | |
|---|---|
| Sys.Flt | Network system fault |
| FAULT | Beginning of fault |
| ANNovfl | Fault annunciations lost (buffer overflow) |
| FT det | General fault detection of device |
| DEV.Trp | General trip of device |
| IL1 | Interrupted fault current of phase L1 ($I_{L1}/I_N$) |
| IL2 | Interrupted fault current of phase L2 ($I_{L2}/I_N$) |
| IL3 | Interrupted fault current of phase L3 ($I_{L3}/I_N$) |

**Fault annunciations of overcurrent time protection:**

| | |
|---|---|
| FD L1 | Fault detection overcurrent time protection, phase L1 |
| FD L1E | Fault detection overcurrent time protection, phase L1 – E |
| FD L2 | Fault detection overcurrent time protection, phase L2 |
| FD L2E | Fault detection overcurrent time protection, phase L1 – E |
| FD L12 | Fault detection overcurrent time protection, phases L1 – L2 |
| FD L12E | Fault detection overcurrent time protection, phases L1 – L2 – E |
| FD L3 | Fault detection overcurrent time protection, phase L3 |
| FD L3E | Fault detection overcurrent time protection, phase L1 – E |
| FD L13 | Fault detection overcurrent time protection, phases L1 – L3 |
| FD L13E | Fault detection overcurrent time protection, phases L1 – L3 – E |
| FD L23 | Fault detection overcurrent time protection, phases L2 – L3 |
| FD L23E | Fault detection overcurrent time protection, phases L2 – L3 – E |
| FD L123 | Fault detection overcurrent time protection, phases L1 – L2 – L3 |
| FDL123E | Fault detection overcurrent time protection, phases L1 – L2 – L3 – E |
| FD E | Fault detection overcurrent time protection, earth fault |

| | |
|---|---|
| FD I>> | Fault detection of the I>> phase current stage |
| Trp I>> | Trip by overcurrent time protection, stage I>> (phases) |
| TrpI>>> | Trip by overcurrent time protection, stage I>>> (phases) |
| FD I> | Fault detection of the I> phase current stage (definite time) |
| Trip I> | Trip by overcurrent time protection, stage I> (phases) |
| FD Ip | Fault detection of the $I_p$ phase current stage (inverse time) |
| Trip Ip | Trip by overcurrent time protection, stage $I_p$ (phases, inverse time) |
| FD IE>> | Fault detection of the $I_E$>> earth current stage |
| TrpIE>> | Trip by overcurrent time protection, stage $I_E$>> (earth) |
| FD IE> | Fault detection of the $I_E$> earth current stage (definite time) |
| Trp IE> | Trip by overcurrent time protection, stage $I_E$> (earth) |
| FD IEp | Fault detection of the $I_{Ep}$ earth current stage (inverse time) |
| Trp IEp | Trip by overcurrent time protection, stage $I_{Ep}$ (earth, inverse time) |

**Fault annunciations of unbalanced load protection:**

| | |
|---|---|
| FD I2>> | Fault detection unbalanced load protection, stage $I_2$>> |
| FD I2> | Fault detection unbalanced load protection, stage $I_2$> |
| Trp I2 | Trip by unbalanced load protection |

**Fault annunciations of thermal overload protection:**

| | |
|---|---|
| O/L wrn | Overload protection with memory: Thermal warning stage |
| O/L p/u | Overload protection without memory: Pick-up |
| O/L Trp | Trip by overload protection |

**Fault annunciation of start-up time monitor:**

| | |
|---|---|
| SRT Trp | Trip by start-up time monitor |

**Fault annunciations of the internal auto-reclosure function:**

| | |
|---|---|
| `>AR St.` | Internal auto-reclosure started via binary input (initiation) |
| `>ARblSt` | Initiation of internal auto-reclosure blocked via binary input |
| `>ARblCl` | Close command of internal auto-reclosure blocked via binary input (statically) |
| `AR ipg` | Auto-reclosure in progress |
| `AR ClCm` | Auto-reclosure: close command |
| `AR dTrp` | Auto-reclosure: definitive (final) trip |
| `AR Strt` | Internal auto-reclosure started (general) |
| `AR blCl` | Close command of internal auto-reclosure blocked (general) |
| `AR blSt` | AR: start blocked (general) |
| `AR DT` | Auto-reclosure: dead time started with number of AR cycle |

**Further messages:**

| | |
|---|---|
| `TABempty` | means that no fault event has been recorded |
| `TABovrfl` | means that other fault data have occurred, however, memory is full |
| `TAB.END` | If not all memory places are used the last message is `TAB.END` |

Use key ◁ to go back to the third operation level. You can reach the **second to last** system fault by pressing the key ▽. The individual fault annunciations can be found with the key ▷ in the fourth operation level and scrolled through with the keys ▽ and △. The available annunciations are the same as for the last fault.

| | |
|---|---|
| ▽ `82 2nd` `FAULT` ▷ | [5220] Beginning of the “Fault annunciations of the second to last system fault” |

In corresponding way the annunciations of the third to last up to the eighth to last fault can be achieved.

### 6.4.4 Read-out of operational measured values – address block 84

Operating measured values can be read out at any time under the address block 84. When the relay is operative and the initial display or the quiescent messages are displayed, press the key ▽ to reach the item “ANNUNC.” Key ▷ is used to change over to the second operation level, where you can go with the key ▽ to the address block 84 which forms the heading of the operational measured values. The individual annunciations can be found in the third operation level (key ▷), see Figure 6.3. Use the keys ▽ and △ to scroll through the individual measured values (Figure 6.4).

Entry of the codeword is not necessary.

The data are displayed in percent of the rated device values and in primary values. They are actuallized in intervals of approx. 1 sec.

In the following example, some example values have been inserted. In practice the actual values appear.

```
8 4   M E A S .
V A L U E S
```

[5200]
Beginning of the block “Operational measured values”

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

```
I L 1 =
7 2 %
```

Page on with the ▽ key to read off the next measured value, or page back with △

The percentage is referred to rated relay current

```
I L 2 =
7 0 %
```

```
I L 3 =
7 3 %
```

```
I L 1 =
2 8 8 A
```

The primary values are calculated on the base of the set primary rated current (address 1105, see Section 6.3.3)

```
I L 2 =
2 8 0 A
```

```
I L 3 =
2 9 1 A
```

```
THETA   =
43%
```

The calculated temperature rise for the overload protection with memory can be read out in percent of the trip temperature rise.

```
t  TRP  =
INVAL
```

When the warning temperature rise is exceeded (overload protection with total memory) or the pick-up value is exceeded (overload protection without memory) the calculated trip time (with constant current) is indicated, either in seconds or in minutes, in two messages. The inapplicable message is marked with “INVALid”. “INVALid” is indicated also when no trip is expected

```
t  REL  =
INVAL
```

When the overload protection with total memory is effective and the protection has tripped, the time is indicated until the temperature rise will have decreased below the warning temperature rise, i.e. the time until reset of the overload protection, is indicated, either in seconds or in minutes, in two messages. The inapplicable message is marked with “INVALid”

## 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. 7SJ600 comprises facilities, e.g. to re-adjust the real time clock and to switch on or off partial functions under specific conditions, or to change over preselected pick-up values (dynamic change-over of pick-up values of the overcurrent time protection).

The functions can be controlled from the operating panel on the front of the device, via the operating interface as well as via binary inputs. Refer to the Sections 6.3.4 to 6.3.10 for the appropriate setting addresses and Section 5.5.2 for the allocation of 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 Section 5.5.2 Marshalling of the binary inputs).

Operational control via the key pad or the operation interface is carried out under the item "ADDITION FUNCTION" (additional functions). When the relay is operative and the initial display or the quiescent messages are displayed, press the key ▽ to reach the item "ADDITION FUNCTION". Key ▷ is used to change over to the second operation level, where one can go with the key ▽ to the required control addresses.

When the relay is operated from a personal computer by means of the protection data processing program DIGSI®, the control items are identified by a four-digit address number. In the following clarifications, this number is indicated at the beginning of the explanations in brackets.

---

△ | ADDITION FUNCTION | ▷

[9000]
Beginning of the block "Additional functions"

---

### 6.5.1 Adjusting and synchronizing the real time clock

Key ▷ is pressed to change to the second operation level. The display shows the first item "TIME SETTING". Change to the third operation level with key ▷. The actual date and time are displayed now. Scroll on with key ▽ to find the setting items for date and time, as illustrated below.

When date and time have not yet been set, the date "01.01.95" appears and the time since the start-up of the processor system.

The next two addresses allow to set date and time.

Codeword entry is not required. Day, month, and year can be altered using the keys ⊞ and ⊟. Key ▷ is used to switch from day to month etc. Confirm with the enter key **E** when the date is completed. Proceed in analog manner to adjust the time.

*Note:* When the day is changed, the display firstly allows 31 days. Only when the month and year is changed, the relay can check plausibility of the complete date. After confirmation with the enter key **E**, the day may be reduced to an existing number.

---

◁ | TIME SETTING | ▷

[8100]
Beginning of the block "Setting the real time clock".

◁
```
0 1 . 0 1 . 9 9
0 1 : 1 5 : 0 6
```
▽

[8101]
At first, the “actual” date (**DD.MM.YY**) and the “actual” time (**HH:MM:SS**) are displayed.
Continue with ▽.

◁
```
D A T E
2 7 . 1 0 . 0 2
```

[8102]
Enter the new date: 2 digits for day, 2 digits for month and 2 digits for year: **DD** ▷ **MM** ▷ **YY**

Use key ⊞ to increase the day or ⊟ to decrease;
use key ▷ to change-over to the month;
use key ⊞ to increase the month or ⊟ to decrease;
use key ▷ to change-over to the year;
use key ⊞ to increase the year or ⊟ to decrease;
confirm with enter key **E**.

◁
```
T I M E
1 3 : 4 4 : 2 7
```

[8103]
Key ▽ is used to come to the time setting. Enter the new time: 2 digits for hour, 2 digits for minute: **HH** ▷ **MM**

Use key ⊞ to increase the hour or ⊟ to decrease;
use key ▷ to change-over to the minute;
use key ⊞ to increase the minute or ⊟ to decrease;

the seconds are not changed. They are automatically set to “00” when the enter key **E** is pressed.

## 6.5.2 Circuit breaker control

Dependent on the ordered model (7SJ600*–*****–**B*), the circuit breaker can be controlled via the device. From the item “ADDITION FUNCTION” of the first operation level, as above, you switch to the second operation level with the key ▷ and select with ▽ the option “BREAKER CONTROL”.

| | | |
|---|---|---|
| △ | BREAKER<br>CONTROL ▷ | [7500]<br>Block “Circuit breaker control” |

Change with the ▷ key to the block with the individual control commands. Select the desired control operation (open or close) with ▽.

| | | |
|---|---|---|
| △ | CB<br>OPEN? **E** | [7501]<br>After confirmation with the enter key **E** the relay requests for codeword input. After correct codeword input, repeat confirmation with the enter key **E**. The relay checks whether breaker operation is permitted. The command is rejected when another command is already being executed or when an auto-reclose cycle is in progress. |
| ◁ | CB<br>STARTED **E** | The device confirms the command. With the ◁ key, the higher operation level can be reached. |
| △ | CB<br>CLOSE? **E** | [7502]<br>After confirmation with the enter key **E** the relay requests for codeword input. After correct codeword input, repeat confirmation with the enter key **E**. When an auto-reclose cycle is in progress, this is aborted. |
| ◁ | CB<br>STARTED **E** | The device confirms the command. With the ◁ key, the higher operation level can be reached. |

# 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 Section 5.2.4).

It is recommended that the actual settings for the relay be used for the testing procedure. If these values are not (yet) available, test the relay with the factory settings. In the following description of the test sequence the preset settings are assumed.

For the functional test a three-phase symmetrical current source with individually adjustable currents should be available. For checking the pick-up values a single-phase current source is sufficient.

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

During all the tests it is important to ensure that the correct command (trip) contacts close, that the proper indications appear at the LEDs and the output relays for remote signalling.

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

### 6.6.2 Testing the high-set overcurrent time protection stages I>>, $I_E$>>, and the instantaneous stage I>>>

In order to test the high-set overcurrent time protection stages, the related functions must be switched on (address block 10 O/C ph = *ON* and/or address block 11 O/C e = *ON* (as delivered).

Testing can be performed with single-phase, two-phase or three-phase test current without difficulties.

**Caution!**

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

For testing the I>> stages and the I>>> stage, 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 block 11, factory setting 0.5 x $I_N$) is exceeded the pick-up annunciation "`FD IE>>`" appears, with further increase above the pick-up value of the high-set phase current stage (address block 10, factory setting 2 x $I_N$) pick-up annunciation "`FD I>>`" and the pick-up indication appears for the tested phase ("`O/C AL*`" and LED 1 for L1 or LED 2 for L2 or LED 3 for L3 at factory setting). Check that the assigned signal relay 2 (at factory setting) contacts close.

After expiry of the time delay (TIE>> for the earth current path, factory setting 0.1 s; TI>> for the phase path, factory setting 0.03 s), trip signal is given (LED 4 at delivery). Check that the assigned trip relay (1) contacts close.

The very high instantaneous stage I>>> is preset to ∞. It can only be tested when a definite value has been set. The test current should be more than twice the setting value to ensure that this stage operates fast; but still observe thermal capability! Annunciation "`TRPI>>>`" appears.

If the change-over facility of dynamic pick-up values is used, this should be checked, too, in order to ensure that the associated binary input operates correctly. The dynamic very high instantaneous stage I>>>dyn is preset to ∞. It can only be tested when a definite value has been set. The binary input assigned to the dynamic switch over is energized (not allocated when delivered). Test must be performed within the set duration for these stages Tdyn (600 s when delivered).

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

### 6.6.3 Testing the definite time overcurrent protection stages I>, $I_E$>

For these tests the related functions must be switched on, furthermore, a mode must have been selected in addresses block 00 (O/Cch) which includes the definite time protection, i.e. *def TIME* (as delivered), *IEC O/C*, or *ANSI O/C*.

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 block 11: IE>, factory setting 0.2 x $I_N$) is exceeded the pick-up annunciation "`FD IE>`" appears, with further increase above the pick-up value of the phase current stage (address block 10: I>, factory setting 1 x $I_N$) pick-up indication appears for the tested phase (LED 1 for L1 or LED 2 for L2 or LED 3 for L3 at factory setting).

After expiry of the time delay (TIE> for the earth current path, factory setting 0.5 s; TI> for the phase path, factory setting 0.5 s), trip signal is given (LED 4 at delivery). Check that the assigned signal relay and trip relay contacts close.

If the change-over facility of dynamic pick-up values is used, this should be checked, too, in order to ensure that the associated binary input operates correctly. The binary input assigned to the dynamic switch over is energized (not allocated when delivered). Test must be performed within the set duration for these stages Tdyn (600 s when delivered).

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

### 6.6.4 Testing the inverse time overcurrent protection stages $I_p$, $I_{Ep}$

For these tests the related functions must be switched on, furthermore, a mode must have been selected in addresses block 00 (O/Cch) which includes an inverse time protection, i.e. *IEC inv.*, *ANSI inv*, *IEC O/C* or *ANSI O/C*. In address block 10, the valid characteristic must have been set.

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 (factory setting 0.1 x $I_N$) is exceeded by more than 1.1 times the set value (for IEC characteristics) or 1.06 times the set value (for ANSI/IEEE characteristic), pick-up indication for $I_{Ep}$ appears: "`FD IEp`", with further increase above 1.1 times the pick-up value (for IEC characteristics) or 1.06 times the set value (for ANSI/IEEE characteristic) of the phase current stage (factory setting 1 x $I_N$) pick-up indication appears for the tested phase (LED 1 for L1 or LED 2 for L2 or LED 3 for L3 at factory setting). Check that the assigned signal relay contacts close.

With current less than 1.05 times setting value (for IEC characteristics) or 1.03 times the set value (for ANSI/IEEE characteristic), no pick-up must occur.

The time delay depends on which characteristic and which set time multiplier has been set. 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 provided the thermal capability is not exceeded. Check that the assigned signal relay and trip relay contacts close.

If the change-over facility of dynamic pick-up values is used, this should be checked, too, in order to ensure that the associated binary input operates correctly. The binary input assigned to the dynamic switch over is energized (not allocated when delivered). Test must be performed within the set duration for these stages Tdyn (600 s when delivered).

### 6.6.5 Testing the unbalanced load protection

The unbalanced load protection can only be tested if this function has been configured in address block 00 as UNB.L = *EXIST* and parameterized as operative (UNB.L = *ON*).

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 single-phase current is described. In this case the unbalanced load amounts to one third of the test current which is referred to the unit current.

When the pick-up value is exceeded (test current > 3 times setting values), the associated annunciations "`FD I2>`" and "`FD I2>>`" (signal relay 2 at delivery) must be indicated. After the associated time delay has expired (TI2> 5 s at delivery, TI2>> 1 s at delivery), trip annunciation "`TRP I2`" is issued (LED 4 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.

### 6.6.6 Testing the overload protection

The overload protection can only be tested if it has been configured in address block 00 with total memory as *preLOAD* or without memory as *no preLD* and parameterized as operative under address block 27: O/L = *ON*.

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

#### 6.6.6.1 Overload protection without memory

The overload protection without memory picks up when 1.1 times the set value IL is exceeded.

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 set value for IL (factory setting 1 x $I_N$) is exceeded by more than 1.1 times the set value, pick-up indication for overload appears: "`O/L p/u`". Check that the assigned signal relay contacts close (signal relay 2 at factory setting).

The time delay depends on which time multiplier has been set. The expected time delays can be calculated from the formula given in the Technical data (Section 3.5.2) or read from the characteristic curves in Figures 3.7 (Section 3.5.2).

It is suggested that one point of the trip time characteristic is checked with 2 x setting value provided the thermal capability is not exceeded. Trip signal "`O/L Trp`" is given.

#### 6.6.6.2 Overload protection with total memory

The basis current for the detection of overload is always the rated current of the device.

When applying the rated current (factory settings) tripping must not occur. After an appropriate time (approximately 5 x $\tau$) a steady-state temperature rise according to the following relationship is established:

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

This value can be read out in address block 84. 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 by either de-activating and re-activating the overload function (address block 27) or by observing a current free period of at least 5 x $k_\tau$ x $\tau$ or by blocking the overload protection via an correspondingly assigned binary input (`>O/L blk`).

**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 $\tau$.

### 6.6.7 Testing the start-up time monitor

The start-up time monitor can only be tested if it has been configured in address block 00 as STRT = *EXIST* and parameterized as operative (STRT = *ON*).

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 and does not pick up at 0.9 times setting value.

The tripping time depends on the set start-up time, the set start-up current, and the test current. It can be calculated from the formula given in the Technical data (Section 3.6).

It is suggested that one point of the trip time characteristic is checked. For example, the preset values (Istrt = 4 x $I_N$, Tstrt = 10 s) result in a tripping time of 2.5 s when the test current amounts to 8 time $I_N$. Trip is annunciated with "`SRT Trp`".

*Note:* The start-up monitor operates independent on the thermal overload protection. Thus, it is possible that the overload protection may trip before the start-up time monitor does, dependent on the set parameters. If necessary, the overload protection may be switched off before testing the start-up time monitor. But do not forget to switch in on again after the tests, when it is to be used.

### 6.6.8 Testing the auto-reclose functions (if fitted)

The internal AR function can be tested provided it is fitted in the relay, configured in address block 00 as AR = *EXIST* (refer to Section 5.4.2) and switched to AR = *ON* (address block 34).

The binary input "circuit breaker ready" must be simulated should it be assigned to the corresponding input function (FNo `2734` "`>ARblCl`", i.e. block closing command, refer also to Section 5.5.2).

Depending of the selected AR program, a 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 previous test has completely terminated; otherwise an auto-reclosure cannot result: annunciation "`AR i pg`" (auto-reclosure in progress, FNo `2801`, not allocated at delivery) must not be present or must be annunciated "**G**oing".

If the circuit breaker is not ready and this is indicated to the relay as described above, a reclose attempt must not result.

### 6.6.9 Testing the trip circuit supervision

The trip circuit supervision function can only be tested if it has been configured in address block 00 (contrary to the state of delivery) *with 2 BI* (with 2 binary inputs) or *bypass–R* (with one binary input, the second is by-passed by a resistor). Furthermore, it must be switched *ON* in address block 39 (CIRsup = *ON*), and the associated binary input(s) must be marshalled for this purpose (refer to Section 5.5.2).

#### 6.6.9.1 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 4.7.1). 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 "`CIR int`" (i.e. trip circuit interrupted, not allocated at delivery) appears after 400 ms to 700 ms.

#### 6.6.9.2 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 4.7.2). 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 "`CIR int`" (not allocated at delivery) appears after 60 s to 90 s.

## 6.7 Commissioning using primary tests

All secondary testing sets and equipment must be removed. Reconnect current transformers. For testing with primary values the protected object must be energized.

**Warning**

Primary tests shall be performed only by qualified personnel which is trained in commissioning of protection systems and familiar with the operation of the protected object as well as the rules and regulations (switching, earthing, etc.)

### 6.7.1 Current circuit checks

Connections to current transformers are checked with primary values. For this purpose a load current of at least 10 % of the rated current is necessary.

Currents can be read off on the display in the front or via the operating interface in block 84 and compared with the actual measured values (refer also to Section 6.4.4). If substantial deviations occur, then the current transformer connections are incorrect.

**DANGER!**

**Secondary connections of the current transformers must be short-circuited before any current leads to the relay are interrupted!**

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

### 6.7.2 Checking the reverse interlock scheme (if used)

For use and tests of the reverse interlock scheme it is necessary that at least one of the binary inputs has been assigned to the function "`>I>> bk`" and/or further blocking inputs. When delivered from factory, binary input BI 2 has been assigned to this function.

Reverse interlocking can be used in "normally open mode", i.e. the I>> stage is blocked when the binary input "`>I>> bk`" is energized, or "normally closed" mode, i.e. the I>> stage is blocked when the binary input "`>I>> bk`" is de-energized. The following procedure is valid for "normally open mode" as preset by the factory.

The protection relay on the incoming feeder and those on all outgoing circuits must be in operation. At first the auxiliary voltage for reverse interlocking should not be switched on.

Apply a test current which makes pick-up the I>> stage as well as the I> or $I_p$ stage. Because of the absence of the blocking signal the relay trips after the (short) delay time TI>>.

**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 TI> (0.5 s) or according to TIp (0.5 s).

If applicable repeat test for the earth current stages.

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

### 6.7.3 Testing the user definable logic functions

The operation of the user definable logic functions is widely dependent of the application. The input condition have to be produced in accordance with the intended function, and the output conditions must be checked.

When measuring the delay times, it must be noted that the set time (pick-up and/or drop-off) delays do not include the inherent time of the input and output modules; these are additional.

### 6.7.4 Testing the switching conditions of binary inputs and outputs

The relay contains a test routine which interrogates the positions of the binary inputs and outputs and indicates them on the display.

Tests can be performed in address block 40. This block is reached by pressing the key ▽ three times so that the block "ADDITION FUNCTION" (additional functions) is displayed. Change to the second operation level by the key ▷; "DATE/TIME" is displayed.

Key ▽ is pressed to scroll to the test blocks.

When the relay is operated from a personal computer by means of the protection data processing program DIGSI®, the test items are identified by a four-digit address number. In the following clarifications, this number is indicated at the beginning of the explanations in brackets.

---

△ | TEST AIDS | ▷

[4000]
Beginning of the block "Tests and commissioning aids"

---

Change over with key ▷ to the next operation level which shows the heading of the input/output conditions. Page to the next operation level by the key ▷ to gain access to the individual tests.

◁ | I/O STAT | ▷

[4100]
Beginning of the block "Input/output status"

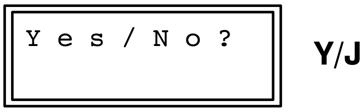
◁ | BI-STAT | **E**

[4101]
Block "Status of the binary inputs"

---

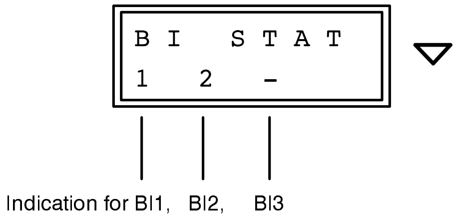
Pressing the enter key **E** causes the relay to display the the question whether the states of the binary inputs shall be checked. Press the "Yes"-key **Y/J** to confirm, or the "No"-key **N** to abort. With the key ▽ the next test item can be selected.

---




Pressing the "Yes"-key **Y/J** makes the relay display the states of the binary inputs (BI). Each energized input is marked by its number, inputs which are not energized are marked with a –:

1: BI 1 is energized (control voltage present)
2: BI 2 is energized (control voltage present)
3: BI 3 is energized (control voltage present)
–: BI is **not** energized (control voltage absent)

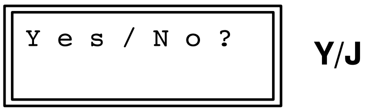



The illustrated example shows that the binary inputs BI 1 and BI 2 are energized, and binary input BI 3 is not energized.

Press the key ▽ to change to the conditions of the signal relays and trip relays:

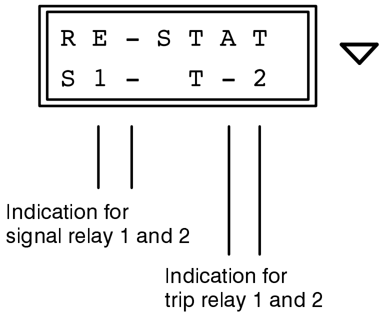

[4102]
Block "Status of the output relays"

Pressing the enter key **E** causes the relay to display the the question whether the states of the binary outputs (relays) shall be checked. Press the "Yes"-key **Y/J** to confirm, or the "No"-key **N** to abort.




Pressing the "Yes"-key **Y/J** makes the relay display the states of the output relays (RE). The letter "S" indicates "Signal relay", "T" indicates "Trip relay". Each energized output is marked by its number, outputs which are not energized are marked with a –:

1: signal (S) or trip (T) relay 1 is energized
2: signal (S) or trip (T) relay 2 is energized
–: signal (S) or trip (T) relay is not energized




The illustrated example shows that the signal relay 1 is energized, signal relay 2 is not energized, trip relay 1 is not energized, trip relay 2 is energized.

Press the key ▽ to change to the conditions of the LED indicators:

```
L E D
S T A T U S
```

△ **E**

[4103]
Block “Status of LED indicators”

```
Y e s / N o ?
```

**Y/J**

Pressing the enter key **E** causes the relay to display the the question whether the states of the LED indicators (LED) shall be checked. Press the “Yes”-key **Y/J** to confirm, or the “No”-key **N** to abort.

Pressing the “Yes”-key **Y/J** makes the relay display the states of the LEDs. Each energized LED is marked by its number, LEDs which are not energized are marked with a −:

1: LED 1 is energized
2: LED 2 is energized
3: LED 3 is energized
4: LED 4 is energized
−: LED is **not** energized

```
L E D
-   2   -   4
```

△

Indication for LED1, LED2, LED3, LED4

The illustrated example shows that the LED 1 is energized, LED 2 is not energized, LED 3 is not energized, LED 4 is energized.

### 6.7.5 Testing the control commands

If the circuit breaker is to be controlled via the control functions of the device this control facility must be checked.

Before control operations are carried out, it must have been ensured that switching is allowed under the actual operating conditions of the plant. If necessary, the circuit breaker must be isolated at both sides.

The circuit breaker is closed and tripped using the device’s front panel as described in Section 6.5.2.

If the circuit breaker does not respond to the control commands, check that the control functions are allocated to the respective output relays that control the breaker (FNo 4640 and 4641), during marshalling (Section 5.5.5).

If the breaker is to be controlled via the serial interface, this must be checked, too.

Blocking the control facility by energizing the respective blocking input (FNo 4632) must be checked as well, if used.

## 6.7.6 Tripping test including circuit breaker

Overcurrent time protection 7SJ600 allows simple checking of the tripping circuit and the circuit breaker. For this, the circuit breaker can be tripped by initiation from the operator keyboard or via the operator interface. If the internal auto-reclose system is activated, a trip-close test cycle is also possible.

Tests can be performed in address block 40. This block is reached by pressing the key ∇ three times so that the block “ADDITION FUNCTION” (additional functions) is displayed. Change to the second operation level by the key ▷; “DATE/TIME” is displayed. Key ∇ is pressed until the display shows the test block “CB–TEST”.

When the relay is operated from a personal computer by means of the protection data processing program DIGSI®, the test items are identified by a four-digit address number. In the following clarifications, this number is indicated at the beginning of the explanations in brackets.

### 6.7.6.1 TRIP-CLOSE test cycle

Prerequisite for the start of a trip-close test cycle is that the integrated auto-reclose function be programmed as *EXIST* (address block 00) and switched on (address block 34).

A TRIP-CLOSE test cycle is also possible with an external auto-reclose system. Since in this case, however, 7SJ600 only gives the tripping command, the procedure shall be followed as described in Section 6.7.6.2.

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

**DANGER!**

**A successfully started test cycle will lead to closing of the circuit breaker!**

The individual test item is reached with the key ▷ in the next operation level.

Prerequisites for the start of test are that no protective function fault detector has picked up and that the conditions for reclose (e.g. AR not blocked) are fulfilled. Codeword input is necessary. The circuit breaker test feature must have been allocated to the trip relay during marshalling.

The relay displays the test sequence in the second display line.

---

△ | CB–TEST / TRP–CLO | ▷

[4300]
Block “Test of circuit breaker – Trip-Close-Cycle”

△ | CB–TEST / TRP–CLO? | **E**

[4304]
After confirmation with the enter key **E** the relay requests for codeword input. After correct codeword input, repeat confirmation with the enter key **E**. The relay checks whether breaker test is permitted or one of the following obstacles is detected:

RUNNING – a circuit breaker test is already running

FAULT – a system fault is in progress

CB OPEN! – the breaker signals via a binary input that it is open

If none of the above mentioned reasons to refuse is present, the test is started. The following messages may occur during the test:

```
ABORTED
```
– circuit breaker test is aborted

```
UNSUCC.
```
– circuit breaker test has been unsuccessful; breaker has not opened

```
EXECUTED
```
– circuit breaker test executed

```
CB  n.opn
```
– breaker is not open (before reclosing)

---

#### 6.7.6.2 Live tripping of the circuit breaker

To check the tripping circuits, the circuit breaker can be tripped by 7SJ600 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 contacts advise the relay, through a binary input, of the circuit breaker position, the test can only be started when the circuit breaker is closed. This additional security feature should not be omitted when an external auto-reclose relay is present.

The individual test item is reached with the key ▷ in the next operation level.

**DANGER!**

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

A prerequisite for starting the test is that no protection function of the relay be picked up. Codeword input is necessary. The circuit breaker test feature must have been allocated to the trip relay during marshalling.

The relay displays the test sequence in the second display line.

---

△
```
CB-TEST
TRIP
```
▷

[4400]
Block “Test of circuit breaker – Trip test”

△
```
CB-TEST
TRIP  ?
```
**E**

[4404]
After confirmation with the enter key **E** the relay requests for codeword input. After correct codeword input, repeat confirmation with the enter key **E**. The relay checks whether breaker test is permitted or one of the above mentioned obstacles is detected

---

If none of the reasons to refuse is present, the test is started.

## 6.8 Putting the relay into operation

All setting values should be checked again, in case they were altered during the tests. Particularly check that all desired protection and ancillary functions have been programmed in the configuration parameters (address blocks 00 and 01, refer Section 5.4) and all desired protection functions have been switched *ON*.

Stored indications on the front plate should be reset by pressing the key “**N**” on the front so that from then on only real faults are indicated. During pushing the RESET button, the LEDs on the front will light up (except the “Blocked”-LED); thus, a LED test is performed at the same time.

Check that the module is properly inserted and fixed. The green LED must be on on the front; the red LED must not be on.

All terminal screws – even those not in use – must be tightened.

If a test switch is available, then this must be in the operating position.

The overcurrent time protection relay is now ready for operation.

# 7 Maintenance and fault tracing

Siemens digital protection relays are designed to require no special maintenance. All measurement and signal processing circuits are fully solid state and therefore completely maintenance free. Input modules are even static, relays are hermetically sealed or provided with protective covers.

As the protection is almost completely self-monitored, 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" (when marshalled).

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 block 81, for defect diagnosis (refer to Section 6.4.2).

## 7.1 Routine checks

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

– Read-out of operational values (address block 84) and comparison with the actual values for checking the analog interfaces.

– Simulation of an internal short-circuit with 4 x $I_N$ for checking the analog input at high currents.

**⚠ Warning**

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

**⚠ Caution!**

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

– Circuit breaker trip circuits are tested by actual live tripping. Respective notes are given in Section 6.7.6.

## 7.2 Fault tracing

If the protective device indicates a defect, the following procedure is suggested:

If none of the LEDs on the front plate of the module is on, then check:

– Has the module been properly pushed in and locked?

– Is the 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 7.1)? If appropriate, replace the fuse according to Section 7.2.1.

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 and, if a parameterizing process has not yet been completed, the last parameters are not stored. Additionally, date and time must be set again (refer to Section 6.5.1).

### 7.2.1 Replacing the mini-fuse

- Select a replacement fuse 5 × 20 mm. Ensure that the rated value, time lag (slow) and code letters are correct. (Figure 7.1).
- Prepare area of work: provide a surface for the module which is suited to electrostatically endangered components (EEC).
- Slip away the covers at top and bottom of the housing in order to gain access to the two fixing screws of the module. Unscrew these screws.

**⚠ Warning**

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

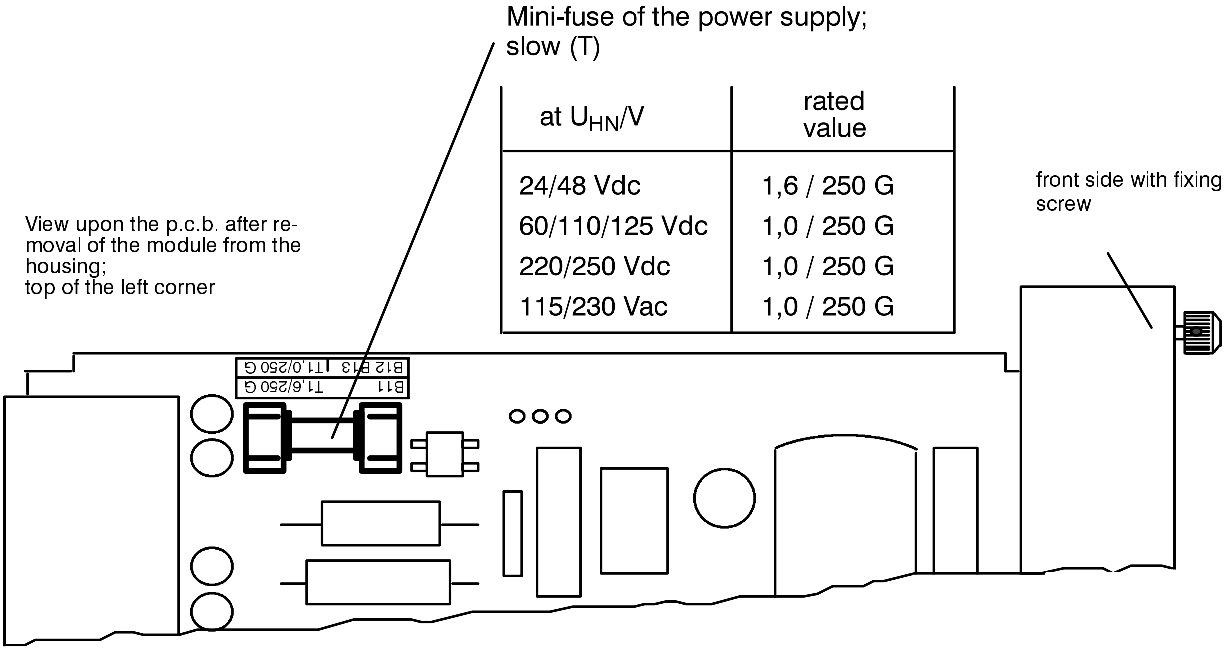
- Pull out the module by taking it at the front cover and place it on a surface which is suited to electrostatically endangered components (EEC);

**⚠ 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 blown fuse from the holder (Figure 7.1).
- Fit new fuse into the holder (Figure 7.1).
- Insert draw-out module into the housing;
- Fix the module into the housing by tightening the two fixing screws.
- Reinsert the covers.

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).




| at $U_{HN}$/V | rated value |
|---|---|
| 24/48 Vdc | 1,6 / 250 G |
| 60/110/125 Vdc | 1,0 / 250 G |
| 220/250 Vdc | 1,0 / 250 G |
| 115/230 Vac | 1,0 / 250 G |

Figure 7.1 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 packaging for return. If alternative packing is used, this must provide the degree of protection against mechanical shock, as laid down in IEC 60255–21–1 class 2 and IEC 60255–21–2 class 1.

If it is unavoidable to replace individual modules, it is imperative that the standards related to the handling of **E**lectrostatically **E**ndangered **C**omponents are observed.

**Warning**

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

**Caution!**

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

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

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

# 9 Storage

Solid state protective relays shall be stored in dry and clean rooms. The limit temperature range for storage of the relays or associated spare parts is –25 °C to +55 °C (refer Section 3.1.4 under the Technical data), corresponding to –12 °F to 130 °F.

The relative humidity must be within limits such that neither condensation nor ice forms.

It is recommended to reduce the storage temperature to the range +10 °C to +35 °C (50 °F to 95 °F); this prevents from early ageing of the electrolytic capacitors which are contained in the power supply.

For very long storage periods, it is recommended that the relay should be connected to the auxiliary voltage source for one or two days every other year, in order to regenerate the electrolytic capacitors. The same is valid before the relay is finally installed. In extreme climatic conditions (tropics) pre-warming would thus be achieved and condensation avoided.

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

# Appendix

## A General diagrams

## B Current transformer circuits

## C Operation structure, Tables

# A General diagrams

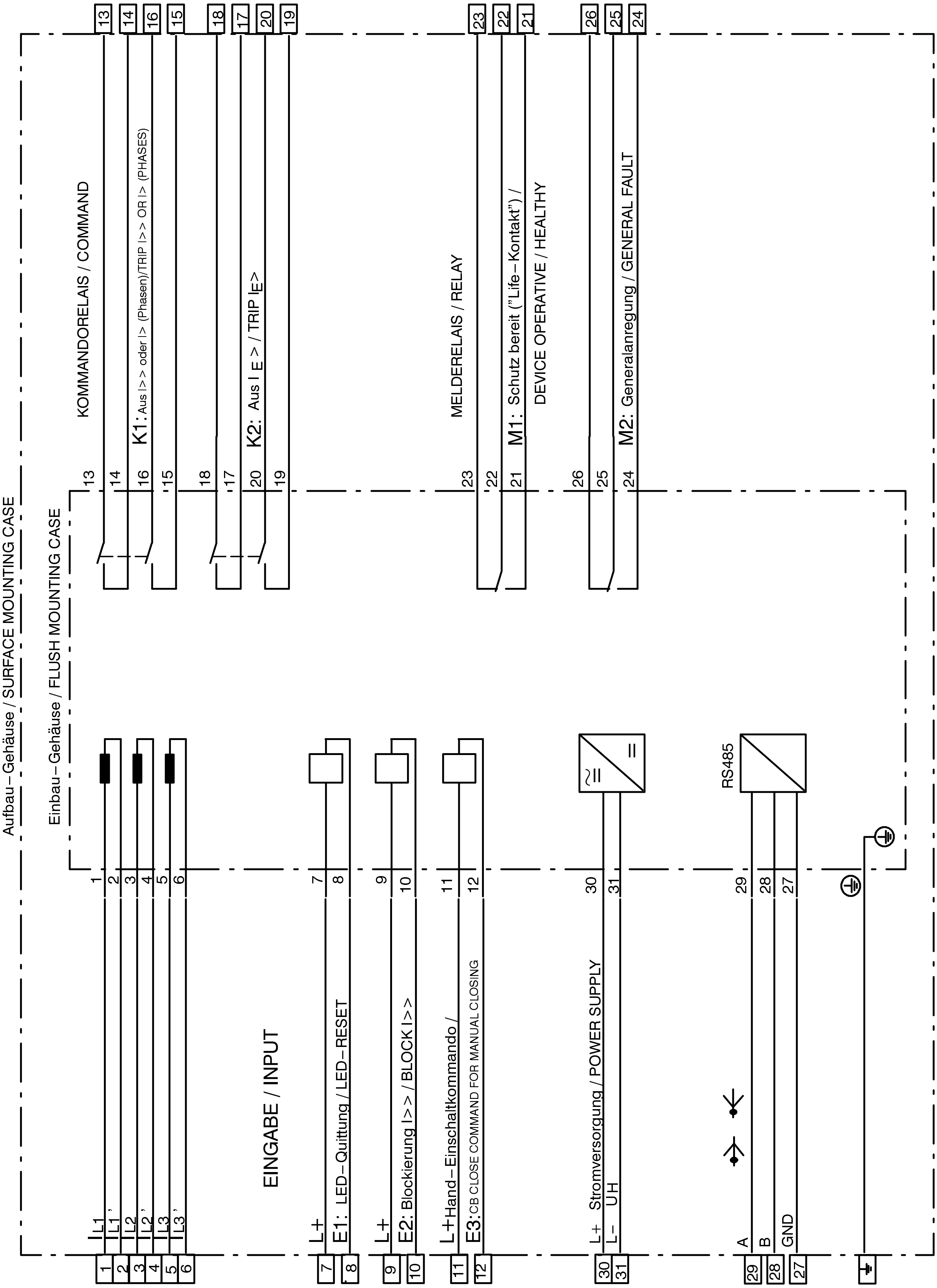



Figure A.1 General diagram of overcurrent time protection relay 7SJ600*−*B*** and 7SJ600*−*E***

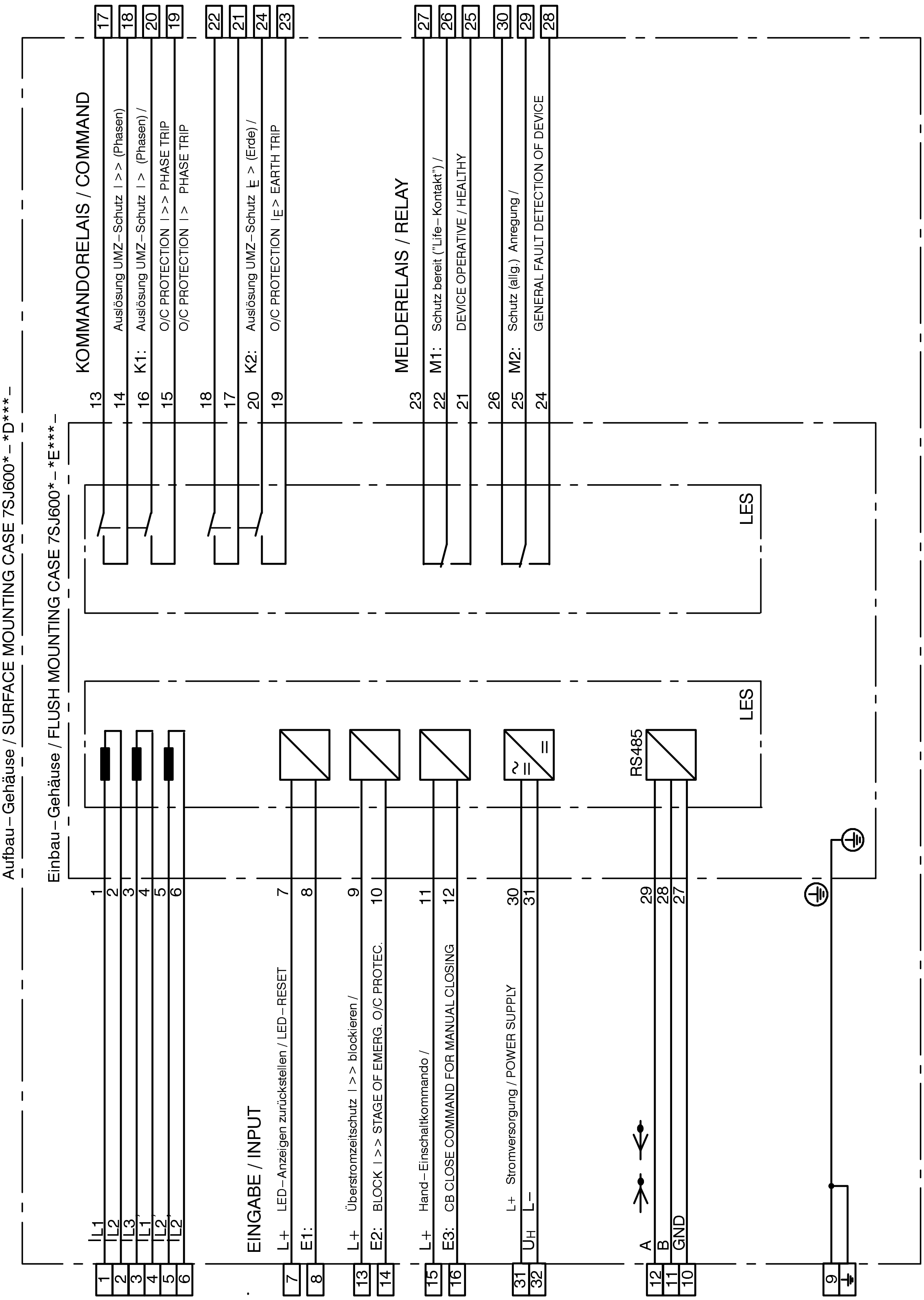



Figure A.2 General diagram of overcurrent time protection relay 7SJ600*–*D*** and 7SJ600*–*E***

# B Current transformer circuits

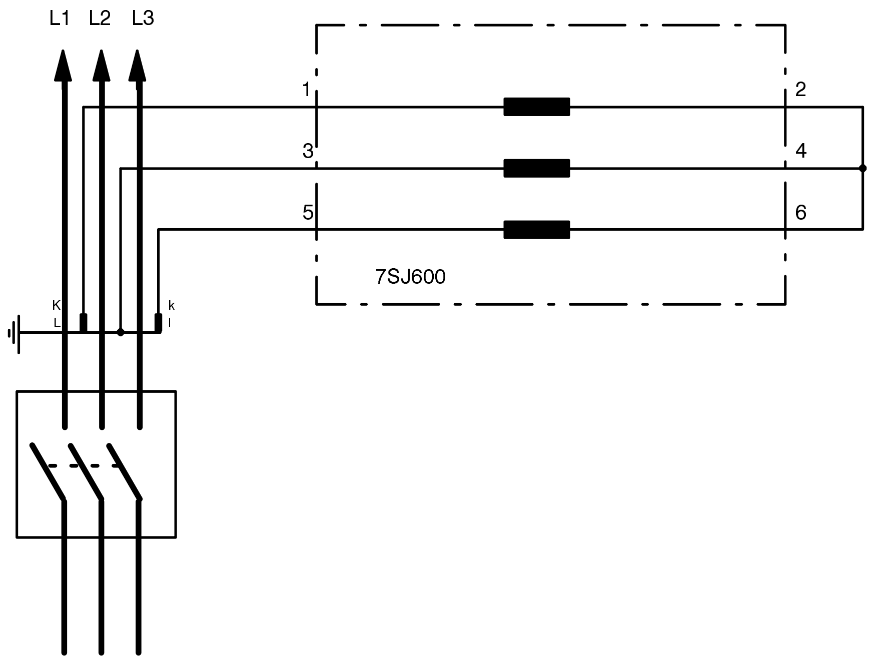



Figure B.1 **Two c.t. connection** only for isolated or compensated systems

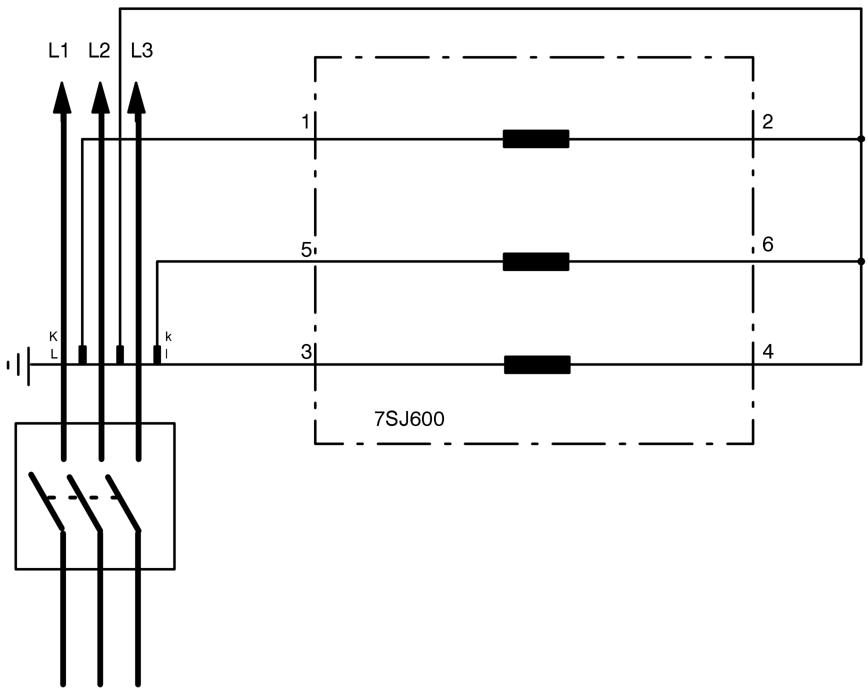



Figure B.2 **Three c.t. connection** with direct measurement of the residual current

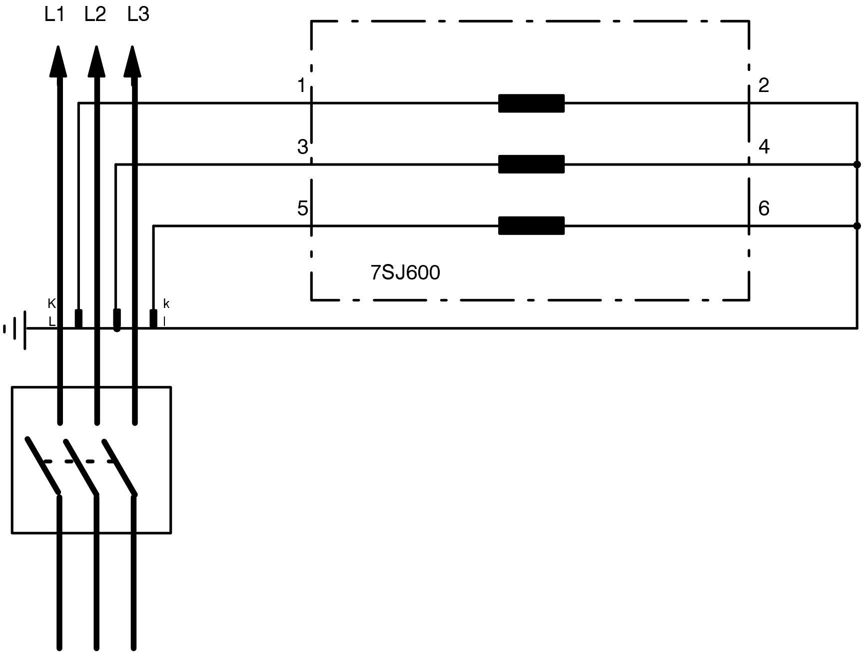



Figure B.3 **Three c.t. connection** with calculation of the residual current

# C Operation structure, Tables

Table C.1 Menu structure . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 152

Table C.2 Annunciations for LSA (according to IEC 60870−5−103) . . . . . . . . . . . . . . . . . . . . . . . . . . . . 160

Table C.3 Annunciations for PC, LC-display, and binary inputs/outputs . . . . . . . . . . . . . . . . . . . . . . . . . . 160

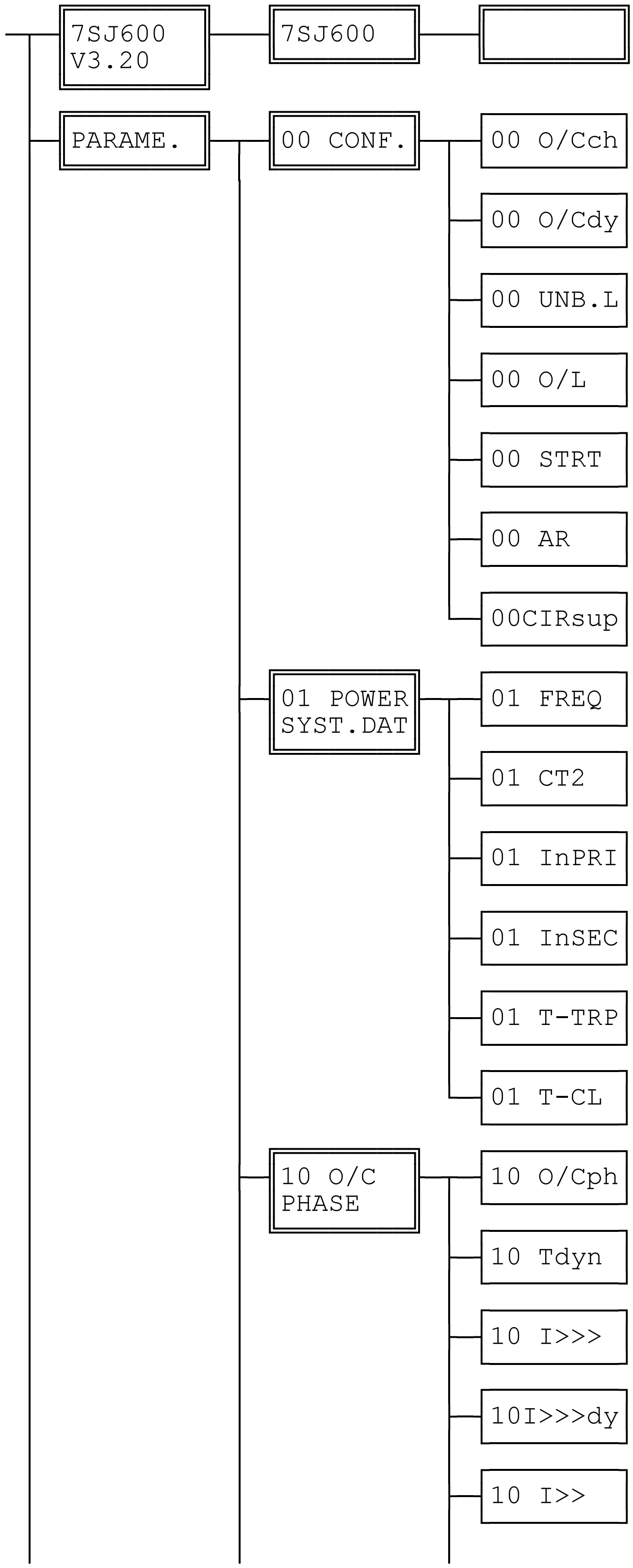
Table C.4 Reference table for functional parameters . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 163

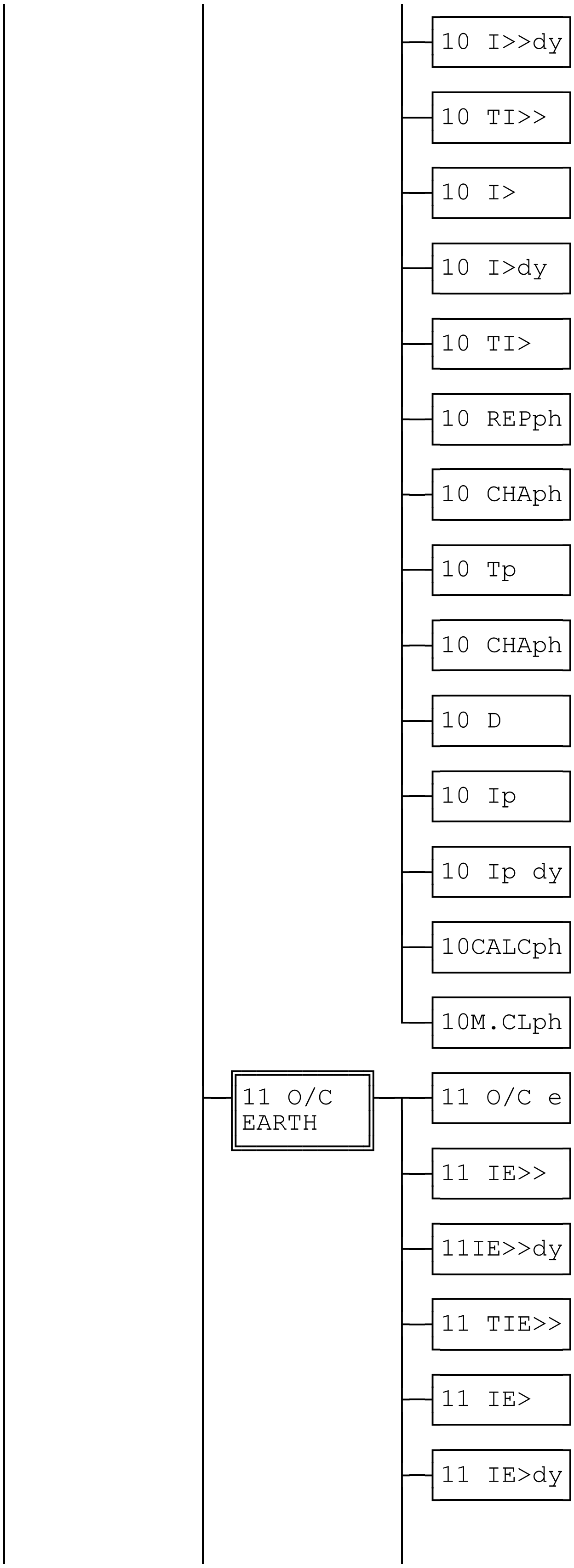
Table C.5 Reference table for configuration parameters . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 169

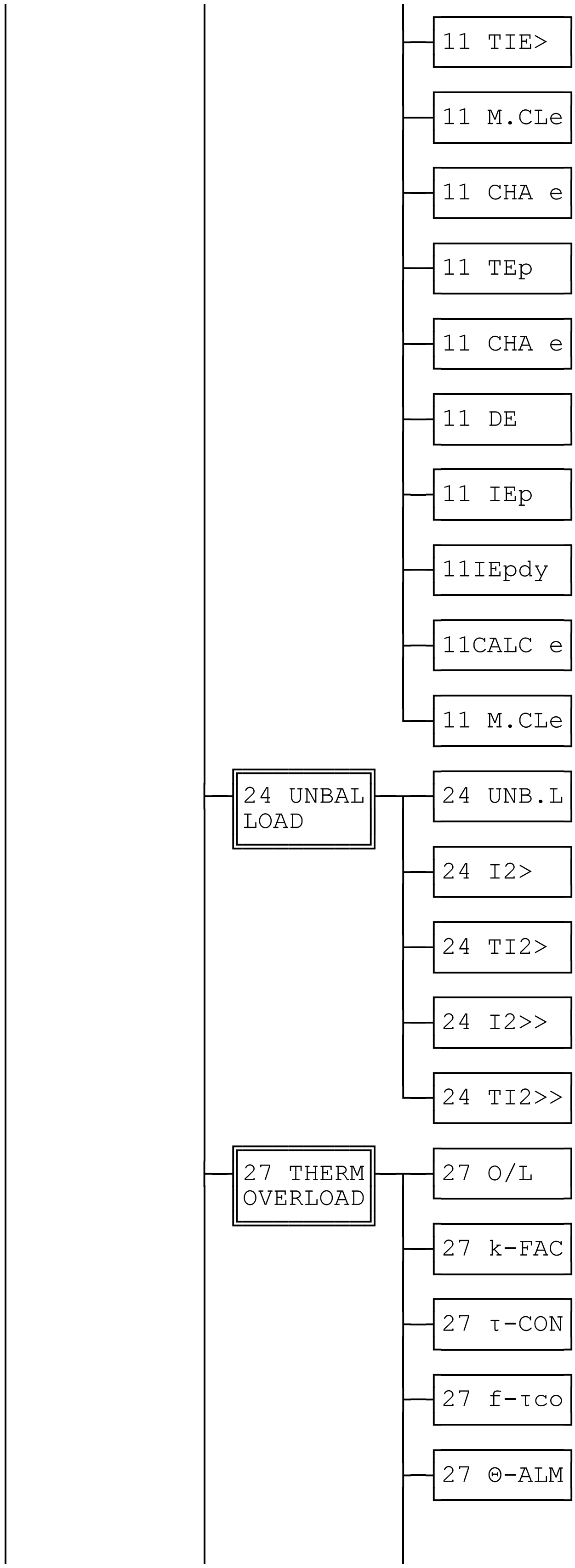
*NOTE:* The following tables list all data which are available in the maximum complement of the device. Dependent on the ordered model, only those data may be present which are valid for the individual version.

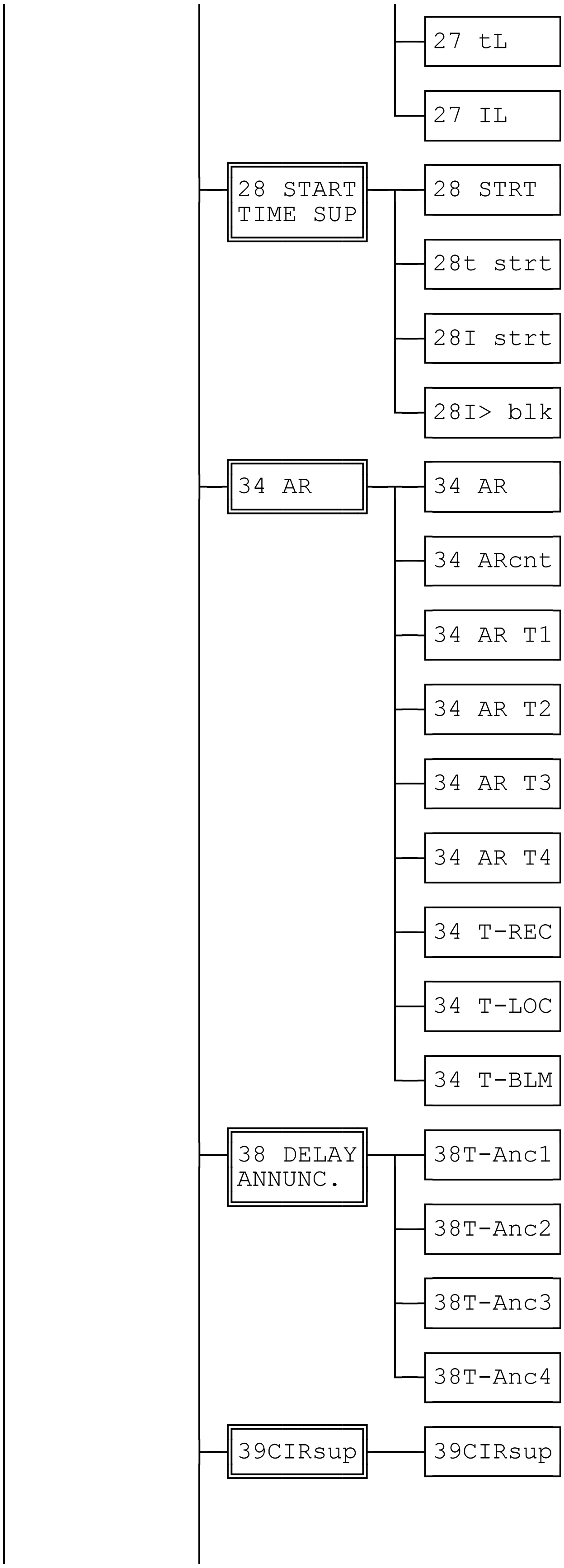
*NOTE:* The actual tables are attached to the purchased relay.

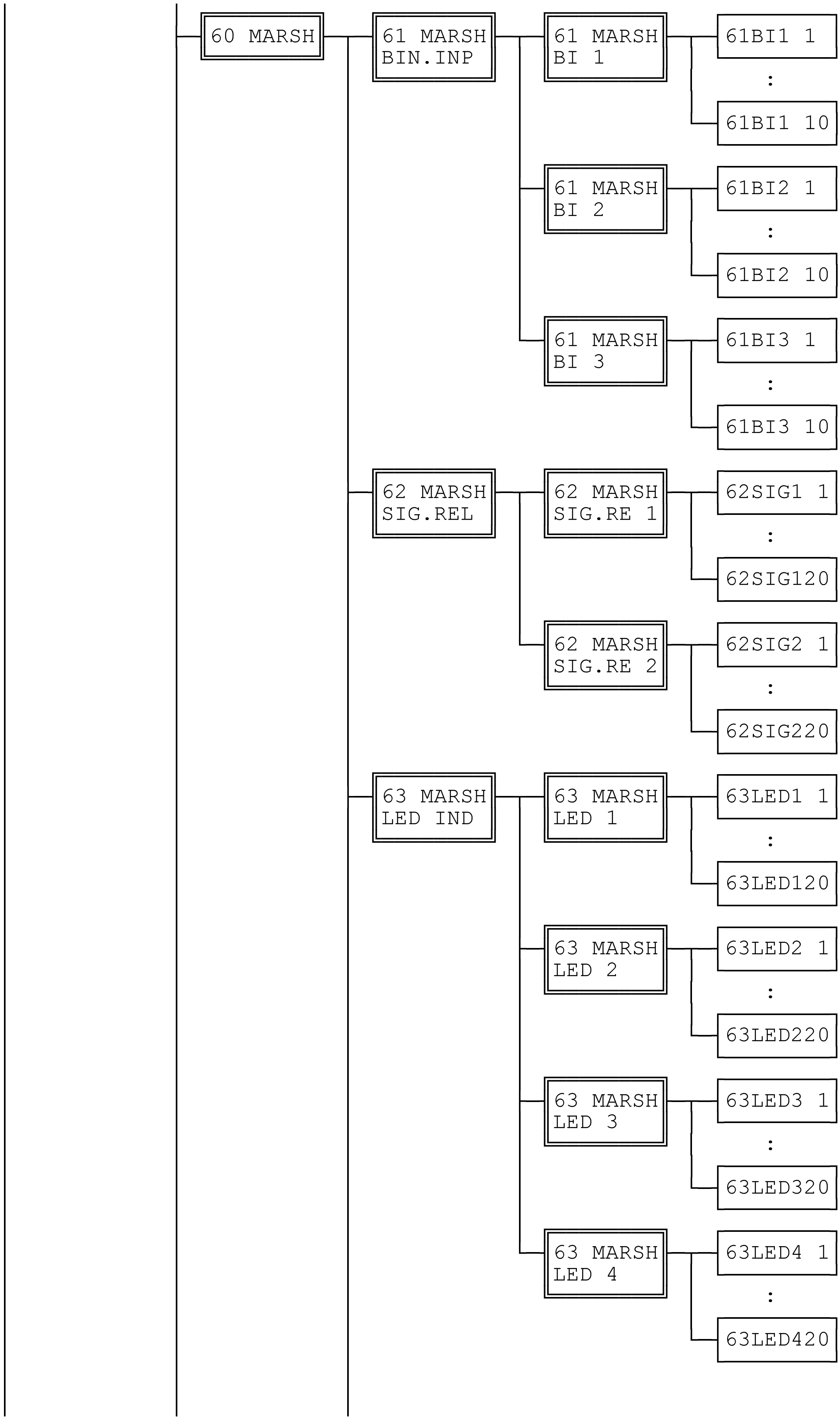
## Menu Structure of 7SJ600

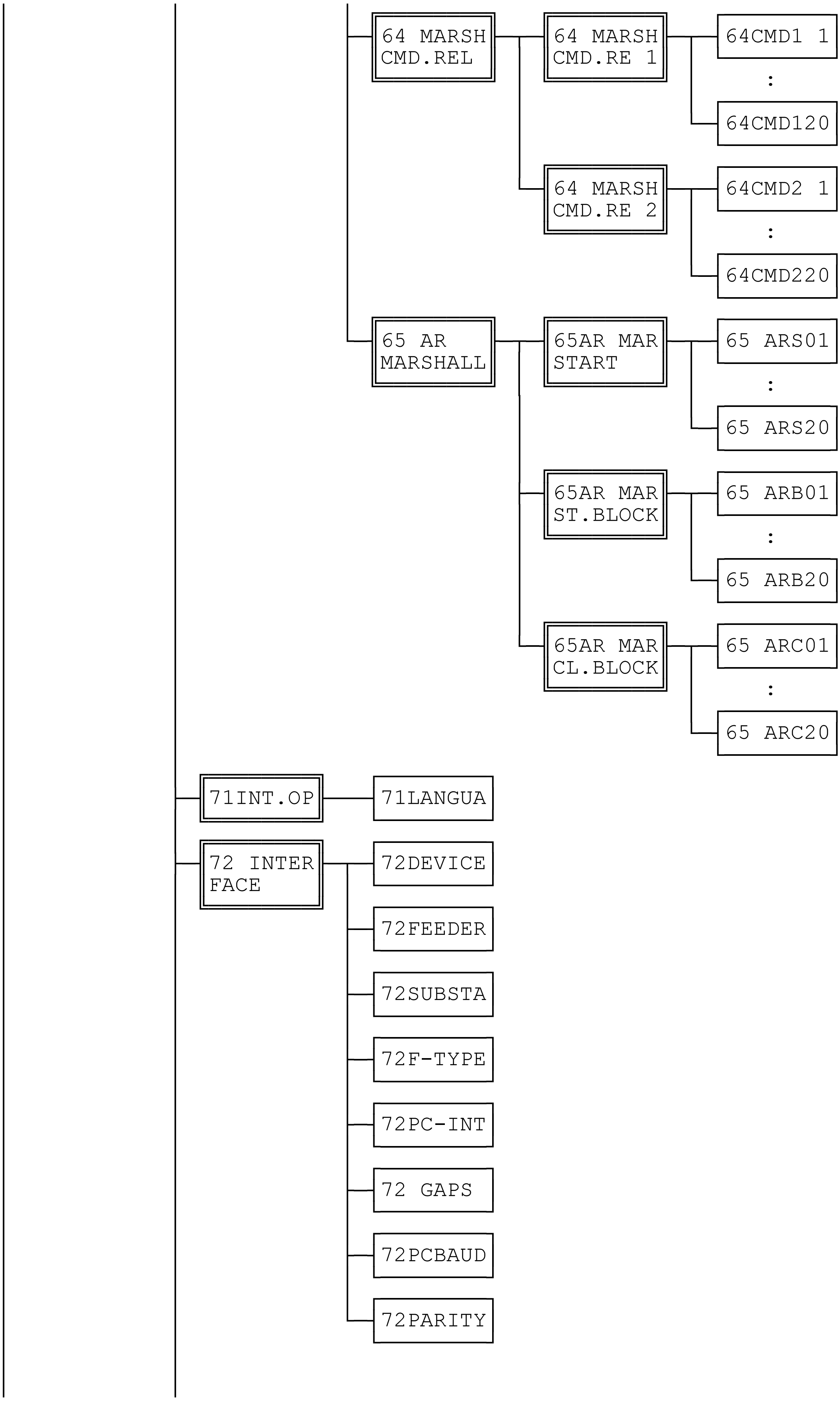


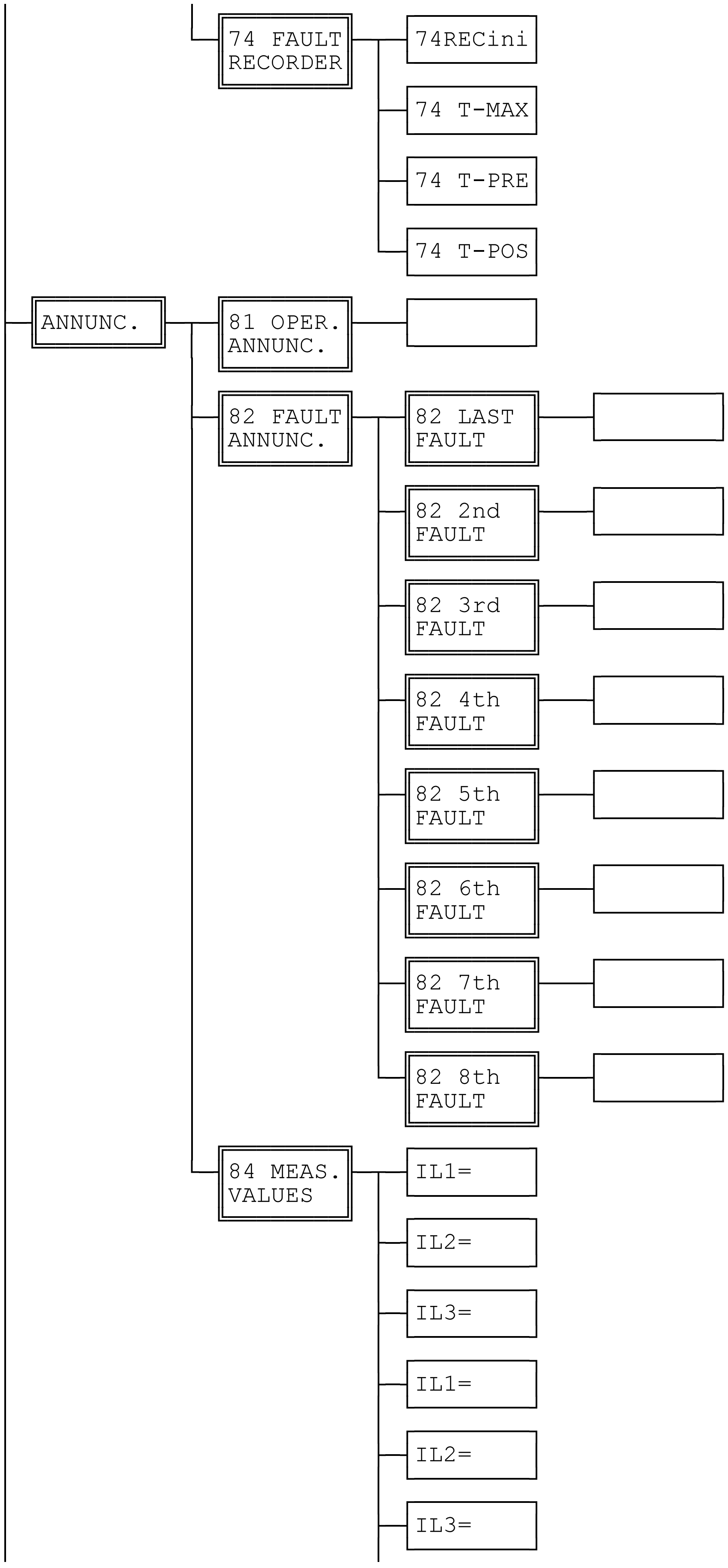

10 I>>dy
10 TI>>
10 I>
10 I>dy
10 TI>
10 REPph
10 CHAph
10 Tp
10 CHAph
10 D
10 Ip
10 Ip dy
10CALCph
10M.CLph
11 O/C EARTH
11 O/C e
11 IE>>
11IE>>dy
11 TIE>>
11 IE>
11 IE>dy

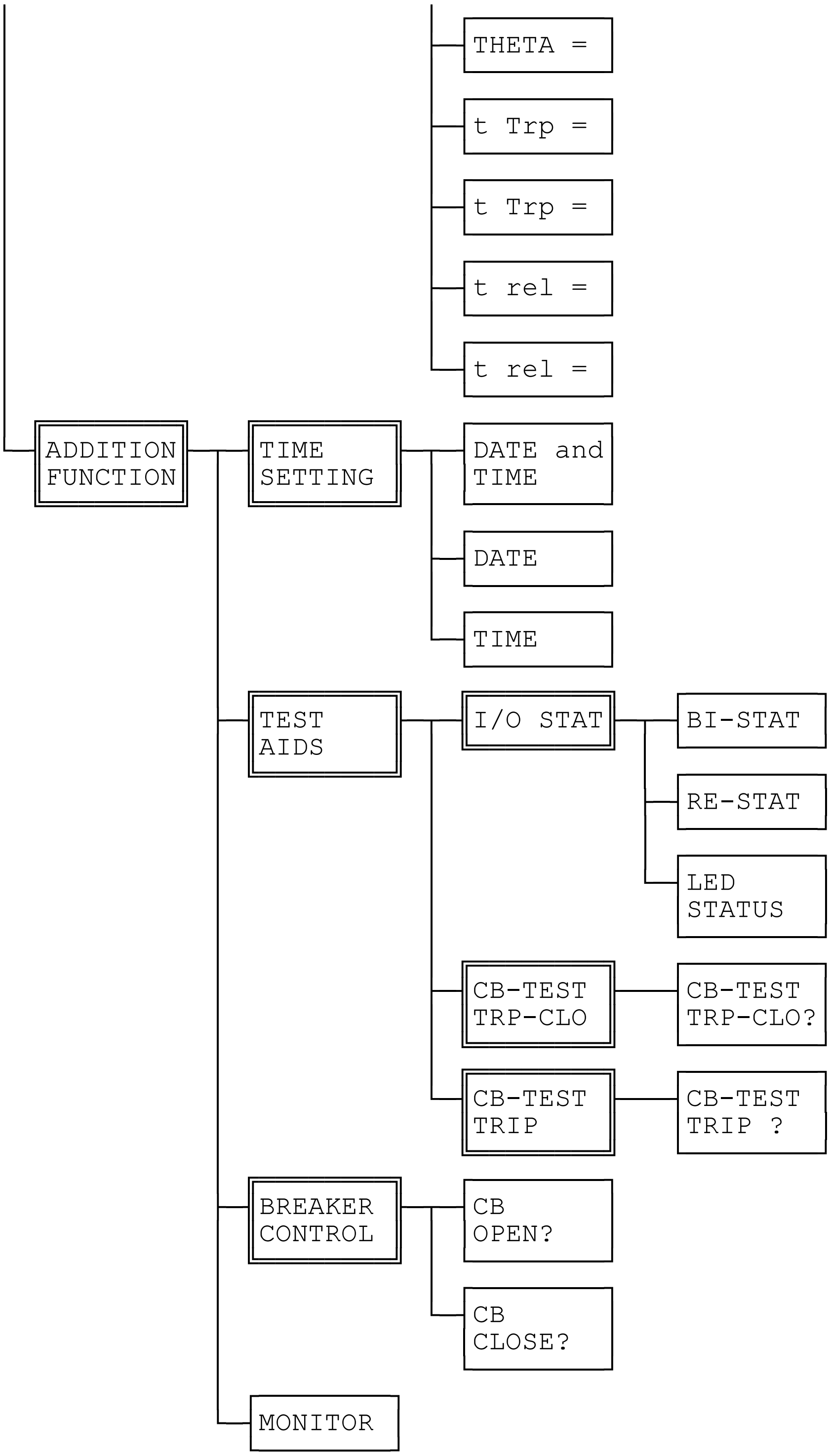

11 TIE>
11 M.CLe
11 CHA e
11 TEp
11 CHA e
11 DE
11 IEp
11IEpdy
11CALC e
11 M.CLe
24 UNBAL LOAD
24 UNB.L
24 I2>
24 TI2>
24 I2>>
24 TI2>>
27 THERM OVERLOAD
27 O/L
27 k-FAC
27 τ-CON
27 f-τco
27 Θ-ALM


27 tL
27 IL
28 START TIME SUP
28 STRT
28t strt
28I strt
28I> blk
34 AR
34 AR
34 ARcnt
34 AR T1
34 AR T2
34 AR T3
34 AR T4
34 T-REC
34 T-LOC
34 T-BLM
38 DELAY ANNUNC.
38T-Anc1
38T-Anc2
38T-Anc3
38T-Anc4
39CIRsup
39CIRsup


60 MARSH
61 MARSH BIN.INP
61 MARSH BI 1
61BI1 1
:
61BI1 10
61 MARSH BI 2
61BI2 1
:
61BI2 10
61 MARSH BI 3
61BI3 1
:
61BI3 10
62 MARSH SIG.REL
62 MARSH SIG.RE 1
62SIG1 1
:
62SIG120
62 MARSH SIG.RE 2
62SIG2 1
:
62SIG220
63 MARSH LED IND
63 MARSH LED 1
63LED1 1
:
63LED120
63 MARSH LED 2
63LED2 1
:
63LED220
63 MARSH LED 3
63LED3 1
:
63LED320
63 MARSH LED 4
63LED4 1
:
63LED420


64 MARSH CMD.REL
64 MARSH CMD.RE 1
64CMD1 1
:
64CMD120
64 MARSH CMD.RE 2
64CMD2 1
:
64CMD220
65 AR MARSHALL
65AR MAR START
65 ARS01
:
65 ARS20
65AR MAR ST.BLOCK
65 ARB01
:
65 ARB20
65AR MAR CL.BLOCK
65 ARC01
:
65 ARC20
71INT.OP
71LANGUA
72 INTER FACE
72DEVICE
72FEEDER
72SUBSTA
72F-TYPE
72PC-INT
72 GAPS
72PCBAUD
72PARITY


74 FAULT RECORDER
74RECini
74 T-MAX
74 T-PRE
74 T-POS
ANNUNC.
81 OPER. ANNUNC.
82 FAULT ANNUNC.
82 LAST FAULT
82 2nd FAULT
82 3rd FAULT
82 4th FAULT
82 5th FAULT
82 6th FAULT
82 7th FAULT
82 8th FAULT
84 MEAS. VALUES
IL1=
IL2=
IL3=
IL1=
IL2=
IL3=


THETA =
t Trp =
t Trp =
t rel =
t rel =
ADDITION FUNCTION
TIME SETTING
DATE and TIME
DATE
TIME
TEST AIDS
I/O STAT
BI-STAT
RE-STAT
LED STATUS
CB-TEST TRP-CLO
CB-TEST TRP-CLO?
CB-TEST TRIP
CB-TEST TRIP ?
BREAKER CONTROL
CB OPEN?
CB CLOSE?
MONITOR

## Annunciations 7SJ600 for LSA (according to IEC 60870-5-103)

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 IEC 60870-5-103:
CA - Compatible Annunciation
GI - Annunciation for General Interrogation
BT - Binary Trace for fault recordings
Typ - Function type (p: according to the configured "Function type")
Inf - Information number

| FNo. | Meaning | Control direct. | Ann. Op | Ann. Ft | IEC 60870-5-103 CA | GI | BT | Typ | Inf |
|---|---|---|---|---|---|---|---|---|---|
| 4642 | Circuit breaker control from LSA | yes | | | | | | 101 | 105 |
| 11 | >User defined annunciation No 1 | | CG | | CA | GI | | p | 27 |
| 12 | >User defined annunciation No 2 | | CG | | CA | GI | | p | 28 |
| 13 | >User defined annunciation No 3 | | CG | | CA | GI | | p | 29 |
| 14 | >User defined annunciation No 4 | | CG | | CA | GI | | p | 30 |
| 501 | General fault detection of the device | | | CG | CA | GI | BT | p | 84 |
| 511 | General trip of the device | | | C | CA | | BT | p | 68 |
| 602 | Current in phase L2 [%] = | | | M | CA | | | p | 144 |
| 4632 | >Block breaker control function | | CG | | | GI | | 101 | 32 |
| 4640 | CLOSE command for breaker (control) | | C | | | | | 101 | 120 |
| 4641 | OPEN command for breaker (control) | | C | | | | | 101 | 121 |

## Annunciations 7SJ600 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
I - can be marshalled to binary input
O - can be marshalled to binary output (LED, signal/trip relay)

| FNo. | Text | Meaning | Op | Ft | I | O |
|---|---|---|---|---|---|---|
| 1 | not all. | Not allocated | | | I | O |
| 3 | >TimeSy | >Time synchronization | | | I | O |
| 5 | >LED r. | >Reset LED indicators | | | I | O |
| 11 | >Annu.1 | >User defined annunciation 1 | CG | | I | O |
| 12 | >Annu.2 | >User defined annunciation 2 | CG | | I | O |
| 13 | >Annu.3 | >User defined annunciation 3 | CG | | I | O |
| 14 | >Annu.4 | >User defined annunciation 4 | CG | | I | O |
| 52 | operat. | Any protection operative | CG | | | O |
| 60 | LED res | LED Reset | C | | | O |
| 110 | ANNlost | Annunciations lost (buffer overflow) | C | | | O |
| 111 | PCannLT | Annunciations for PC lost | C | | | O |
| 115 | ANNovfl | Fault annunciation buffer overflow | | C | | O |
| 203 | REC del | Fault recording data deleted | C | | | O |
| 301 | Sys.Flt | Fault in the power system | C | C | | O |
| 302 | FAULT | Fault event with consecutive number | C | C | | O |

| FNo. | Text | Meaning | Op | Ft | I | O |
|---|---|---|---|---|---|---|
| 356 | >mCLOSE | >Manual close | CG | | I | O |
| 501 | FT det | General fault detection of device | | CG | | O |
| 511 | DEV.Trp | General trip of device | | C | | O |
| 521 | IL1 | Interrupted current: Phase L1 (I/In) | | C | | |
| 522 | IL2 | Interrupted current: Phase L2 (I/In) | | C | | |
| 523 | IL3 | Interrupted current: Phase L3 (I/In) | | C | | |
| 563 | CBA sup | CB alarm suppressed | | | | O |
| 601 | IL1= | IL1 [%] = | M | | | |
| 602 | IL2= | IL2 [%] = | M | | | |
| 603 | IL3= | IL3 [%] = | M | | | |
| 651 | IL1= | Current in phase IL1 = | M | | | |
| 652 | IL2= | Current in phase IL2 = | M | | | |
| 653 | IL3= | Current in phase IL3 = | M | | | |
| 1157 | >CBclo | >Circuit breaker closed | CG | | I | O |
| 1174 | CBtest | Circuit breaker test in progress | CG | | | O |
| 1185 | CBtpTST | Circuit breaker test: Trip 3pole | CG | | | O |
| 1188 | CBTwAR | Circuit breaker test: Trip w. reclosure | CG | | | O |
| 1501 | >O/L on | >Switch on thermal overload protection | | | I | O |
| 1502 | >O/Loff | >Switch off thermal overload protection | | | I | O |
| 1503 | >O/Lblk | >Block thermal overload protection | | | I | O |
| 1511 | O/L off | Thermal overload prot. is switched off | CG | | | O |
| 1512 | O/L blk | Thermal overload protection is blocked | CG | | | O |
| 1513 | O/L act | Thermal overload protection is active | CG | | | O |
| 1516 | O/L wrn | Thermal overload prot.: Thermal warning | CG | CG | | O |
| 1518 | O/L p/u | Thermal overload prot.: Pick-up | CG | CG | | O |
| 1521 | O/L Trp | Thermal overload protection trip | | C | | O |
| 1530 | THETA = | Operating temperature = | M | | | |
| 1531 | t Trp = | O/L: estimated time to trip | M | | | |
| 1532 | t Trp = | O/L: estimated time to trip | M | | | |
| 1533 | t rel = | O/L: estimated time to release closing | M | | | |
| 1534 | t rel = | O/L: estimated time to release closing | M | | | |
| 1701 | >O/Cpon | >Switch on O/C protection phase | | | I | O |
| 1702 | >O/Cpof | >Switch off O/C protection phase | | | I | O |
| 1704 | >O/Cpbk | >Block overcurrent protection phases | | | I | O |
| 1711 | >O/Ceon | >Switch on overcurrent protection earth | | | I | O |
| 1712 | >O/Ceof | >Switch off overcurrent protec. earth | | | I | O |
| 1714 | >O/Cebk | >Block overcurrent protection earth | | | I | O |
| 1721 | >I>>blk | >Overcurrent protection: blockstage I>> | CG | | I | O |
| 1722 | >I> blk | >Overcurrent protection: block stage I> | CG | | I | O |
| 1723 | >Ip blk | >Overcurrent protection: blockstage Ip | CG | | I | O |
| 1724 | >IE>>bk | >Overcurrent protec.: blockstage IE>> | CG | | I | O |
| 1725 | >IE> bk | >Overcurrent protection: blockstage IE> | CG | | I | O |
| 1726 | >IEp bk | >Overcurrent protection: blockstage IEp | CG | | I | O |
| 1727 | >C/O | >C/O of overcurrent fault detec. level | | | I | O |
| 1751 | O/Cpoff | Overcurrent prot. phase is switched off | CG | | | O |
| 1752 | O/Cpblk | Overcurrent prot. phase is blocked | CG | | | O |
| 1753 | O/Cpact | Overcurrent prot. phase is active | CG | | | O |
| 1756 | O/Ceoff | O/C protection earth is switched off | CG | | | O |
| 1757 | O/Ceblk | O/C protection earth is blocked | CG | | | O |
| 1758 | O/Ceact | O/C protection earth is active | CG | | | O |
| 1762 | O/C L1 | O/C fault detection phase L1 | | | | O |
| 1763 | O/C L2 | O/C fault detection phase L2 | | | | O |
| 1764 | O/C L3 | O/C fault detection phase L3 | | | | O |
| 1765 | O/C E | O/C fault detection earth | | | | O |
| 1771 | FD L1 | O/C fault detection L1 only | | C | | O |
| 1772 | FD L1E | O/C fault detection L1-E | | C | | O |
| 1773 | FD L2 | O/C fault detection L2 only | | C | | O |
| 1774 | FD L2E | O/C fault detection L2-E | | C | | O |
| 1775 | FD L12 | O/C fault detection L1-L2 | | C | | O |
| 1776 | FD L12E | O/C fault detection L1-L2-E | | C | | O |
| 1777 | FD L3 | O/C fault detection L3 only | | C | | O |
| 1778 | FD L3E | O/C fault detection L3E | | C | | O |

| FNo. | Text | Meaning | Op | Ft | I | O |
|---|---|---|---|---|---|---|
| 1779 | FD L13 | O/C fault detection L1-L3 | | C | | O |
| 1780 | FD L13E | O/C fault detection L1-L3-E | | C | | O |
| 1781 | FD L23 | O/C fault detection L2-L3 | | C | | O |
| 1782 | FD L23E | O/C fault detection L2-L3-E | | C | | O |
| 1783 | FD L123 | O/C fault detection L1-L2-L3 | | C | | O |
| 1784 | FDL123E | O/C fault detection L1-L2-L3-E | | C | | O |
| 1785 | FD E | O/C fault detection E only | | C | | O |
| 1800 | FD I>> | O/C fault detection stage I>> | | CG | | O |
| 1805 | Trp I>> | O/C protection I>> phase trip | | C | | O |
| 1810 | FD I> | O/C fault detection stage I> | | CG | | O |
| 1815 | Trip I> | O/C protection I> phase trip | | C | | O |
| 1820 | FD Ip | O/C fault detection Ip | | CG | | O |
| 1825 | Trip Ip | O/C protection Ip phase trip | | C | | O |
| 1831 | FD IE>> | O/C fault detection IE>> earth | | CG | | O |
| 1833 | TrpIE>> | O/C protection IE>> earth trip | | C | | O |
| 1834 | FD IE> | O/C fault detection IE> earth | | CG | | O |
| 1836 | Trp IE> | O/C protection IE> earth trip | | C | | O |
| 1837 | FD IEp | O/C fault detection IEp earth | | CG | | O |
| 1839 | Trp IEp | O/C protection IEp earth trip | | C | | O |
| 1850 | FD dyn | O/C prot. : dynamic Parameters activ | CG | | | O |
| 2701 | >AR on | >AR: Switch on auto-reclose function | | | I | O |
| 2702 | >AR off | >AR: Switch off auto-reclose function | | | I | O |
| 2732 | >AR St. | >AR: Start external | CG | CG | I | O |
| 2733 | >ARblSt | >AR: External Blocking of Start | CG | CG | I | O |
| 2734 | >ARblCl | >AR: External Blocking of reclosure | CG | CG | I | O |
| 2736 | AR act. | AR: Auto reclosure is active | CG | | | O |
| 2781 | AR off | AR: Auto-reclose is switched off | CG | | | O |
| 2801 | AR i pg | AR: Auto-reclose in progress | | CG | | O |
| 2851 | AR ClCm | AR: Close command from auto-reclose | | CG | | O |
| 2863 | AR dTrp | AR: Definitive trip | | CG | | O |
| 2872 | AR Strt | AR: Start | | CG | | O |
| 2873 | AR blSt | AR: blocked | | CG | | O |
| 2874 | AR blCl | AR: Reclosure blocked | | CG | | O |
| 2875 | AR blMC | AR: Blocked by manual close | CG | | | O |
| 2876 | AR DT | AR: Dead time | C | C | | O |
| 4632 | >SWblo. | >Switching authorization: blocked | | | I | O |
| 4640 | Q0 Clo. | Control-Close-Command CB-Q0 | C | | | O |
| 4641 | Q0 Trp. | Control-Trip-Command CB-Q0 | C | | | O |
| 5143 | >I2 blk | >Block unbalanced load protection | | | I | O |
| 5144 | >revPhR | >Reversed phase rotation | CG | | I | O |
| 5151 | I2 off | Unbalanced load prot. is switched off | CG | | | O |
| 5152 | I2 blk | Unbalanced load protection is blocked | CG | | | O |
| 5153 | I2 act | Unbalanced load protection is active | CG | | | O |
| 5159 | FD I2>> | Unbalanced load: Fault detec. I2>> | | CG | | O |
| 5165 | FD I2> | Fault detection neg. seq. I (I2>) | | CG | | O |
| 5170 | Trp I2 | neg. seq. I. (I2) prot.: Trip | | C | | O |
| 6757 | TrpI>>> | O/C protection I>>> phase trip | | CG | | O |
| 6758 | >I>>>bk | >inst. high set prot.: Block stage I>>> | CG | | I | O |
| 6801 | >SRT bk | >Starting time supervision: Block stage | | | I | O |
| 6811 | SRT off | Supervision of starting time off | CG | | | O |
| 6812 | SRT blk | Supervision of starting time blocked | CG | | | O |
| 6813 | SRT act | Supervision of starting time active | CG | | | O |
| 6821 | SRT Trp | Supervision of starting time trip | CG | C | | O |
| 6851 | >SUP bk | >Blocking trip circuit supervision | | | I | O |
| 6852 | >TrpRel | >Trip circuit supervision: Trip relay | CG | | I | O |
| 6853 | >CBaux | >Trip circuit supervision: CB aux. | CG | | I | O |
| 6861 | SUP off | Trip circuit supervision off | CG | | | O |
| 6862 | SUP blk | Trip circuit supervision blocked | CG | | | O |
| 6863 | SUP act | Trip circuit supervision active | CG | | | O |
| 6864 | SUPnoBI | TC superv. blocked: BI not marshalled | CG | | | O |
| 6865 | CIR int | Trip circuit interrupted | CG | | | O |

## Reference Table for Functional Parameters 7SJ600

```
PARAME. - PARAMETER SETTINGS

   00 CONF. - SCOPE OF FUNCTIONS

      00 O/Cch                 Characteristic of O/C protection
         def TIME          [ ] Definite time
         I>>> I>>          [ ] I>>> I>>
         IEC inv.          [ ] Inverse time
         ANSI inv          [ ] ANSI inv
         IEC O/C           [ ] IEC O/C
         ANSI O/C          [ ] ANSI O/C
         nonEXIST          [ ] Non-existent

      00 O/Cdy                 temporary pick-up value change over (O/C-st.)
         nonEXIST          [ ] Non-existent
         EXIST             [ ] Existent

      00 UNB.L                 Unbalanced load protection
         nonEXIST          [ ] Non-existent
         EXIST             [ ] Existent

      00 O/L                   Thermal overload protection
         nonEXIST          [ ] Non-existent
         pre LOAD          [ ] With memory
         no preLD          [ ] Without memory

      00 STRT                  Supervision of startup time
         nonEXIST          [ ] Non-existent
         EXIST             [ ] Existent

      00 AR                    Internal auto-reclose function
         nonEXIST          [ ] Non-existent
         EXIST             [ ] Existent

      00CIRsup                 Trip circuit supervision
         nonEXIST          [ ] Non-existent
         with 2BI          [ ] No resist., 2 BI
         bypass-R          [ ] bypass resistor,1 BI
```

---

```
   01 POWER SYST.DAT - POWER SYSTEM DATA

      01 FREQ                  Rated system frequency
         50 Hz             [ ] fN 50 Hz
         60 Hz             [ ] fN 60 Hz

      01 CT2                   Connection of CT2
         IL2               [ ] IL2
         IE                [ ] IE

      01 InPRI                 Primary rated current
         min. 10               A
         max. 50000      ____

      01 InSEC                 Secondary rated current
         1A                [ ] 1A
         5A                [ ] 5A

      01 T-TRP                 Minimum trip command duration
         min. 0.01             s
         max. 32.00      ____
```

```
01 T-CL                 Maximum close command duration
   min. 0.01            s
   max. 60.00     ____
```

---

```
10 O/C PHASE - O/C PROTECTION PHASE FAULTS

   10 O/Cph                 O/C protection for phase faults
      ON                [ ] on
      OFF               [ ] off

   10 Tdyn                  Duration of temporary pick-up value c/o
      min. 0.1              s
      max. 10000.0   ____

   10 I>>>                  Pick-up value of the high-set inst. stage I>>>
      min. 0.3              I/In
      max. 12.5/∞    ____

   10I>>>dy                 Pick-up val. of high-set ins. stage I>>> (dyn)
      min. 0.3              I/In
      max. 12.5/∞    ____

   10 I>>                   Pick-up value of the high-set stage I>>
      min. 0.1              I/In
      max. 25.0/∞    ____

   10 I>>dy                 Pick-up value of the high-set stage I>> (dyn)
      min. 0.1              I/In
      max. 25.0/∞    ____

   10 TI>>                  Trip time delay of the high-set stage I>>
      min. 0.00             s
      max. 60.00     ____

   10 I>                    Pick-up value of the overcurrent stage I>
      min. 0.1              I/In
      max. 25.0/∞    ____

   10 I>dy                  Pick-up value of the O/C stage I> (dyn)
      min. 0.1              I/In
      max. 25.0/∞    ____

   10 TI>                   Trip time delay of the overcurrent stage I>
      min. 0.00             s
      max. 60.00     ____

   10 REPph                 Measurement repetition
      NO                [ ] no
      YES               [ ] yes

   10 CHAph                 Characteristic of the O/C stage Ip
      inverse           [ ] Normal inverse
      short in          [ ] Very inverse
      extr.inv          [ ] Extremely inverse
      long inv          [ ] long inverse
      never             [ ] Never

   10 Tp                    Trip time delay inverse time O/C stage Ip
      min. 0.05             s
      max. 3.20      ____
```

```
10 CHAph                 Characteristic of the O/C stage Ip
   inverse           [ ] Inverse
   short in          [ ] Short inverse
   long inv          [ ] Long inverse
   mode inv          [ ] Moderately inverse
   very inv          [ ] Very inverse
   extr inv          [ ] Extremely inverse
   def inv           [ ] Definite inverse
   IsqaredT          [ ] I-squared-t
   never             [ ] Never

10 D                     Delayfactor of inverse phase-current protec.
   min. 0.5              s
   max. 15.0        ____

10 Ip                    Pick-up value inverse time O/C stage Ip
   min. 0.1              I/In
   max. 4.0         ____

10 Ip dy                 Pick-up value inverse time O/C stage Ip (dyn)
   min. 0.1              I/In
   max. 4.0         ____

10CALCph                 RMS format for inverse time O/C protection
   noHARMON          [ ] Without harmonics
   HARMONIC          [ ] With harmonics

10M.CLph                 Manual close
   I>>undel          [ ] I>> undelayed
   I>undela          [ ] I> undelayed
   Ip undel          [ ] Ip undelayed
   INEFFECT          [ ] Ineffective
```

---

## 11 O/C EARTH - O/C PROTECTION EARTH FAULTS

```
11 O/C e                 O/C protection for earth faults
   ON                [ ] on
   OFF               [ ] off

11 IE>>                  Pick-up value of the high-set stage IE>>
   min. 0.05             I/In
   max. 25.00/∞     ____

11IE>>dy                 Pick-up value of high-set E/F stage IE>> (dyn)
   min. 0.05             I/In
   max. 25.00/∞     ____

11 TIE>>                 Trip time delay of the high-set stage IE>>
   min. 0.00             s
   max. 60.00       ____

11 IE>                   Pick-up value of the overcurrent stage IE>
   min. 0.05             I/In
   max. 25.00/∞     ____

11 IE>dy                 Pick-up value of def. time E/F stage IE> (dyn)
   min. 0.05             I/In
   max. 25.00/∞     ____

11 TIE>                  Trip time delay of the overcurrent stage IE>
   min. 0.00             s
   max. 60.00       ____
```

```
11 M.CLe                   Measurement repetition
   NO                  [ ] no
   YES                 [ ] yes

11 CHA e                   Characteristic of the O/C stage IEp
   inverse             [ ] Normal inverse
   short in            [ ] Very inverse
   extr.inv            [ ] Extremely inverse
   long inv            [ ] long inverse
   never               [ ] Never

11 TEp                     Trip time delay inverse time O/C stage IEp
   min. 0.05               s
   max. 3.20          ____

11 CHA e                   Characteristic of the O/C stage IEp
   inverse             [ ] Inverse
   short in            [ ] Short inverse
   long inv            [ ] Long inverse
   mode inv            [ ] Moderately inverse
   very inv            [ ] Very inverse
   extr inv            [ ] Extremely inverse
   def inv             [ ] Definite inverse
   IsqaredT            [ ] I-squared-t
   never               [ ] Never

11 DE                      Delayfactor of inverse earth-current protec.
   min. 0.5                s
   max. 15.0          ____

11 IEp                     Pick-up value inverse time O/C stage IEp
   min. 0.05               I/In
   max. 4.00          ____

11IEpdy                    Pick-up value inverse time E/F stage IEp (dyn)
   min. 0.05               I/In
   max. 4.00          ____

11CALC e                   RMS format for inverse time O/C protection
   noHARMON            [ ] Without harmonics
   HARMONIC            [ ] With harmonics

11 M.CLe                   Manual close
   IE>>unde            [ ] IE>> undelayed
   IE>undel            [ ] Ie> undelayed
   IEp unde            [ ] IEp undelayed
   INEFFECT            [ ] Ineffective
```

---

```
24 UNBAL LOAD - UNBALANCED LOAD PROTECTION

   24 UNB.L                   State of the unbalanced load protection
      ON                  [ ] on
      OFF                 [ ] off

   24 I2>                     Pick-up value of neg. seq. I low-set stageI2>
      min. 8                  %
      max. 80            ____

   24 TI2>                    Trip delay of neg. seq. I low-set stage TI2>
      min. 0.00               s
      max. 60.00         ____
```

```
    24 I2>>                     Pick-up value for high current stage
       min. 8                   %
       max. 80          ____

    24 TI2>>                    Trip time delay for high current stage
       min. 0.00                s
       max. 60.00       ____
```

---

```
 27 THERM OVERLOAD - THERMAL OVERLOAD PROTECTION

    27 O/L                      State of thermal overload protection
       ON                   [ ] on
       OFF                  [ ] off

    27 k-FAC                    K-factor for thermal overload protection
       min. 0.40
       max. 2.00        ____

    27 τ-CON                    Time constant for thermal overload protection
       min. 1.0                 min
       max. 999.9       ____

    27 f-τco                    Multiplier of time constant at standstill
       min. 1.00
       max. 10.00       ____

    27 Θ-ALM                    Thermal warning stage
       min. 50                  %
       max. 99          ____

    27 tL                       Time-setting for I-squared-t overload stage
       min. 1.0                 s
       max. 120.0       ____

    27 IL                       Pick-up value for I-squared-t overload stage
       min. 0.4                 I/In
       max. 4.0         ____
```

---

```
 28 START TIME SUP - STARTING-TIME SUPERVISION

    28 STRT                     Supervision of starting time
       ON                   [ ] on
       OFF                  [ ] off

    28t strt                    permissible starting time
       min. 1.0                 s
       max. 360.0       ____

    28I strt                    permissible starting current
       min. 0.4                 I/In
       max. 20.0        ____

    28I> blk                    Block of the I>/Ip stages during start-up
       NO                   [ ] no
       YES                  [ ] yes
```

---

```
34 AR - AUTO-RECLOSE FUNCTION

   34 AR                     Auto-reclose function
      ON                [ ] on
      OFF               [ ] off

   34 ARcnt                  Number of shots
      min. 1
      max. 9            ____

   34 AR T1                  Dead time for 1st shot
      min. 0.05              s
      max. 1800.00      ____

   34 AR T2                  Dead time for 2nd shot
      min. 0.05              s
      max. 1800.00      ____

   34 AR T3                  Dead time for 3rd shot
      min. 0.05              s
      max. 1800.00      ____

   34 AR T4                  Dead time for 4th to 9th shot
      min. 0.05              s
      max. 1800.00      ____

   34 T-REC                  Reclaim time after successful AR
      min. 0.05              s
      max. 320.00       ____

   34 T-LOC                  Lock-out time after unsuccessful AR
      min. 0.05              s
      max. 320.00       ____

   34 T-BLM                  Blocking duration with manual close
      min. 0.50              s
      max. 320.00       ____
```

---

```
38 DELAY ANNUNC. - ANNUNCIATION DELAY TIMES

   38T-Anc1                  Delay time for 1st user defined annunciation
      min. 0.00              s
      max. 10.00/∞        ____

   38T-Anc2                  Delay time for 2nd user defined annunciation
      min. 0.00              s
      max. 10.00/∞        ____

   38T-Anc3                  Delay time for 3rd user defined annunciation
      min. 0.00              s
      max. 10.00/∞        ____

   38T-Anc4                  Delay time for 4th user defined annunciation
      min. 0.00              s
      max. 10.00/∞        ____
```

---

```
39CIRsup - TRIP CIRCUIT SUPERVISION

   39CIRsup                  Trip circuit supervision
      ON                [ ] on
      OFF               [ ] off
```

Reference Table for Configuration Parameters 7SJ600

```
60 MARSH - MARSHALLING

   61 MARSH BIN.INP - MARSHALLING BINARY INPUTS

      61 MARSH BI 1 - MARSHALLING OF BINARY INPUT 1

         61BI1 1               BINARY INPUT 1 1st FUNCTION
         ...
         61BI1 10              BINARY INPUT 1 10th FUNCTION
```

---

```
      61 MARSH BI 2 - MARSHALLING OF BINARY INPUT 2

         61BI2 1               BINARY INPUT 2 1st FUNCTION
         ...
         61BI2 10              BINARY INPUT 2 10th FUNCTION
```

---

```
      61 MARSH BI 3 - MARSHALLING OF BINARY INPUT 3

         61BI3 1               BINARY INPUT 3 1st FUNCTION
         ...
         61BI3 10              BINARY INPUT 3 10th FUNCTION
```

---

```
   62 MARSH SIG.REL - MARSHALLING SIGNAL RELAYS

      62 MARSH SIG.RE 1 - MARSHALLING OF SIGNAL RELAY 1

         62SIG1 1              Signal RELAY 1 1st CONDITION
         ...
         62SIG120              Signal RELAY 1 20th CONDITION
```

---

```
      62 MARSH SIG.RE 2 - MARSHALLING OF SIGNAL RELAY 2

         62SIG2 1              Signal RELAY 2 1st CONDITION
         ...
         62SIG220              Signal RELAY 2 20th CONDITION
```

---

```
   63 MARSH LED IND - MARSHALLING LED INDICATORS

      63 MARSH LED 1 - MARSHALLING OF LED INDICATOR 1

         63LED1 1              LED 1 1st CONDITION
         ...
         63LED120              LED 1 20th CONDITION
```

---

```
      63 MARSH LED 2 - MARSHALLING OF LED INDICATOR 2

         63LED2 1              LED 2 1st CONDITION
         ...
         63LED220              LED 2 20th CONDITION
```

---

```
      63 MARSH LED 3 - MARSHALLING OF LED INDICATOR 3

         63LED3 1              LED 3 1st CONDITION
         ...
         63LED320              LED 3 20th CONDITION
```

---

```
      63 MARSH LED 4 - MARSHALLING OF LED INDICATOR 4

         63LED4 1              LED 4 1st CONDITION
         ...
         63LED420              LED 4 20th CONDITION
```

---

```
   64 MARSH CMD.REL - MARSHALLING TRIP RELAYS

      64 MARSH CMD.RE 1 - MARSHALLING OF COMMAND RELAY 1

         64CMD1 1              COMMAND RELAY 1 1st CONDITION
         ...
         64CMD120              COMMAND RELAY 1 20th CONDITION
```

---

```
      64 MARSH CMD.RE 2 - MARSHALLING OF COMMAND RELAY 2

         64CMD2 1              COMMAND RELAY 2 1st CONDITION
         ...
         64CMD220              COMMAND RELAY 2 20th CONDITION
```

---

```
   65 AR MARSHALL - MARSHALLING OF AUTORECLOSE INPUTS

      65AR MAR START - MARSHALLING OF AUTORECLOSE START

         65 ARS01              AUTORECLOSE START 1st FUNCTION
         ...
         65 ARS20              AUTORECLOSE START 20th FUNCTION
```

---

```
      65AR MAR ST.BLOCK - MARSHALLING OF AUTORECLOSE BLOCK

         65 ARB01              AUTORECLOSE BLOC. 1st FUNCTION
         ...
         65 ARB20              AUTORECLOSE BLOC. 20th FUNCTION
```

---

```
65AR MAR CL.BLOCK - MARSHALLING OF AR COMMAND BLOCK

   65 ARC01              AUTORECLOSE BLOC. COM. 1st FUNCTION
   ...
   65 ARC20              AUTORECLOSE BLOC. COM. 20th FUNCTION
```

---

```
71INT.OP - INTEGRATED OPERATION

   71LANGUA                Language
      ENGLISH          [ ] English
      DEUTSCH          [ ] German
      FRANCAIS         [ ] French
      ESPANOL          [ ] Spanish
```

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```
72 INTER FACE - PC AND SYSTEM INTERFACES

   72DEVICE                Device address
      min. 1
      max. 254        ____

   72FEEDER                Feeder address
      min. 1
      max. 254        ____

   72SUBSTA                Substation address
      min. 1
      max. 254        ____

   72F-TYPE                Function type in accordance with VDEW/ZVEI
      min. 1
      max. 254        ____

   72PC-INT                Data format for PC-interface
      DIGSI V3         [ ] DIGSI V3
      ASCII            [ ] ASCII
      IEC com.         [ ] IEC 60870 compatible
      IEC ext.         [ ] IEC 60870 extended

   72 GAPS                 Transmission gaps for PC-interface
      min. 0.0             s
      max. 5.0        ____

   72PCBAUD                Transmission baud rate for PC-interface
      9600BAUD         [ ] 9600 Baud
      19200 BD         [ ] 19200 Baud
      1200BAUD         [ ] 1200 Baud
      2400BAUD         [ ] 2400 Baud
      4800BAUD         [ ] 4800 Baud

   72PARITY                Parity and stop-bits for PC-interface
      DIGSI V3         [ ] DIGSI V3
      8O1              [ ] Odd parity,1 stopbit
      8N2              [ ] No parity,2 stopbits
      8N1              [ ] No parity,1 stopbit
```

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74 FAULT RECORDER - FAULT RECORDINGS

   74RECini               Initiation of data storage
      RECbyFT         [ ] Storage by fault det
      RECbyTP         [ ] Storage by trip
      SRTwitTP        [ ] Start with trip

   74 T-MAX               Maximum time period of a fault recording
      min. 0.30           s
      max. 5.00     ____

   74 T-PRE               Pre-trigger time for fault recording
      min. 0.05           s
      max. 0.50     ____

   74 T-POS               Post-fault time for fault recording
      min. 0.05           s
      max. 0.50     ____
```

**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.

**From**

Name

Company/Dept.

Address

Telephone no.

## Corrections/Suggestions

Subject to technical alteration

Siemens Aktiengesellschaft

Order No. C53000–G1176–C106–9
Available from: LZF Fürth-Bislohe
Printed in the Federal Republic of Germany
AG 0303 0.2 XX 174 En