SIEMENS

Multifunction Overcurrent and Motor Protection Relay

SIPROTEC 7SJ602 V3.5

Instruction Manual Order No: C53000–G1176–C125–5

Figure 1 Illustration of the multifunction overcurrent protection relay 7SJ602 (in flush mounting case)

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CE

Indication of Conformity

This product complies 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 61000–6–2 and EN 61000–6–4 (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 specifications VDE 0435.

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

This product is UL-certified with the values specified in the technical data.

c UL us
LISTED

IND. CONT. EQ.
TYPE 1
69CA

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.

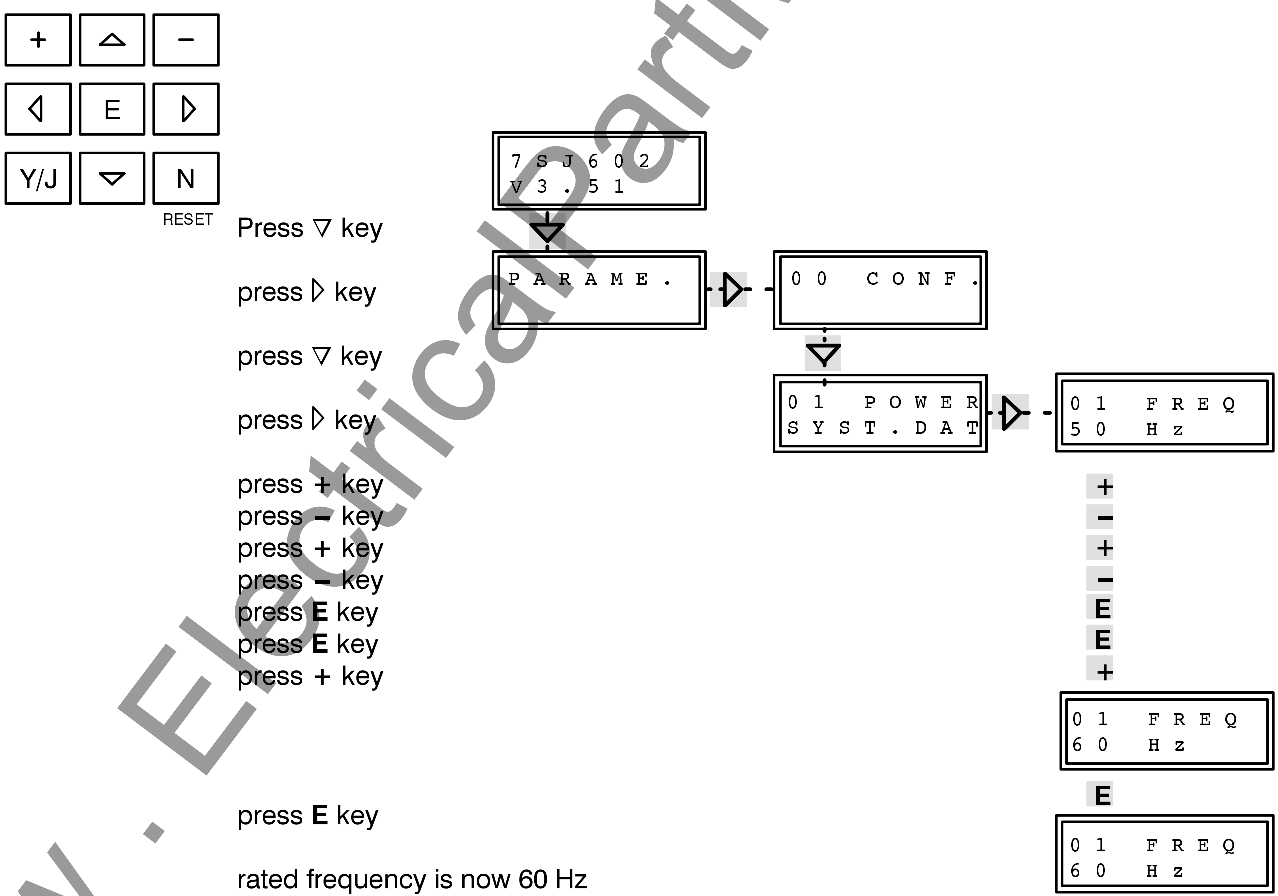
The operating interface is built up by a hierarchically structured menu tree, which can be passed through by means of the scrolling keys ◁ , ▷ , △ , and ▽. Thus, each operation object can be reached as illustrated in the example below for change-over of the rated frequency.

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 (“7SJ602”) and the version of the implemented firmware (e.g. “V3.51”).

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.



Contents

NOTE:

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

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

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

1 Introduction

1.1 Application

The relay SIPROTEC 7SJ602 is used as definite time overcurrent protection and/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 unit protection.

Functions for monitoring and protection of motors are included, like thermal overload and unbalanced load protection as well as start-up time and undercurrent monitoring and restart inhibit. An externally connected RTD-box can include the temperature measured by up to 6 RTDs (resistance temperature detectors) in the protected object which can be supervised and signalled by the device.

For use on overhead lines, a model with integrated auto-reclosure function is available which allows up to nine auto-reclosure attempts. On cables, the overload protection can be used.

The circuit breaker failure protection monitors the response of the breaker and issues trip commands to the adjacent breakers in case the local breaker fails.

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. The serial operator interface allows for comfortable and clear evaluation of the fault history including fault recording as well as comfortable operation of the relay, by means of a personal computer with appropriate programs. This interface is suited for communication via a modem link.

The relay can be equipped with a serial system interface. There are optional models with a SIPROTEC communication module for RS232, RS485, or optical fibre connections. Different transmission protocols are available: according to IEC 60870–5–103 or Profibus DP or Modbus RTU/ASCII, dependent on the ordered version.

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

The scope of functions depends on the ordered version. The following functions may not be implemented in the device all at the same time.

– 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.

– Simple setting and operation using the integrated operation panel or a connected personal computer with menu-guided software, connected via the front port.

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

– Continuous monitoring of the hardware and software of the relay as well as supervision of the sum of the four current inputs.

– Optional serial interface with a communication module: RS232, RS485, or optical fibre. Transmission protocols according to IEC 60870–5–103 or Profibus DP or Modbus RTU/ASCII, or connection of a modem or RTD-box are possible.

– Circuit breaker control and measured value indication and transmission are possible, dependent on the ordered version.

Time overcurrent protection

– Phase segregated overcurrent detection.

– Separate overcurrent detection in the residual (earth) path.

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

– Selectable trip time characteristics: either definite time lag or inverse time lag with a large number of characteristics according to IEC or ANSI/IEEE. Optional disk emulation for the reset process with inverse time lag. Alternative RI-characteristic or, for earth faults, RD-characteristic.

– Each characteristic with an independent instantaneous or definite time 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.

High-sensitivity earth fault protection

– Highly sensitive earth current detection for recognition of high-resistive earth faults in solidly or low-resistant earthed systems, or for detection of earth faults in isolated or arc-compensated systems.

– Selectable tripping time characteristics: either definite time lag or inverse time lag with a large number of characteristics according to IEC or ANSI/IEEE. Optional disk emulation for the reset process with inverse time lag. Alternative RI- or RD-characteristic.

– Additional independent instantaneous or definite time lag I_{EE}>> stage.

– Optional sensitive direction discrimination.

– Optional displacement voltage detection with or without trip.

Thermal overload protection

– Processing of the thermal current losses in cables, power transformers and rotating machines.

– Optionally without or with total memory (thermal replica of the current heat losses).

Circuit breaker failure protection

– Monitoring the response of the circuit breaker to the trip command.

– Detection of current flow and/or the position of the breaker auxiliary contact.

Unbalanced load / negative sequence protection

– Detection of phase failure or phase interruption and wrong phase rotation.

– Detection of impermissible unsymmetrical load condition in electrical machines.

Auto-reclosure

– Three-pole automatic reclosure after faults in overhead line systems.

– Single- or multi-shot (up to nine auto-reclosure attempts), with separately allocated timers for the first four shots.

Start-up time monitor for motors

– Start-up time monitor for use on motors, e.g. at locked rotor.

Restart inhibit for motors

– Lock-out of restart on imminent thermal overheat of the motor by multiple restart attempts.

Undercurrent detection for motors

– Detection of idle state or weak-load condition of motors by undercurrent recognition.

Temperature monitoring via RTD-box

– Connection of an RTD-box in order to monitor up to 6 temperature measuring points in transformers or motors.

– Numerical temperature values are coupled into the relay via a serial interface, coming from an external RTD-box which transmits the values of the RTDs (resistance temperature detectors). Evaluation of this ambient temperature for the overload protection.

Further functions

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

– Trip circuit supervision for the tripping coil including the wiring.

– Circuit breaker control during healthy operation.

2 Design

2.1 Arrangements

All protection functions including the dc/dc or ac/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 terminal 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 terminal 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.

At the bottom of the housing, an optional communication module may be arranged. This module is fixed with two screws at the housing.

The heavy duty current terminals 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.

Two different types of housings can be delivered:

– **7SJ602⋆–⋆B⋆⋆⋆–** in housing 7XP20 with **screwed terminals top and bottom**, for **panel surface mounting**

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

With the exception of the optional communication port, 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 2.1.

– **7SJ602⋆–⋆E⋆⋆⋆–** in housing 7XP20 with **screwed terminals at the rear**, for **panel flush mounting** or **cubicle installation**

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

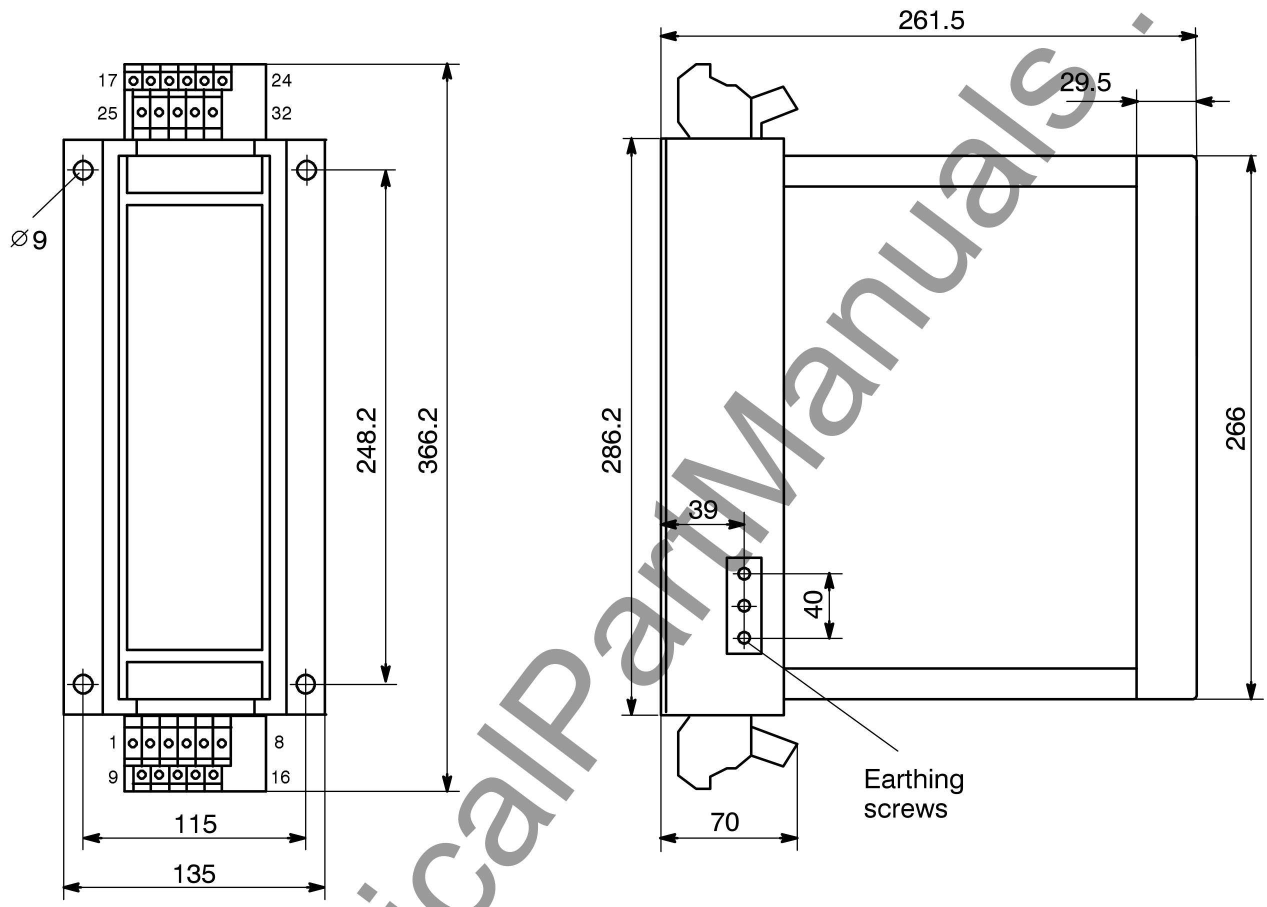
With the exception of the optional communication port, all external signals are connected to terminal modules which are mounted without screws at the rear of the housing. For each electrical connection, one screwed terminal is provided. This allows for connection of up to 2 ring or fork type cable lugs or up to 2 solid conductors or stranded conductors with connector sleeve. Use copper conductors only!

For dimensions please refer to Figure 2.2.

2.2 Dimensions

Figures 2.1 and 2.2 show the dimensions of the various types of housings available.

7SJ602★–★B★★★ in housing for **panel surface mounting** 7XP20 with terminals top and bottom



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

7SJ602★–★E★★★ Housing for **panel flush mounting** or **cubicle installation** 7XP20

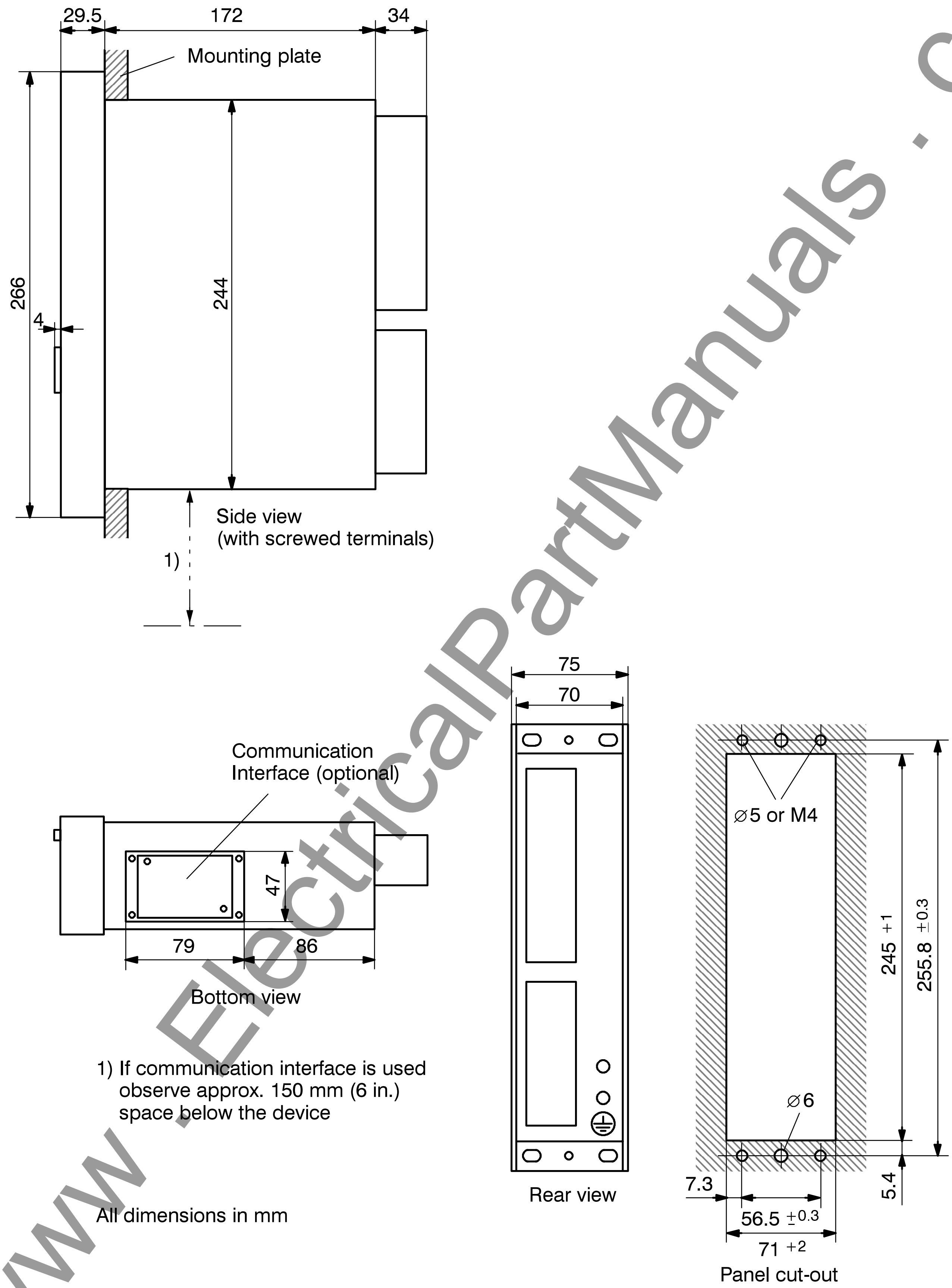


Figure 2.2 Dimensions for housing 7XP20 for panel flush mounting or cubicle installation

2.3 Connections

2.3.1 Connections to screwed terminals top and bottom

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.

The heavy duty current plug terminals 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 following data must be observed:

Direct connection with solid bare wire or flexible wire with end sleeves;
for cross-section 0.5 mm^2 to 5.0 mm^2; AWG 20 to AWG 10.
Use copper conductors only!

Wire strip length solid bare wire 7 to 8 mm.

Max torque value: 1.7 Nm or 15 in-lb.

2.3.2 Connections to screwed terminals on the rear

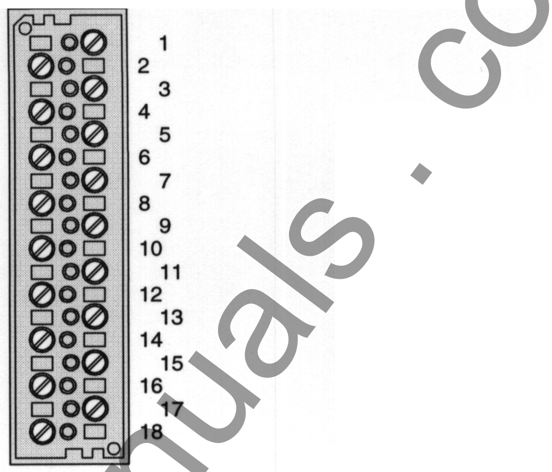
The following must be distinguished in the case of connection via screw terminals:
terminal plugs for voltage connections and
terminal plugs for current connections.

The terminal screws have a slot head for tightening or loosening with a flat screw driver, sized 6 x 1.

Voltage terminals

Voltage modules are provided with 18 terminals.

Ring-type and fork-type lugs may be used. To ensure that the insulating clearance is maintained, insulated lugs must be used. Alternatively, the crimping area must be insulated with other methods, e.g. by covering with a shrink sleeve.



18-pole

Figure 2.3 Connection module for screwed terminals (voltage) – rear view

The following data must be observed:

Cable lugs: for bolt diameter 4 mm;
max. major diameter 10 mm;
for cross-section 1.0 mm^2 to 2.6 mm^2; AWG 16 to AWG 14.
Use copper conductors only!

Recommended cable lugs series PIDG of Messrs. Tyco Electronics AMP, e.g.
ring-type cable lug type: PIDG PN 320565–0,
fork-type cable lug type: PIDG PN 321233–0.

Direct connection
with solid bare wire or flexible wire with end sleeves for cross-section 0.5 mm^2 to 2.6 mm^2; AWG 20 to AWG 14.
When using one solid bare wire, the conductor end must be inserted such that it will be drawn into the contact cavity while tightening the screw.
Use copper conductors only!

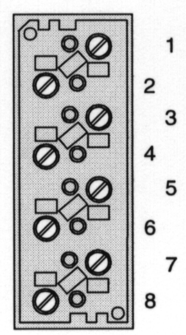
Wire strip length solid bare wire 9 mm to 10 mm.

Max torque value: 1.8 Nm or 16 in-lb.

Current terminals

Current modules are provided with 8 terminals. The terminals are arranged into terminal pairs, each containing two poles. In this manner, two neighbouring terminals form one pair. Accordingly, the current terminal module with 8 poles contains four pairs.

In combination with the plug connections on the p.c.b. side, these terminal pairs have an integrated short-circuit function which shorts the two neighboring current passages when the module is withdrawn.



8-pole

Figure 2.4 Connection module for screwed terminals (current) – rear view

When the module is inserted, the current path has a low impedance termination via the measuring inputs on the module. During insertion of the module, the short-circuit of the current path is automatically removed. The interruption of the short-circuit only occurs once a reliable contact to the plug terminal on the module is established. This does not reduce the care that must be taken when working on the current transformer secondary circuits!

Ring-type and fork-type lugs may be used. To ensure that the insulation clearance is maintained, insulated lugs must be used. Alternatively, the crimping area must be insulated with other methods, e.g. by covering with a shrink sleeve.

The following data must be observed:

Cable lugs: for bolt diameter 5 mm;
max. major diameter 12 mm;
cross-section 2.6 mm^2 to 6.6 mm^2; AWG 14 to AWG 10.
Use copper conductors only!

Recommended cable lugs series PIDG of Messrs. Tyco Electronics AMP, e.g.
ring-type cable lug type: PIDG PN 130171–0,
fork-type cable lug type: PIDG PN 326865–0.

Direct connection
with solid bare wire or flexible wire with end sleeves cross-section 2.5 mm^2 to 4 mm^2; AWG 14 to AWG 12.
When using one solid bare wire, the conductor end must be inserted such that it will be drawn into the contact cavity while tightening the screw.
Use copper conductors only!

Wire strip length solid bare wire 10 mm bis 11 mm.

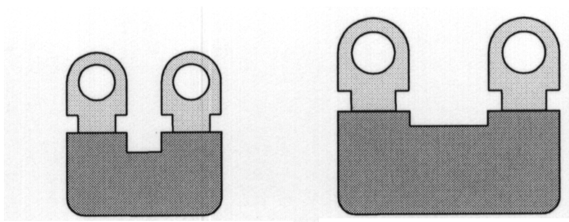
Max torque value: 2.7 Nm or 24 in-lb.

Short-circuit links

Short-circuit links are available for convenience in making terminal connections. The short circuit links can connect two neighboring terminals located on the same side of the terminal module. By connecting further links, neighbouring terminals can be included in the short circuit. On each terminal it is possible to connect two short-circuiting links, or one short-circuit link and one lug, or one individual conductor.

The links meet the safety requirements for protection against electronic shock.

There are two types of links, one for voltage connections and one for current connections. The links are illustrated in Figure 2.5. Ordering information for the links is provided in Section 2.5 Accessories.



Short-circuit link for voltage terminals

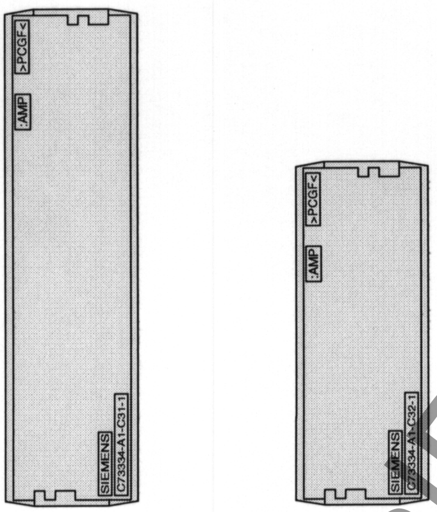
Short-circuit link for current terminals

Figure 2.5 Short-circuit links for voltage and current connections

Cover caps

Terminal cover caps are available for the screw terminal modules, to increase the protection of personnel against hazardous voltages (degree of protection against access to dangerous parts) on the terminal modules. The degree of protection is increased from the standard “back of the hand protection (IP1x)” to “finger protection (IP2x)”.

There are two types of cover caps, as shown in Figure 2.6. Ordering information is provided in Section 2.5 Accessories.



Cover cap for 18-pole voltage terminal module

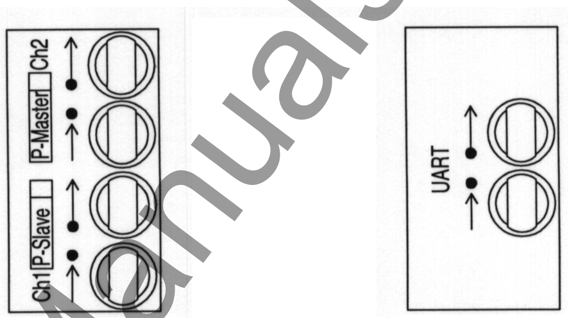
Cover cap for 8-pole current terminal module

Figure 2.6 Cover caps for terminal modules

The terminal cover caps provide an enclosure which securely covers all voltage carrying components. They are simply snapped onto the terminal module. It must be noted that all screws on the terminal module must be screws in before snapping the cover on. The terminal covering cap can simply be removed with a screw driver 6 x 1.

2.3.3 Optical fibre interface

The two available versions of optical communication interfaces are shown in Figure 2.7. The ports are supplied with caps to protect the optical components against dust or other contaminants. The caps can be removed by turning them 90° to the left.



2-channel

1-channel

Figure 2.7 Optical interfaces with protective caps

Optical connecter type: ST-terminal
Fibre type:
Multimode graded-index (“G”) optical fibre
G50/125 µm, G62,5/125 µm, G100/140 µm
Optical wavelength: λ approx. 820 nm

<u>Permissible bending radius:</u>
for indoor cables r_{min} = 5 cm (2 in)
for outdoor cables r_{min} = 20 cm (8 in)
Laser class 1 (acc. EN 60825−1) is achieved with fibre type G50/125 µm and G62,5/125 µm

2.3.4 Electrical interfaces

9-pin D-subminiature female socket terminals are provided for all electrical communication interfaces (Figure 2.8). The pin-assignment is shown in Table 2.1.

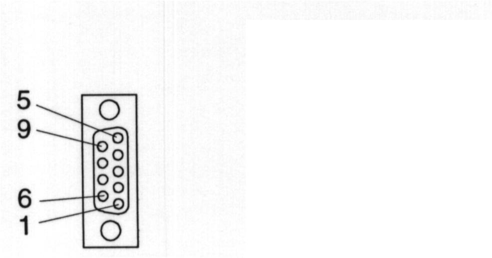


Figure 2.8 9-pin D-subminiature terminal

Standard 9-pin D-subminiature plug terminals per MIL–C–24 308 and DIN 41652 can be used.

The necessary communication cables are depend on the type of interface:

– RS232/EIA232: five-wire, twisted and shielded, e.g. interface cable 7XV5100–4.

– RS485/EIA485: three-wire, twisted and shielded.

– Profibus: two-wire or four-wire, twisted and shielded.
  Wire type A, DIN 19245 part 2 and EN 50170 vol.2, twisted and shielded,
  Wire resistance: 135 Ω to 165 Ω (f > 100 kHz),
  Capacitance: <30 nF/km (48 nF/mile),
  Circuit resistance: <110 Ω/km (177 Ω/mile),
  Conductor diameter: >0.64 mm,
  Conductor cross-sectional area: > 0.34 mm^2
  e.g. SINEC L2 Industrial twisted pair installation wire (see catalogue IK 10 "SIMATIC NET, Industrial Communications Networks").

Pin-No.	Operating interface	RS232	RS485	Profibus RS485	Modbus RS485
1	—	Schield	Shield	Shield	Shield
2	RxD	RxD	—	—	—
3	TxD	TxD	A/A'	B/B'	A
4	—	—	—	CNTR–A	RTS
5	GND	GND	C/C'	C/C'	GND1
6	—	—	—	+5 V (<100 mA)	VCC1
7	—	$\overline{\text{RTS}}$	—	—	—
8	—	$\overline{\text{CTS}}$	B/B'	A/A'	B
9	—	—	—	—	—

Table 2.1 Pin-assignment of the electrical interfaces

2.4 Ordering data

Multifunction Overcurrent and Motor Protection Relay 7 S J 6 0 2

Order position	7.	–	8.	9.	10.	11.	12.	–	13.	14.	15.	16.
7 S J 6 0 2	☐	–	☐	☐	B	☐	☐	–	☐	☐	☐	☐

Measured value inputs (4×I) 1)
I_N = 1 A 1
I_N = 5 A 5

Measured value inputs (3×I, 1×U) 2)
I_{NPh} = 1 A; I_{EE} (sensitive ≤1.6 A) 2
I_{NPh} = 5 A; I_{EE} (sensitive ≤8 A) 6

Auxiliary voltage

24/48 Vdc; binary input threshold 19 V 2

60/110 Vdc; binary input threshold 19 V 4

110/220/250 Vdc;115/230 Vac;
binary input threshold 88 V 5

Construction

in housing for panel surface mounting
with screw-type terminals top and bottom . . . . B

in housing for panel flush mounting/cubicle
with screw-type terminals at the rear . . . . E

System interface

without system interface 0

IEC 60870–5–103; electrical RS232 1

IEC 60870–5–103; electrical RS485 2

IEC 60870–5–103; optical 820 nm; ST-connector 3

RTD-box; electrical RS485 3) 8

others: see additional specification L 9

Additional specification L: + L 0 ☐
Profibus DP Slave; electrical RS485 . . . . A
Profibus DP Slave; optical double-ring; ST-connector . . . . B
Modbus ASCII/RTU; electrical RS485 . . . . D
Modbus ASCII/RTU; optical 820 nm; ST-connector . . . . E

1) only with “A” at the 15th order position
2) only with “B” or “J” at the 15th order position
3) only with external RTD-box (see 2.5 Accessories)

(continued next page)

Multifunction Overcurrent and Motor Protection Relay 7 S J 6 0 2 [7.] – [8.] [9.] [10.] [11.] [12.] – [13.] [14.] [15.] [16.]

Breaker control (without feedback)

	Pos. 12
without breaker control	0
with breaker control	1

Measurement functions

	Pos. 13
with fault recording	1
with fault recording, min-, max-, mean-values	3

Protection functions

	Pos. 14	Pos. 15
Time overcurrent protection, definite and inverse time, phase currents ($I>>>$, $I>>$, $I>$, I_p); time overcurrent protection, definite and inverse time, earth current ($I_E>>$, $I_E>$, I_{Ep}); dynamic switch-over of pick-up values; thermal overload protection; unbalanced load protection $I2>$; circuit breaker failure protection; trip circuit supervision	F	A
Time overcurrent protection, definite and inverse time, phase currents ($I>>>$, $I>>$, $I>$, I_p); sensitive earth fault protection, definite and inverse time ($I_{EE}>>$, $I_{EE}>$, I_{EEp}) sensitive directional earth fault detection ($I_{EE}>>$, $I_{EE}>$, I_{EEp}, I_a, I_r) dynamic switch-over of pick-up values; displacement voltage detection $U_E>$; thermal overload protection; unbalanced load protection $I2>$; circuit breaker failure protection; trip circuit supervision	F	B
Time overcurrent protection, definite and inverse time, phase currents ($I>>>$, $I>>$, $I>$, I_p); sensitive earth fault protection, definite and inverse time ($I_{EE}>>$, $I_{EE}>$, I_{EEp}) dynamic switch-over of pick-up values; thermal overload protection; unbalanced load protection $I2>$; circuit breaker failure protection; trip circuit supervision; voltage and power measurement	F	J

(next page)

Multifunction Overcurrent and Motor Protection Relay 7 S J 6 0 2 [7.] – [8.] [9.] [10.] [11.] [12.] – [13.] [14.] [15.] [16.]

Protection functions (contin.)

Time overcurrent protection, definite and inverse time, phase currents ($I>>>$, $I>>$, $I>$, I_p);
time overcurrent protection, definite and inverse time, earth current ($I_E>>$, $I_E>$, I_{Ep});
dynamic switch-over of pick-up values;
thermal overload protection;
unbalanced load protection $I2>$;
circuit breaker failure protection;
start-up time monitoring;
undercurrent monitoring;
restart inhibit;
trip circuit supervision . . . . H A

Time overcurrent protection, definite and inverse time, phase currents ($I>>>$, $I>>$, $I>$, I_p);
sensitive earth fault protection, definite and inverse time ($I_{EE}>>$, $I_{EE}>$, I_{EEp})
sensitive directional earth fault detection ($I_{EE}>>$, $I_{EE}>$, I_{EEp}, I_a, I_r)
dynamic switch-over of pick-up values;
displacement voltage detection $U_E>$;
thermal overload protection;
unbalanced load protection $I2>$;
circuit breaker failure protection;
start-up time monitoring;
undercurrent monitoring;
restart inhibit;
trip circuit supervision . . . . H B

Time overcurrent protection, definite and inverse time, phase currents ($I>>>$, $I>>$, $I>$, I_p);
sensitive earth fault protection, definite and inverse time ($I_{EE}>>$, $I_{EE}>$, I_{EEp})
dynamic switch-over of pick-up values;
thermal overload protection;
unbalanced load protection $I2>$;
circuit breaker failure protection;
start-up time monitoring;
undercurrent monitoring;
restart inhibit;
trip circuit supervision;
voltage and power measurement . . . . H J

Supplementary functions

without auto-reclosure 0

with auto-reclosure 1

2.5 Accessories

RTD-box

for converting measured temperatures from up to 6 RTDs (resistance temperature detectors) into numerical information for the 7SJ602 device
auxiliary voltages 24 V to 60 V dc or ac . . . . **7XV5662−2AD10**
auxiliary voltages 90 V to 240 V dc or ac . . . . **7XV5662−5AD10**

Copper connecting cable

for connection of the 9-pin terminal at the 7SJ602 device with the
personal computer or laptop (9-pin), 3 m (10 ft) . . . . **7XV5100−4**

Operating software DIGSI 4

The 7SJ602 protection device is operated by 7SJ602 DIGSI 3, which is integrated into DIGSI 4.

Basic
Full version with license for 10 computers, on DIGSI 4 and DIGSI 3
CD-ROM (authorization with license number) . . . . **7XS5400−0AA00**

Professional
Complete version: Basic and all optional packages
with license for 10 computers on DIGSI 4 and DIGSI 3 CD-ROM . . . . **7XS5402−0AA00**

Basic Upgrade 3 → 4
(Basic, SIGRA, Graphic Tools)
Full version with license for 10 computers on DIGSI 4 and DIGSI 3 CD-ROM
(authorization with license number, service agreement
for version 3 expires automatically) . . . . **7XS5405−0AA00**

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

Installation accessories

Cover caps for screwed terminal modules
voltage terminal 18-pole **C73334–A1–C31–1**
current terminal 8-pole **C73334–A1–C32–1**

Short circuit links for voltage and current terminal modules
voltage terminal 18-pole **C73334–A1–C34–1**
current terminal 8-pole **C73334–A1–C33–1**

Mounting rail
for installation in 19”-rack **C73165–A63–C200–3**

Battery
Lithium-Battery 3 V/1 Ah, Type CR 1/2 AA
VARTA **6127 101 501**

3 Technical data

3.1 General data

3.1.1 Inputs/outputs

Measuring circuits

Rated current	I_N	1 A or 5 A (adjustable)
Rated voltage	U_N	100 V to 125 V (settable)
Rated frequency	f_N	50 Hz/60 Hz (settable)
Power consumption	current path at I_N = 1 A	<0.1 VA
	current path at I_N = 5 A	<0.3 VA
– for sensitive earth fault detection at 1 A		approx 0.05 VA
Power consumption	voltage path at 100 V	$\leq$ 0.3 VA
Overload capability	current path	
– thermal (rms)		100 $\times$ I_N for $\leq$1 s
		30 $\times$ I_N for $\leq$10 s
		4 $\times$ I_N continuous
– dynamic (pulse current)		250 $\times$ I_N one half cycle
Overload capability for sensitive earth fault detection		
– thermal (r.m.s.)		300 A for 1 second
		100 A for 10 seconds
		15 A continuous
– dynamic (pulse current)		750 A one half cycle
Overload capability v.t. circuits		
– thermal (r.m.s.)		230 V continuous

Auxiliary voltage

Power supply via integrated DC/DC or AC/DC converter

Rated auxiliary voltage U_{aux} DC	24/48 VDC	60/110 VDC	110/125/220/250 VDC
Permissible variations	19 to 58 VDC	48 to 132 VDC	88 to 300 VDC

Superimposed ac voltage, peak-to-peak	$\leq$ 12 % at rated voltage $\leq$ 6 % at limits of admissible voltage
Power consumption	approx. 3 W to 6 W dependent on operating condition and aux. voltage
Bridging time during failure/short-circuit of auxiliary voltage (IEC 60255–11)	not picked up $\geq$ 50 ms at $U_{aux} \geq$ 110 VDC $\geq$ 20 ms at U_{aux} < 110 VDC

Rated auxiliary voltage U_{aux} AC	115/230 VAC, 50/60 Hz
Permissible variations	92 to 265 VAC

Power consumption	approx. 3 VA to 6 VA dependent on operating condition and aux. voltage
Bridging time during failure/short-circuit of auxiliary voltage	$\geq$ 50 ms

Output relays

Command/signalling relays		4 (configurable) with 1 NO contact each 2 contacts can be changed to NC contact
Live status/alarm relay		1 with 1 NO or 1 NC contact (adjustable)
Switching capacity	MAKE	1000 W/VA
	BREAK	30 VA 40 W resistive 25 W at L/R $\leq$ 50 ms
Switching voltage		250 V
Permissible current per contact		5 A continuous
	Make and Carry (NO contact)	30 A for 0.5 s
Total current on common path		5 A continuous
	Make and Carry (NO contact)	30 A for 0.5 s
UL-Listing/Recognition for output contacts with the following rated data:		120 V ac Pilot duty, B 300 240 V ac Pilot duty, B 300 240 V ac 5 A General Purpose 24 V dc 5 A General Purpose 48 V dc 0.8 A General Purpose 240 V dc 0.1 A General Purpose 120 V ac 1/6 hp (4.4 FLA) 240 V ac 1/2 hp (4.9 FLA)

Binary inputs, number		3 (configurable)
Nominal operating voltage		24 to 250 VDC; bipolar
Current consumption, energized		approx. 1.8 mA, independent of control voltage
Pick-up threshold		adjustable by jumpers
– rated aux. voltage 24/48/60/110 VDC	$U_{pick-up}$	$\geq$ 19 Vdc
	$U_{drop-off}$	< 14 Vdc
– rated aux. voltage 110/125/220/250 VDC	$U_{pick-up}$	$\geq$ 88 Vdc
	$U_{drop-off}$	< 66 Vdc
Max permissible control voltage		300 Vdc

Serial operator interface	non-isolated
– connection	at the front panel, 9-pin DSUB port RS232 for connecting a personal computer
– operation	with DIGSI® V4.3 or higher
– transmission speed	min. 1200 Baud; max. 19200 Baud as delivered 19200 Baud; parity 8E1
– max. transmission distance	15 m (50 feet)

Serial system interface	isolated
– Connection	RS232/RS485/optical fibre dependent on ordered model; located at the bottom of the housing
Protocol IEC 60870–5–103	
– Transmission speed	min. 1200 Baud; max. 19200 Baud as delivered 9600 Baud
RS232	
– Connection	9-pin DSUB port on the case bottom
– Test voltage	500 V; 50 Hz
– Max. transmission distance	15 m (50 feet)
RS485	
– Connection	9-pin DSUB port on the case bottom
– Test voltage	500 V; 50 Hz
– Max. transmission distance	1000 m (3300 feet)
Optical fibre	
– Connection	ST-connector on the case bottom
– Optical wave length	λ = 820 nm
– Laser class 1 acc. EN 60825–1/–2	using glass fibre 50/125 μm or 62.5/125 μm
– Permissible signal attenuation	8 dB with glass fiber 62.5/125 μm
– Max. transmission distance	1500 m (5000 feet)
– Character idle state	selectable; as delivered "Light off"
Protocol PROFIBUS-DP	
– Transmission speed	up to 1.5 MBaud
– Transmission reliability	Hamming distance d = 4
RS485	
– Connection	9-pin DSUB port on the case bottom
– Test voltage	500 V, 50 Hz, against earth
– Max. transmission distance	1000 m (3300 ft) up to 93.75 kBaud; 500 m (1660 ft) up to 187.5 kBaud; 200 m (660 ft) up to 1.5 MBaud
Optical fibre	
– Connection	ST-connector on the case bottom; double ring
– Optical wave length	λ = 820 nm
– Laser class 1 acc. EN 60825–1/–2	using glass fibre 50/125 μm or 62.5/125 μm
– Permissible signal attenuation	8 dB with glass fiber 62.5/125 μm
– Max. transmission distance	1500 m (5000 feet)
– Character idle state	selectable; as delivered "Light off"
Protocol MODBUS RTU / ASCII	
– Transmission speed	up to 19200 Baud
– Transmission reliability	Hamming distance d = 4

RS485	
– Connection	9-pin DSUB port on the case bottom
– Test voltage	500 V, 50 Hz, against earth
– Max. transmission distance	1000 m (3300 ft)
Optical fibre	
– Connection	ST-connector on the case bottom
– Optical wave length	λ = 820 nm
– Laser class 1 acc. EN 60825–1/–2	using glass fibre 50/125 μm or 62.5/125 μm
– Permissible signal attenuation	8 dB with glass fiber 62.5/125 μm
– Max. transmission distance	1500 m (5000 ft)
– Character idle state	settable; as delivered "Light off"

3.1.2 Electrical tests

Insulation tests	
Standards:	IEC 60255–5 and IEC 60870–2–1; ANSI/IEEE Std. C37.90.0
– High voltage test (routine test) except power supply input, binary inputs, and communication interfaces	2.5 kV (rms); 50 Hz
– High voltage test (routine test) only d.c. voltage supply input and binary inputs	3.5 kV DC
– High voltage test (routine test) only system interface	500 V (rms); 50 Hz
– Impulse voltage test (type test) all circuits except communication interfaces, class III	5 kV (peak); 1.2/50 μs; 0.5 Ws; 3 positive and 3 negative shots at intervals of 5 s
EMC tests; immunity (type tests)	
Standards:	IEC 60255–6, IEC 60255–22 (product standards) EN 61000–6–2 (generic standard) VDE 0435 /part 303
– High frequency test IEC 60255–22–1, VDE 0435 /part 303 class III	2.5 kV (peak); 1 MHz; τ =15 μs; 400 shots/s; duration >10 s; R_i = 200 Ω
– Electrostatic discharge IEC 60255–22–2, IEC 61000–4–2 class IV	8 kV contact discharge; 15 kV air discharge; both polarities; 150 pF; R_i = 330 Ω

– Irradiation with HF field, frequency sweep, IEC 60255–22–3, IEC 61000–4–3 class III	10 V/m; 80 MHz to 1000 MHz; 80 % AM; 1 kHz
– Irradiation with HF field, individual frequencies IEC 60255–22–3, IEC 61000–4–3 class III	10 V/m
amplitude modulated	80 MHz; 160 MHz; 450 MHz; 900 MHz; 80 % AM; duty >10 s
pulse modulated	900 MHz; 50 % PM; repetition frequency 200 Hz
– Fast transient disturbance/burst IEC 60255–22–4, IEC 61000–4–4 class IV	4 kV; 5/50 ns; 5 kHz; burst length 15 ms; repetition rate 300 ms; both polarities; R_i = 50 Ω; test duration 1 min
– High energy surge voltages (SURGE), IEC 61 000–4–5; installation class 3	impulse: 1.2/50 μs
power supply	common mode: 2 kV; 12 Ω; 9 μF differential mode: 1 kV; 2 Ω; 18 μF
analog inputs, binary inputs and outputs	common mode: 2 kV; 42 Ω; 0.5 μF differential mode: 1 kV; 42 Ω; 0.5 μF
– Line conducted HF disturbances amplitude modulated IEC 61000–4–6, class III	10 V; 150 kHz to 80 MHz; 80 % AM; 1 kHz
– Power frequency magnetic field IEC 61000–4–8, IEC 60255–6; class IV	30 A/m continuous; 300 A/m for 3 s; 50 Hz; 0.5 mT; 50 Hz
– Oscillatory surge withstand capability ANSI/IEEE Std. C37.90.1	2.5 kV (peak value); 1 MHz, τ = 15 μs; 400 surges per s; R_i = 200 Ω; duration 2 s;
– Fast transient surge withstand capability ANSI/IEEE Std. C37.90.1	4 kV; 5/50 ns; 5 kHz; burst length 15 ms; repetition rate 300 ms; both polarities; R_i = 80 Ω; duration 1 min
– Radiated Electromagnetic Interference ANSI/IEEE Std C37.90.2	35 V/m; 25 MHz to 1000 MHz
– Damped wave IEC 60694 or IEC 61000–4–12	2.5 kV (peak), alternating polarity; 100 kHz, 1 MHz, 10 MHz, and 50 MHz; R_i = 200 Ω

EMC tests; emission (type tests)

Standard:	EN 50081–⋆ (generic standard)
– Conducted interference voltage, aux. voltage IEC–CISPR 22	150 kHz to 30 MHz limit class B
– Interference field strength IEC–CISPR 22	30 MHz to 1000 MHz limit class B
– Harmonic currents on the mains leads at 230 Vac; IEC 61000–3–2	limit values according class A are met
– Voltage variations and flicker on the mains leads at 230 Vac; IEC 61000–3–3	Limits are met

3.1.3 Mechanical stress tests

Vibration and shock during operation

Standards:	IEC 60255–21 and IEC 60068–2
– Vibration IEC 60255–21–1, class 2 IEC 60068–2–6	sinusoidal 10 Hz to 60 Hz: ± 0.075 mm amplitude; 60 Hz to 150 Hz: 1 g acceleration sweep rate 1 octave/min 20 cycles in 3 orthogonal axes
– Shock IEC 60255–21–2, class 1 IEC 60068–2–27	half sine acceleration 5 g, duration 11 ms, 3 shocks in each direction of 3 orthogonal axes
– Seismic vibration IEC 60255–21–3, class 1 IEC 60068–3–3	sinusoidal 1 Hz to 8 Hz: ± 3.5 mm amplitude (hor. axis) 1 Hz to 8 Hz: ± 1.5 mm amplitude (vert. axis) 8 Hz to 35 Hz: 1 g acceleration (hor. axis) 8 Hz to 35 Hz: 0.5 g acceleration (vert. axis) sweep rate 1 octave/min 1 cycle in 3 orthogonal axes

Vibration and shock during transport

Standards:	IEC 60255–21 and IEC 60068–2
– Vibration IEC 60255–21–1, class 2 IEC 60068–2–6	sinusoidal 5 Hz to 8 Hz: ± 7.5 mm amplitude; 8 Hz to 150 Hz: 2 g acceleration sweep rate 1 octave/min 20 cycles in 3 orthogonal axes
– Shock IEC 60255–21–2, class 1 IEC 60068–2–27	half sine acceleration 15 g, duration 11 ms, 3 shocks in each direction of 3 orthogonal axes
– Continuous shock IEC 60255–21–2, class 1 IEC 60068–2–29	half sine acceleration 10 g, duration 16 ms, 1000 shocks in each direction of 3 orthogonal axes

All stress specifications apply for standard works packaging!

3.1.4 Climatic stress tests

– Type tested (according to IEC 60068–2–1 and –2)	−25 °C to +85 °C (test condition for 16 hours) −13 °F to +185 °F (test condition for 16 hours)
– Limit temperature (transient) during operation	−20 °C to +70 °C −4 °F to +158 °F (tested for 96 hours) (> 55 °C/130 °F decreased display contrast)
– Recommended permanent operating temperature (according to IEC 60255–6)	−5 °C to +55 °C +23 °F to +131 °F
– Limiting temperature during permanent storage	−25 °C to +55 °C −13 °F to +131 °F
– Limiting temperature during transport	−25 °C to +70 °C −13 °F to +158 °F

Storage and transport with standard works packaging!

– Permissible humidity	mean value per year $\leq$75 % relative humidity; on 56 days per year 93 % relative humidity; condensation not permissible!

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

3.1.5 Service conditions

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

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

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

– The shield of the interface cable – if used – 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.

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		
– for the equipment		
in the surface mounted case		IP 51
in the flush mounted case	front	IP 51
	rear	IP 20
– for personal protection		IP 2x terminals covered with terminal cap

3.2 Definite time overcurrent protection

Setting range/steps

Overcurrent pick-up	I> (phases)	I/I_N	0.1 to 25.0 or ∞ (ineffective)	(steps 0.1)
Overcurrent pick-up	I_E> (earth)	I/I_N	0.05 to 25.00 or ∞ (ineffective)	(steps 0.01)
Overcurrent pick-up	I>> (phases)	I/I_N	0.1 to 25.0 or ∞ (ineffective)	(steps 0.1)
Overcurrent pick-up	I_E>> (earth)	I/I_N	0.05 to 25.00 or ∞ (ineffective)	(steps 0.01)
Overcurrent pick-up	I>>> (phases)	I/I_N	0.3 to 12.5 or ∞ (ineffective)	(steps 0.1)
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. 27 ms
– at 2 x setting value, with meas. repetition	approx. 40 ms
Pick-up times for I>>> at >2 x setting value	approx. 12 ms

Reset times

I>, I>>, I_E>, I_E>>	approx. 40 ms
I>>>	approx. 45 ms

Reset ratios approx. 0.95 for $I/I_N \geq 0.5$

Tolerances

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

Influence variables

– Auxiliary voltage in range $0.8 \leq U_{aux}/U_{auxN} \leq 1.2$	$\leq$ 1 %
– Temperature in range $-5\ °C \leq \vartheta_{amb} \leq +40\ °C$ (23 °F to 104 °F)	$\leq$ 0.5 %/10 K
– Frequency in range $0.98 \leq f/f_N \leq 1.02$	$\leq$ 1.5 %
$0.95 \leq f/f_N \leq 1.05$	$\leq$ 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 or ∞ (ineffective)	(steps 0.1)
Overcurrent pick-up I_E>> (earth)	I/I_N	0.05 to 25.00 or ∞ (ineffective)	(steps 0.01)
Overcurrent pick-up I>>> (phases)	I/I_N	0.3 to 12.5 or ∞ (ineffective)	(steps 0.1)
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 additional RI- and RD-curves

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)

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

RI-curve ("RI")

$$T = \frac{1}{0.339 - 0.236 \cdot (I_p/I)} \cdot T_p$$

RD-curve ("RD")

$$T = 5.8 - 1.35 \cdot \mathit{ln} \frac{I}{T_p \cdot I_p}$$

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

The formulae are valid in the range $1.1 \leq I/I_p \leq 20$. Tripping times do not decrease above $I/I_p > 20$

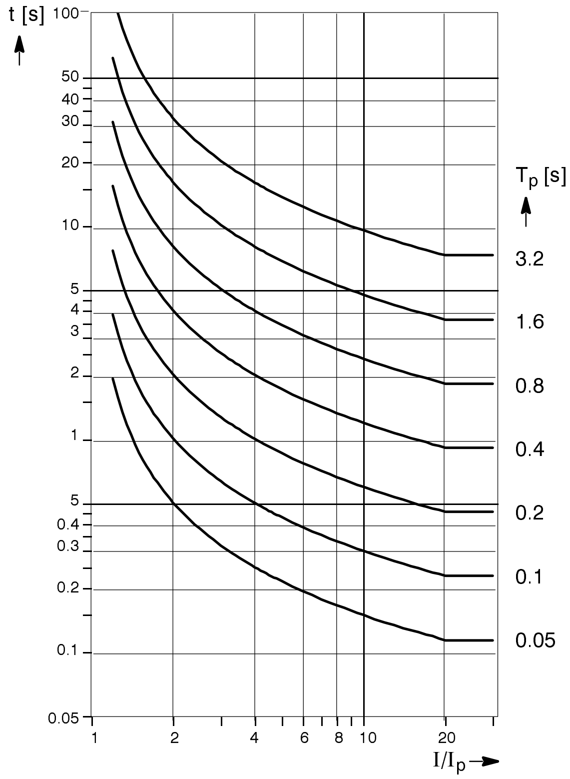
Pick-up threshold of inverse time stages	approx. 1.1 · I_p
Drop-off threshold of inverse time stages	approx. 1.03 x I_p without disk emulation approx. 0.9 x I_p with disk emulation
Drop-off time	approx. 30 ms or disk-emulation (Fig. 3.3)

Tolerances

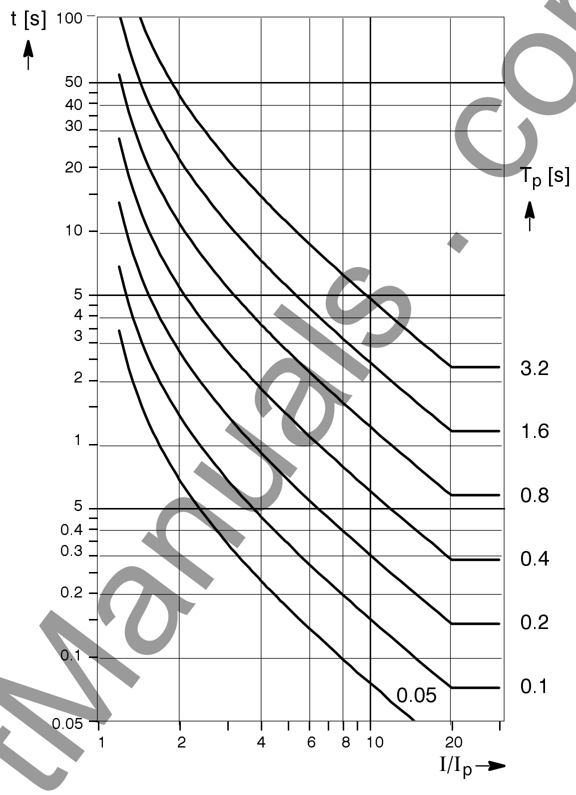
– Pick-up values	5 % of set value or 5 % of rated value
– Delay time for $2 \leq I/I_p \leq 20$ and $0.5 \leq I/I_N \leq 24$	5 % of theoretical value ± 2 % current tolerance; at least 30 ms

Influence variables

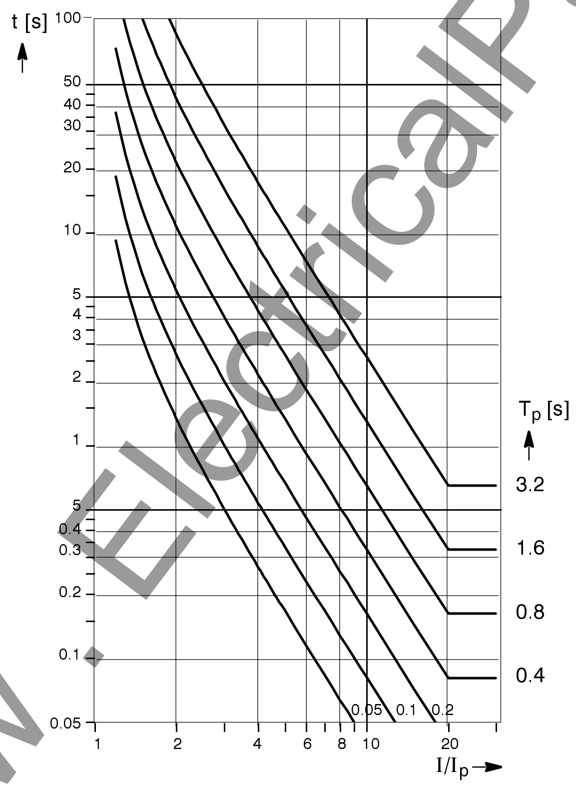
– Auxiliary voltage in range $0.8 \leq U_{aux}/U_{auxN} \leq 1.2$	$\leq$ 1 %
– Temperature in range $-5\ °C \leq \vartheta_{amb} \leq +40\ °C$ (23 °F to 104 °F)	$\leq$ 0.5 %/10 K
– Frequency in range $0.95 \leq f/f_N \leq 1.05$	$\leq$ 8 % referred to theoretical time value



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]

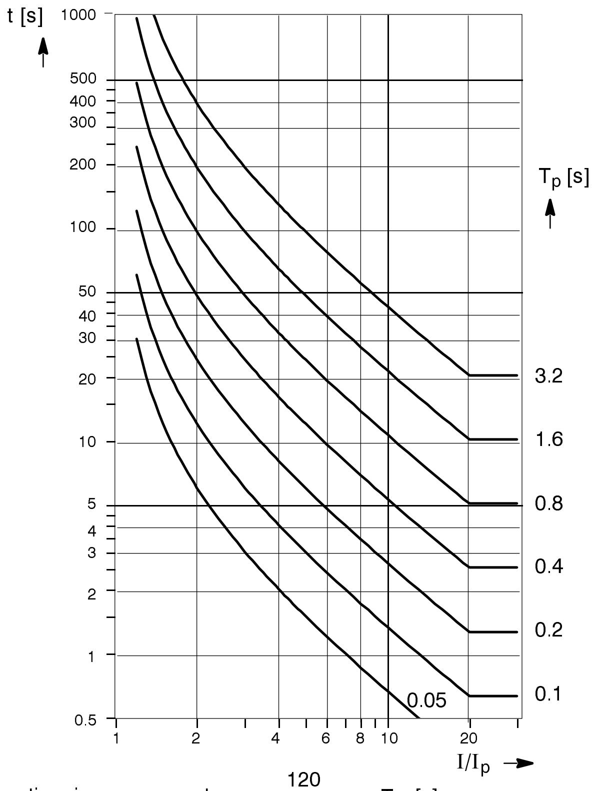


Extremely inverse: $t = \frac{80}{(I/I_p)^2 - 1} \cdot T_p$ [s]

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

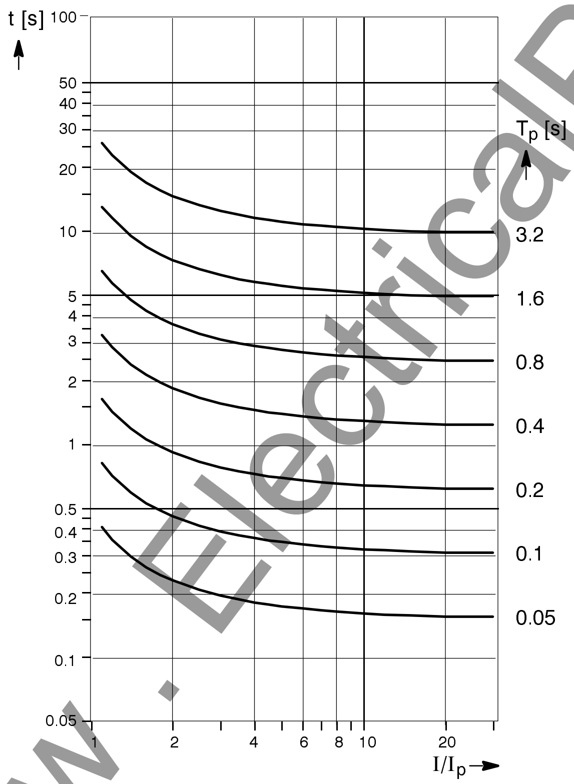
Figure 3.1 Trip time characteristics of inverse time overcurrent protection, according IEC

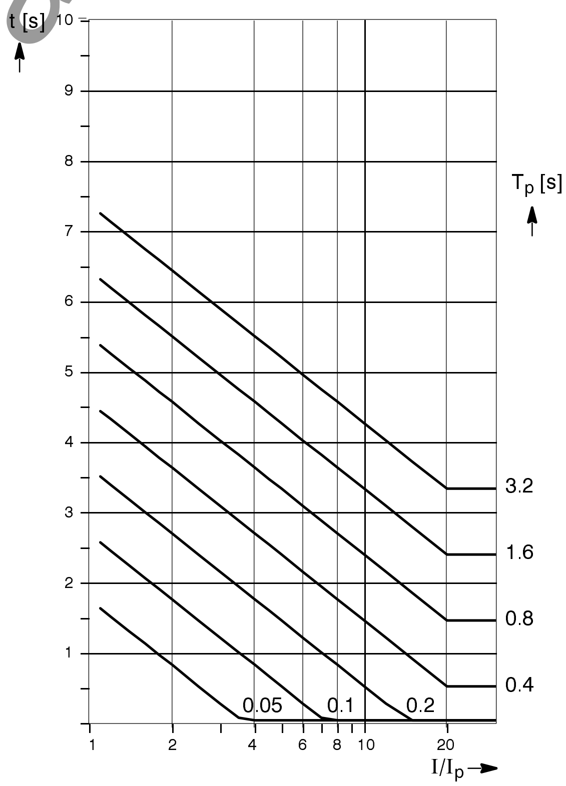


t trip time
T_p set time multiplier
I Fault current
I_p Set pick-up current

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

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

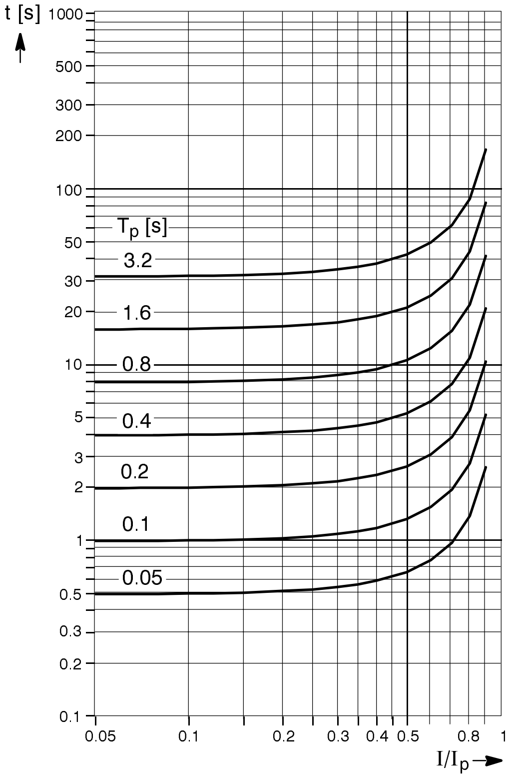




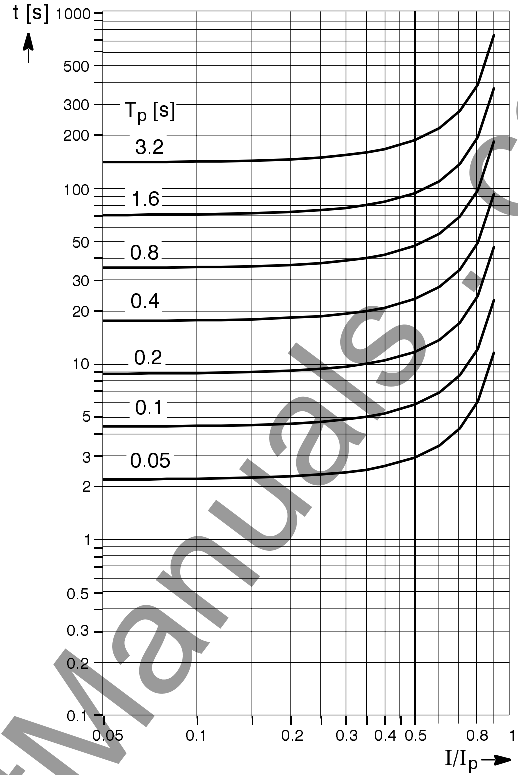
RI-curve: $t = \dfrac{1}{0.339 - 0.236 \cdot \dfrac{I_p}{I}} \cdot T_p$ [s]

RD-curve: $t = 5.8 - 1.35 \cdot ln \dfrac{I}{T_p \cdot I_p}$ [s]
(only for earth current stage)

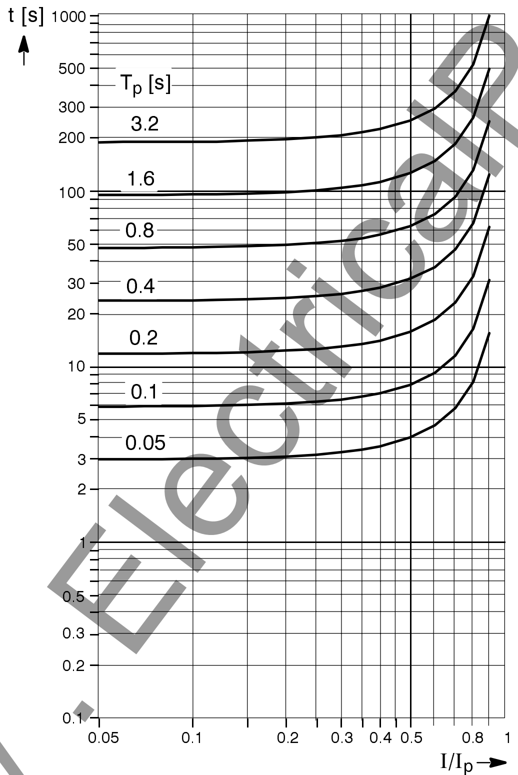
Figure 3.2 Trip time characteristic of inverse time overcurrent protection, according IEC, and RI/RD



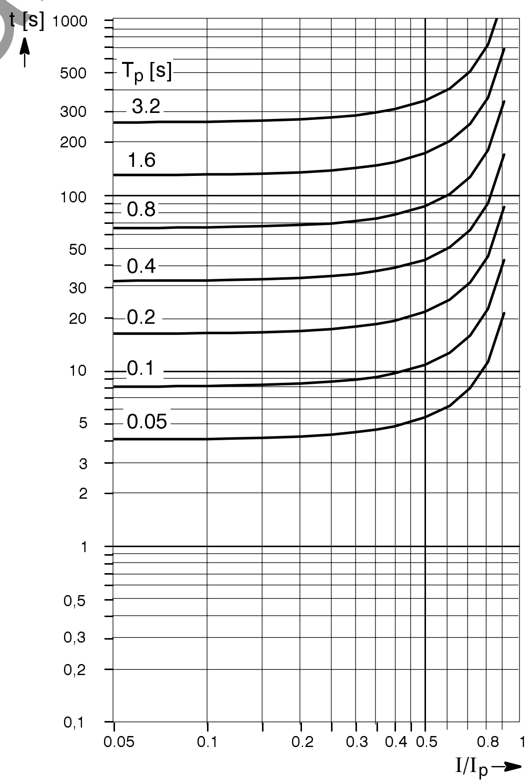
Normal inverse: $t_{Reset} = \frac{9.7}{1-(I/I_p)^2} \cdot T_p$ [s]



Very inverse: $t_{Reset} = \frac{43.2}{1-(I/I_p)^2} \cdot T_p$ [s]



Extremely inverse: $t_{Reset} = \frac{58.2}{1-(I/I_p)^2} \cdot T_p$ [s]



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

t Reset time
T_p Set time multiplier
I Interrupted current
I_p Set pick-up current

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

Figure 3.3 Reset time characteristic of inverse time overcurrent protection, according IEC, with disk emulation

Trip time characteristics acc. ANSI/IEEE (refer to Figures 3.4 and 3.5)

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”)

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

Squared inverse (“I−squared−t”)

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

tripping times do not decrease above $I/I_p > 20$

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

Pick-up threshold approx. $1.06 \cdot I_p$

Drop-off threshold approx. $1.01 \cdot I_p$ without disk emulation; approx. $0.9 \cdot I_p$ with disk emulation

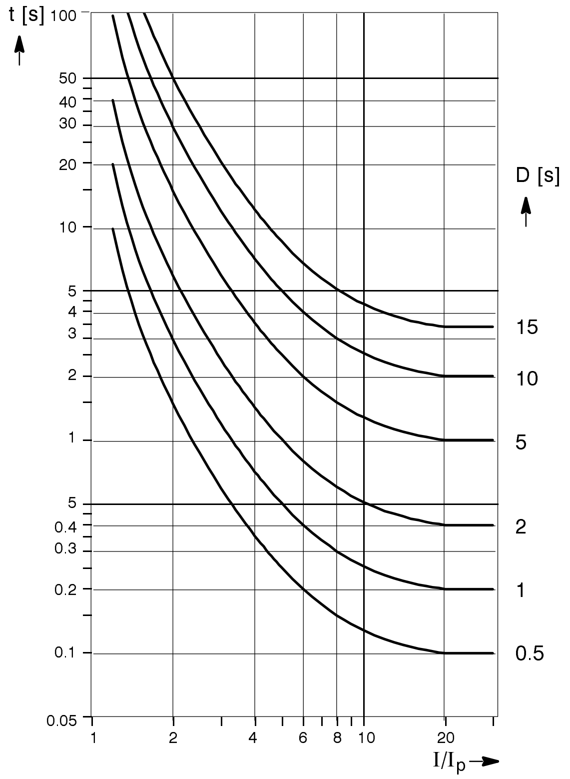
Drop-off time approx. 30 ms or disk-emulation (Figs. 3.6, 3.7)

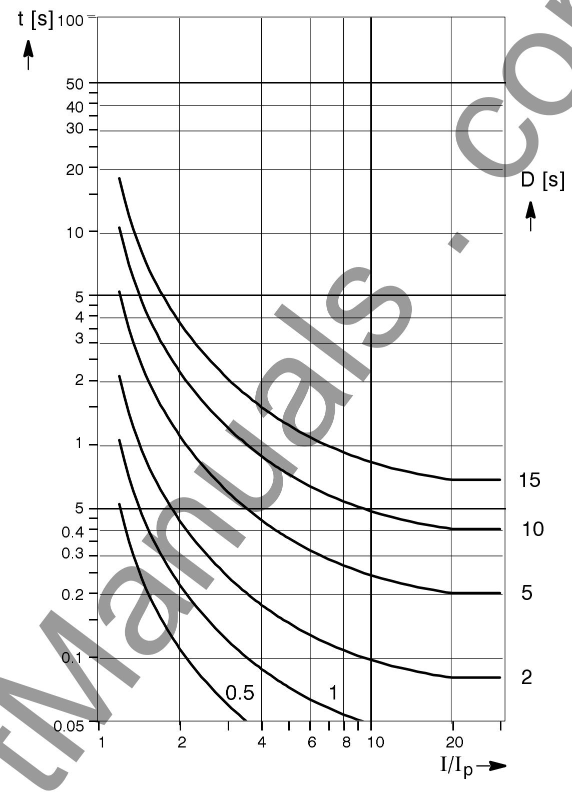
Tolerances

– Pick-up values	5 % of set value or 5 % of rated value
– 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

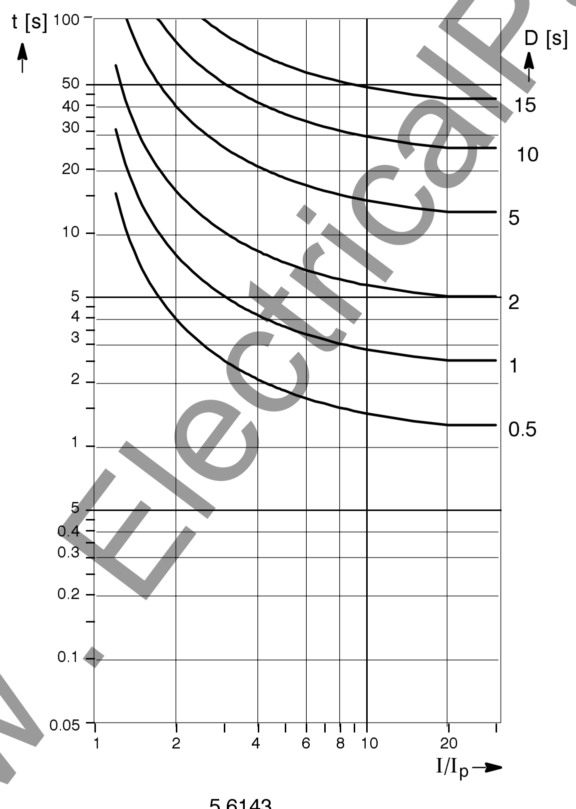
– Auxiliary voltage in range $0.8 \leq U_{aux}/U_{auxN} \leq 1.2$	$\leq$ 1 %
– Temperature in range $-5\ °C \leq \vartheta_{amb} \leq +40\ °C$ (23 °F to 104 °F)	$\leq$ 0.5 %/10 K
– Frequency in range $0.95 \leq f/f_N \leq 1.05$	$\leq$ 8 % referred to theoretical time value

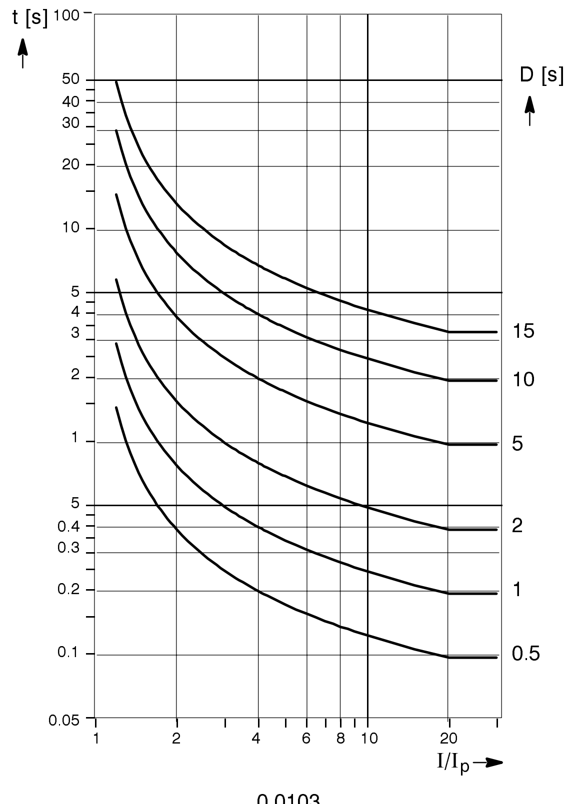




Inverse: $t = \left(\frac{8.9341}{(I/I_p)^{2.0938} - 1} + 0.17966 \right) \cdot D$ [s]

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

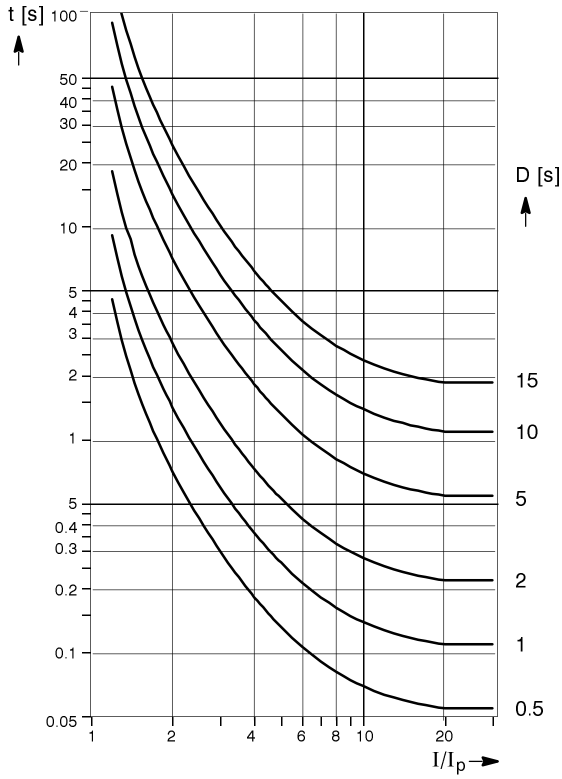




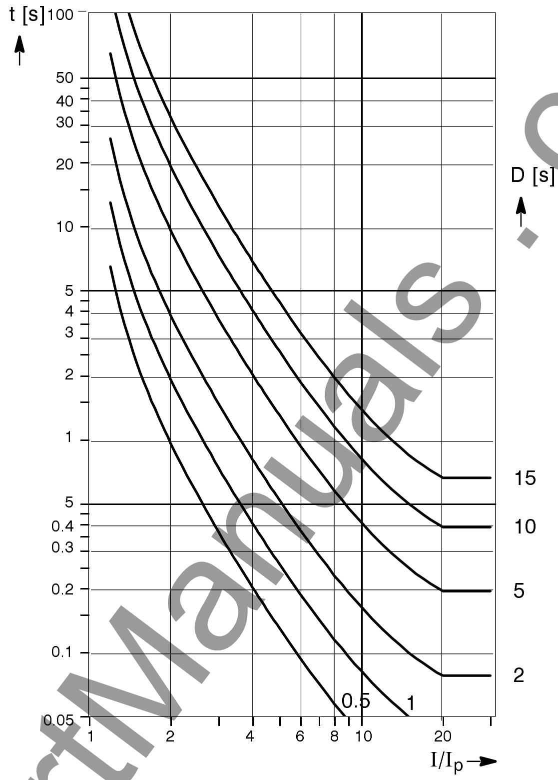
long inverse: $t = \left(\frac{5.6143}{(I/I_p) - 1} + 2.18592 \right) \cdot D$ [s]

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

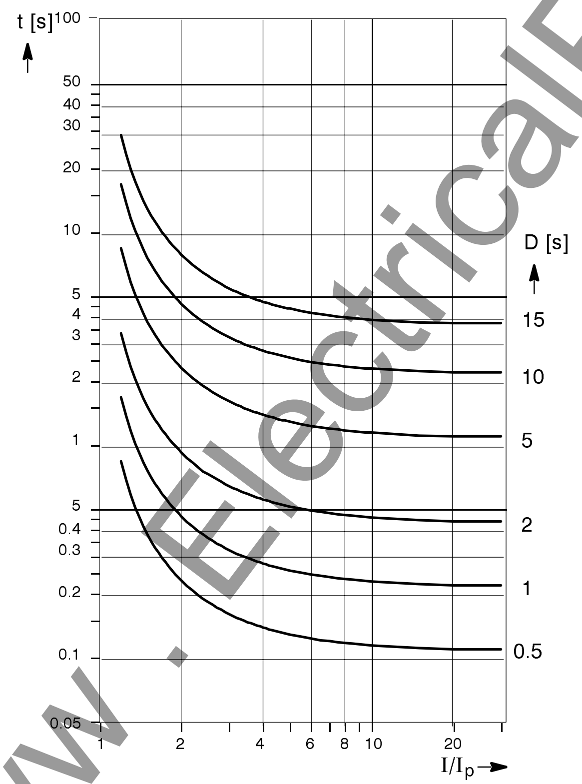
Figure 3.4 Trip time characteristic of inverse time overcurrent protection, according ANSI/IEEE



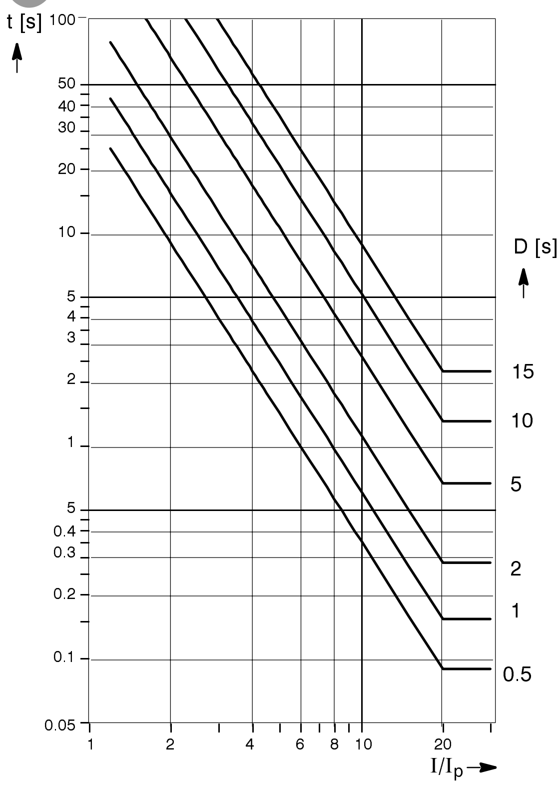
very inverse: $t = \left(\frac{3.922}{(I/I_p)^2 - 1} + 0.0982 \right) \cdot D$ [s]



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

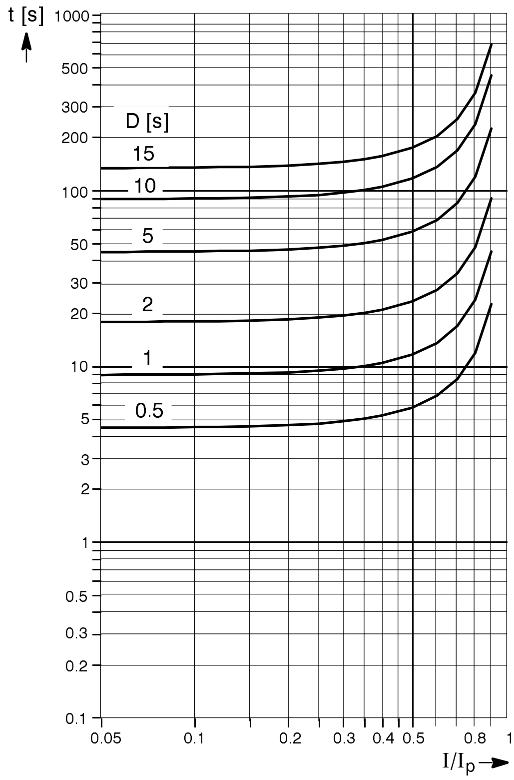


definite inverse: $t = \left(\frac{0.4797}{(I/I_p)^{1.5625} - 1} + 0.21359 \right) \cdot D$ [s]

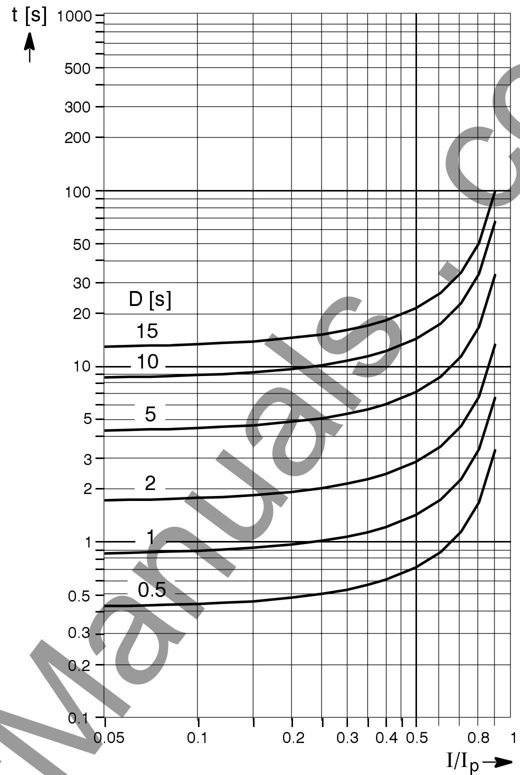


i–squared–t: $t = \frac{50.7 \cdot D + 10.14}{(I/I_p)^2}$ [s]

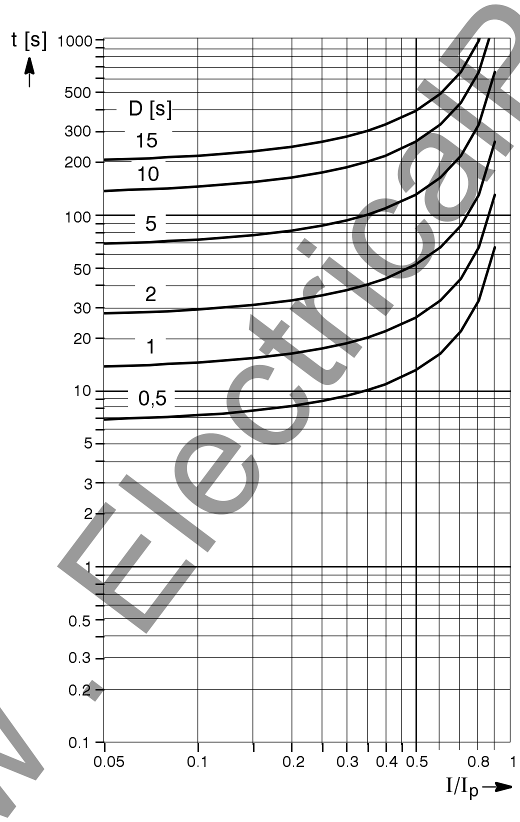
Figure 3.5 Trip time characteristic of inverse time overcurrent protection, according ANSI/IEEE



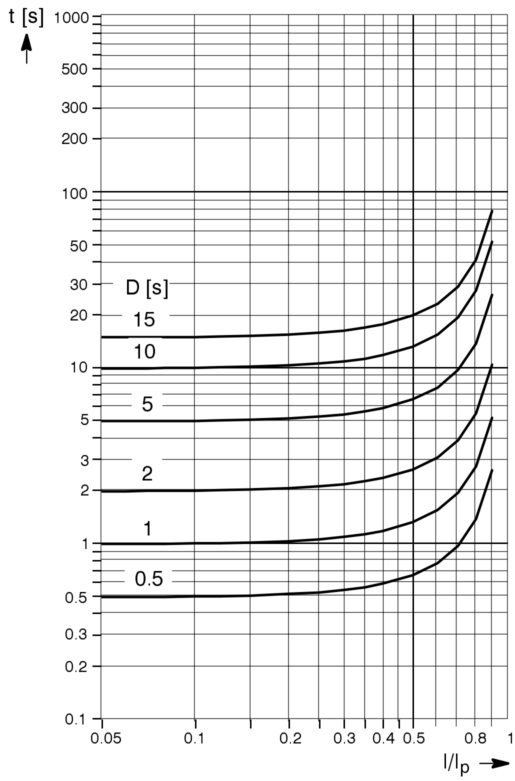
Inverse: $t_{Reset} = \frac{8.8}{1-(I/I_p)^{2.0938}} \cdot D$ [s]



Short inverse: $t_{Reset} = \frac{0.831}{1-(I/I_p)^{1.2969}} \cdot D$ [s]

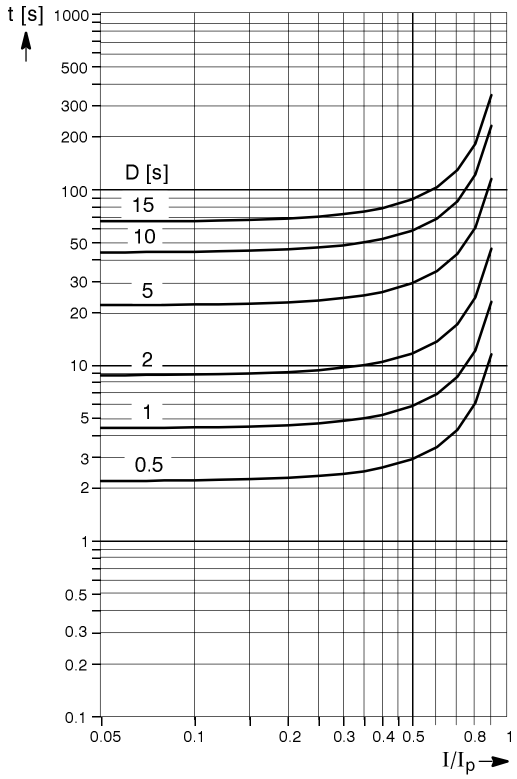


Long inverse: $t_{Reset} = \frac{12.9}{1-(I/I_p)^{1}} \cdot D$ [s]

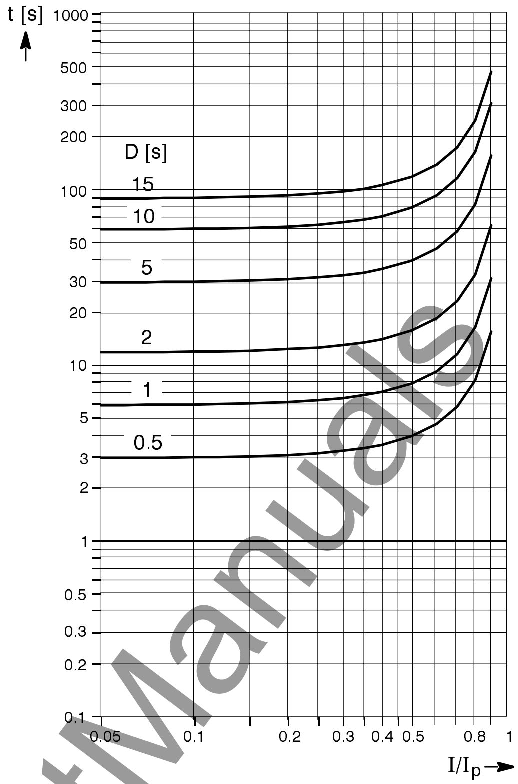


Moderately inverse: $t_{Reset} = \frac{0.97}{1-(I/I_p)^{2}} \cdot D$ [s]

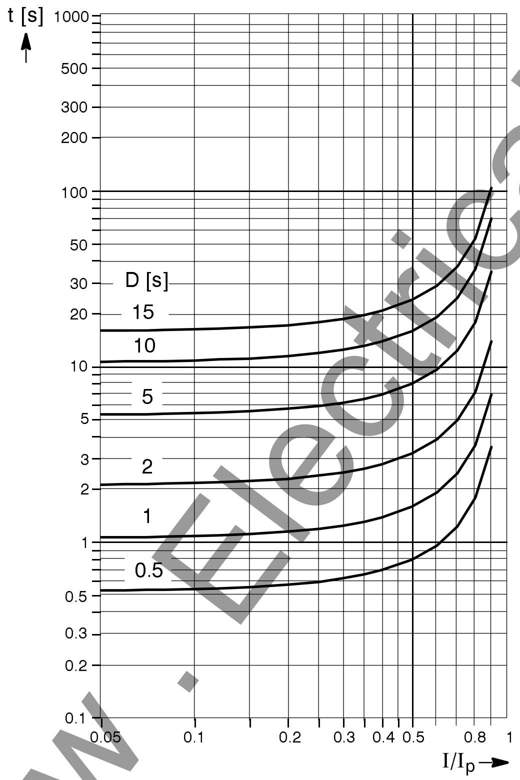
Figure 3.6 Reset time characteristic of inverse time overcurrent protection, according ANSI/IEEE, with disk emulation



Very inverse: $t_{Reset} = \frac{4.32}{1-(I/I_p)^2} \cdot D$ [s]



Extremely inverse: $t_{Reset} = \frac{5.82}{1-(I/I_p)^2} \cdot D$ [s]



Definite inverse: $t_{Reset} = \frac{1.03940}{1-(I/I_p)^{1.5625}} \cdot D$ [s]

t	Reset time
D	Set time multiplier
I	Interrupted current
I_p	Set pick-up current

Note: For earth faults read I_{Ep} or I_{EEp} instead of I_p and D_E or D_{IEEp} instead of D

Figure 3.7 Reset time characteristic of inverse time overcurrent protection, according ANSI/IEEE, with disk emulation

3.4 Sensitive earth fault protection

Earth current detection

High-stage earth current pick-up I_{EE}>>	$I_{EE}>>/I_{EEN}$	0.003 to 1.500 or ∞ (ineffective)	(steps 0.001)
Delay time	$T_{IEE>>}$	0.00 s to 60.00 s	(steps 0.01 s)
Earth current pick-up (definite time)	$I_{EE}>/I_{EEN}$	0.003 to 1.500 or ∞ (ineffective)	(steps 0.001)
Delay time for I_{EE}>> (definite time)		0.00 s to 60.00 s	(steps 0.01 s)
Measurement time (definite time)		approx. 60 ms approx. 100 ms	(non-directional) (directional)
Earth current pick-up I_{EEp} (inverse time)	I_{EEp}/I_{EEN}	0.003 to 1.400	(steps 0.001)
Time multiplier T_{IEEP} (inverse time acc. IEC)		0.05 s to 3.20 s	(steps 0.01 s)
Time dialer D_{IEEP} (inverse time acc. ANSI)		0.5 s to 15.0 s	(steps 0.01 s)
Characteristics (inverse time acc. IEC) see Section 3.3, Figures 3.1 and 3.2		normal inverse very inverse extremely inverse long time inverse RI or RD	
Characteristics (inverse time acc. ANSI) see Section 3.3, Figures 3.4 and 3.5		normal inverse short inverse long inverse moderately inverse very inverse extremely inverse definite inverse squared inverse	

Pick-up threshold of inverse time stages	IEC ANSI	approx. 1.1 · I_p approx. 1.06 · I_p
Drop-out threshold of inverse time stages	IEC ANSI	approx. 1.03 · I_p without disk emulation approx. 0.9 · I_p with disk emulation approx. 1.01 · I_p without disk emulation approx. 0.9 · I_p with disk emulation
Drop-out ratio of definite time stages		approx. 0.95 for $I/I_{EEN} \geq 0.5$
Drop-out time		approx. 30 ms or with disk-emulation: Figure 3.3 for IEC-curves Figures 3.6, 3.7 for ANSI-curves

Measuring tolerance according VDE 0435 part 303
– definite time — 5 % of set value or 5 % of rated value
– inverse time — pick-up at $1.05 \leq I/I_p \leq 1.15$

Time tolerances
– definite time — 1 % of set value or 10 ms
– inverse time within linear range — 5 % of theoretical value for $2 \leq I/I_{EEP} \leq 20$ ± 2 % current tolerance; at least 30 ms

Note: Due to the high sensitivity of this protection function, the measured current input has restricted linearity range of 0.003 I_{EEN} to 1.6 I_{EEN}. No time reduction according to the characteristics (Figures 3.1, 3.2, 3.4, and 3.5) are to be expected for currents above 1.6 I_{EEN} at this current input.

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

Displacement voltage detection

Displacement voltage	V_E>	$0.02 \cdot V_N$ to $1.05 \cdot V_N$	(steps $0.01 \cdot V_N$)
Measurement time		approx. 60 ms	
Pick-up delay	$T_{E/F}$	0.04 s to 320.00 s or ∞ (ineffective)	(steps 0.01 s)
Additional trip delay	$T_{Ve\ TRIP}$	0.10 s to 40000.00 s or ∞ (ineffective)	(steps 0.01 s)
Drop-off ratio		approx. 0.95	
Measuring tolerance according VDE 0435 part 303		5 % of set value or 5 % of V_N	
Time tolerances		1 % of set value or 10 ms	

The set times are pure delay times.

Direction determination

Measurement		with I_E (= $3 \cdot I_0$) and V_E	
Measuring principle		measurement of active and reactive power	
Measurement release (perpendicular (90°) to direction phasor)	$I_{EE\ DIREC}/I_{EEN}$	0.003 to 1.200	(steps 0.001)
Directional characteristic		$I_E \cdot \cos\varphi$ or $I_E \cdot \sin\varphi$, additional phase shifting ±45° possible	
CT angle error correction of summation c.t. (for compensated systems)		0.0° to 5.0° (steps 0.1°) for 2 operating points of the c.t. characteristic	
Measuring tolerance for $I_{EE\ DIREC}$		10 % of set value for I_E < 0.45 I_{EEN}	
Angle tolerance for direction characteristic		2° for I_E = 0.2 I_{EEN} to 1.2 I_{EEN} 7° for I_E < 0.2 I_{EEN}	

Note: Due to the high sensitivity of this protection function, the measured current input has restricted linearity range of 0.003 I_{EEN} to 1.6 I_{EEN}. No correct directional decision is ensured for currents above 1.6 I_{EEN} at this current input.

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	τ_{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_τ		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
τ_{th}	thermal time constant
I	load current
I_{pre}	preload current
k	factor according to IEC 60255−8
	refer also Figures 3.8 and 3.9

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

Reset ratios

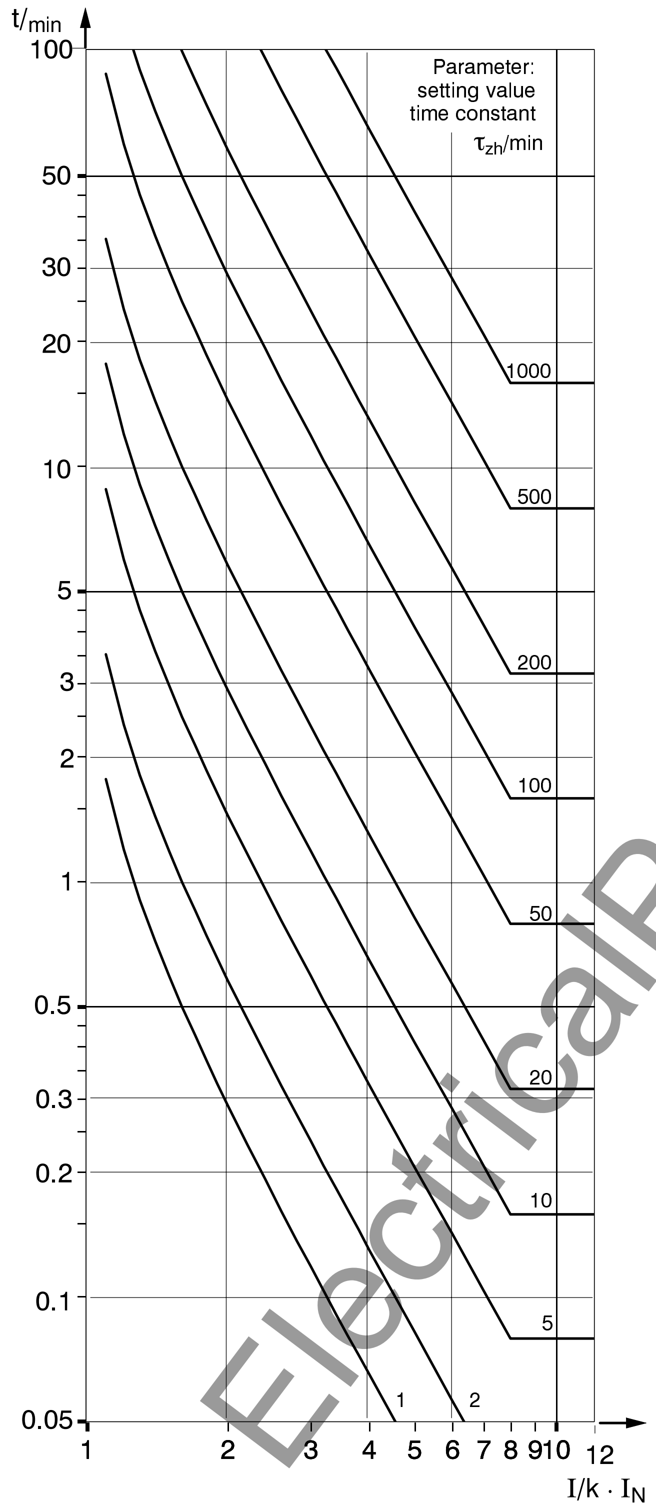
Θ / Θ_{trip}	reset below Θ_{warn}
Θ / Θ_{warn}	approx. 0.99

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

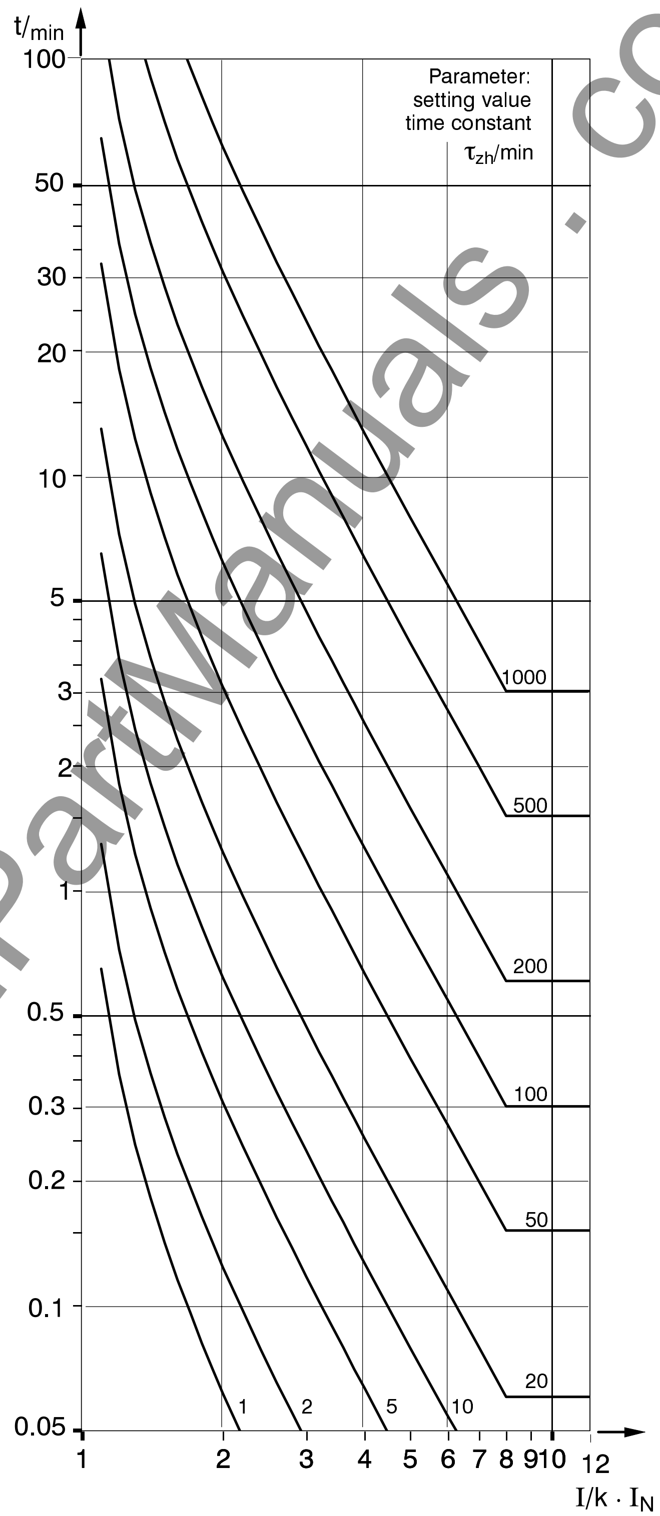
Influence variables referred to $k \cdot I_N$

− Auxiliary dc voltage in range $0.8 \leq U_{aux}/U_{auxN} \leq 1.2$	$\leq$ 1 %
− Temperature in range $-5\ °C \leq \vartheta_{amb} \leq +40\ °C$ (23 °F to 104 °F)	$\leq$ 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 3.8 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 3.9 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 3.10

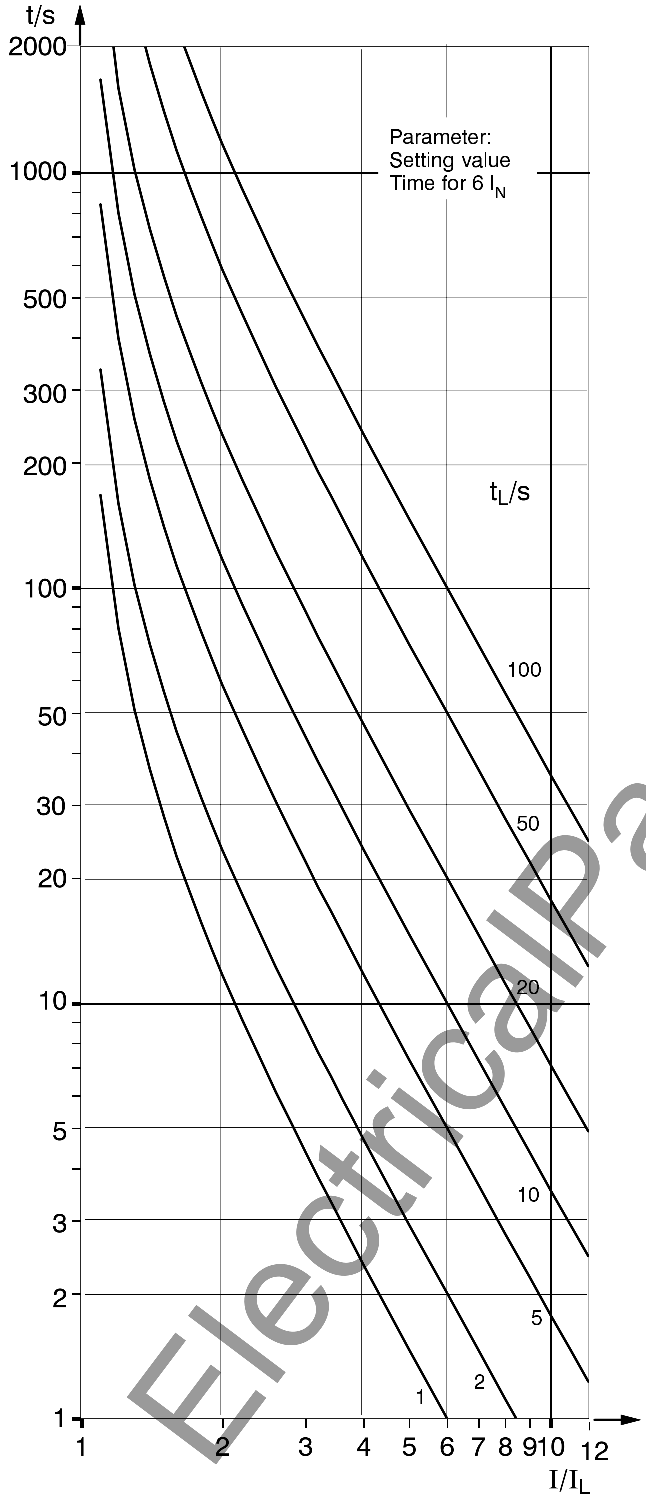
Reset ratio I/I_L approx. 0.94

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 $0.8 \leq U_{aux}/U_{auxN} \leq 1.2$ $\leq$ 1 %
– Temperature in range $-5\ °C \leq \vartheta_{amb} \leq +40\ °C$ (23 °F to 104 °F) $\leq$ 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 3.10 Trip time characteristic of overload protection – without memory –

3.6 Circuit breaker failure protection

Setting ranges/steps			
Pick-up value of current element	I/I_N	0.04 to 1.00	(steps 0.01)
Time stage	T_{BF}	0.06 s to 60.00 s or ∞ (ineffective)	(steps 0.01 s)
Times			
pick-up time – with internal start – with external start		 included in delay time approx. 40 ms	
Dropout time		approx. 40 ms	
Tolerances			
– Pick-up value		5 % of setting value	
– Delay time T		5 % of setting value or 30 ms	

3.7 Unbalanced load / negative sequence protection

Setting ranges/steps

Tripping stage I_2>	8 % to 80 % of I_N	(steps 1 %)
Tripping stage I_2>>	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 ≥ 0.1 · I_N

Pick-up times	at f_N = 50 Hz	at f_N = 60 Hz
– Tripping stage I_2>, tripping stage I_2>>	approx. 50 ms	approx. 45 ms
– but with currents I/I_N > 1.5 (overcurrent case) or neg. sequence current < (set value + 0.1 × I_N)	approx. 200 ms	approx. 180 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. 33 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 ≤ 1.5	5 % of rated value
	current I/I_N > 1.5	5 % of rated value
– stage delay times		± 1 % but min. 10 ms

Influence variables

– Auxiliary d.c. voltage in range 0.8 ≤ U_{aux}/U_{auxN} ≤ 1.2	≤ 1 %
– Temperature in range −5 °C ≤ ϑ_{amb} ≤ +40 °C (23 °F to 104 °F)	≤ 0.5 %/10 K
– Frequency in range 0.98 ≤ f/f_N ≤ 1.02	≤ 2 % of I_N
0.95 ≤ f/f_N ≤ 1.05	≤ 5 % of I_N

3.8 Auto-reclosure

Number of possible shots	1 up to 9	
Auto-reclose mode	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)

3.9 Start-up time monitoring for motors

Setting ranges/steps

Start-up current ref. to nominal motor current	Istrt/Im	0.4 to 20.0	(steps 0.1)
Ratio rated motor current/rated c.t. current	Im/I_N	0.2 to 1.2	(steps 0.1)
Pickup threshold/nominal motor current	Istrt>/Im	0.4 to 20.0	(steps 0.1)
Permissible start-up time	TStUp	1.0 s to 360.0 s	(steps 0.1 s)

Tripping characteristic

$$t = \left(\frac{Istrt}{Irms}\right)^2 \cdot tStUp \quad \text{for } Irms > Istrt>$$

with Istrt> = pickup threshold

Reset ratio Irms/Istrt approx 0.94

Tolerances

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

3.10 Restart inhibit for motors

Setting ranges/steps			
Start-up current ref. to nominal motor current	Istrt/Im	0.4 to 20.0	(steps 0.1)
Ratio rated motor current/rated c.t. current	Im/I_N	0.2 to 1.2	(steps 0.1)
Max permissible start-up time	tStUp	1.0 s to 360.0 s	(steps 0,1 s)
Time of thermal equilibrium of the rotor	T_{equal}	0.0 min to 60.0 min	(steps 0.1 min)
Max. permissible number of hot starts	n_w	1 to 4	(steps 1)
Difference between cold starts and hot starts	$n_c - n_w$	1 to 2	(steps 1)
Cooling-down factor during operation	$k\tau 2$	1.0 to 10.0	(steps 1)
Cooling-down factor at rotor stand-still	$k\tau$	1.0 to 10.0	(steps 1)
Minimum lockout time	T_{MotBl}	0.2 min to 120.0 min	(steps 0.1 min)

3.11 Undercurrent monitoring for motors

Setting ranges/steps			
Undercurrent pick-up	IL<	0.10 to $4.00 \cdot I_N$	(steps 0.01)
Delay time	$T_{IL<}$	0.0 s to 320.0 s	(steps 0.01 s)
Pick-up time		approx 40 ms	
Reset time		approx 60 ms	
Reset ratio		approx 1.05 or + 0.01 I_N	
Tolerances			
– Pick-up value $I_L<$		5 % of setting value	
– Delay time $T_{IL<}$		5 % of setting value or 30 ms	

3.12 Temperature detection via RTD-box

Temperature detectors	
Number of temperature detectors (RTD)	max. 6
RTD type	Pt 100 Ω or Ni 100 Ω or Ni 120 Ω
Annunciation thresholds	
For each measuring point:	
Warning temperature (stage 1)	−50 °C to 250 °C (steps 1 °C) −58 °F to 482 °F (steps 1 °F) or ∞ (no warning)
Alarm temperature (stage 2)	−50 °C to 250 °C (steps 1 °C) −58 °F to 482 °F (steps 1 °F) or ∞ (no alarm)

3.13 Ancillary functions

Operational value measurements

Notes:
Indication of voltage, power and energy values presumes connection of a measured voltage to the relay. Power and energy values are valid for symmetrical voltage conditions.

– Operational current values	I_{L1}; I_{L2}; I_{L3} in kA/A primary and % of I_N
measurement range	0 % to 240 % I_N
tolerance	3 % of measured value or of rated value
– Earth current at the high-sensitivity input	I_{EE} in kA/A primary and % of I_{EEN}
measurement range	0 % to 160 %
tolerance	3 % of measured value or of rated value
– Operational voltage line-earth	U_{L1-E} in kV primary and % of $U_N/\sqrt{3}$
measurement range	10 % to 120 % U_N
tolerance	3 % of measured value or of rated value for $U < U_N$
– Displacement voltage	U_E in kV primary and % of U_N
measurement range	2 % to 120 % U_N
tolerance	3 % of measured value or of rated value for $U < U_N$
– Operational apparent power	S in kVA/MVA/GVA primary and % of S_N
measurement range	0 % to 120 % S_N
tolerance	6 % of S_N for U/U_N and I/I_N = 0.5 to 1.2
– Operational active power	P in kW/MW/GW primary and % of S_N
measurement range	0 % to ±120 % S_N
tolerance	6 % of S_N for U/U_N and I/I_N = 0.5 to 1.2 and cos $\varphi > 0.707$
– Operational reactive power	Q in kvar/Mvar/Gvar primary and % of S_N
measurement range	0 % to ±120 % S_N
tolerance	6 % of S_N for U/U_N and I/I_N = 0.5 to 1.2 and cos $\varphi < 0.707$
– Operational power factor	cos φ
measurement range	0.000 to ±1.000
tolerance	6 % for U/U_N and I/I_N = 0.5 to 1.2 and cos $\varphi > 0.707$
– Metered value active energy	W_p in kWh/MWh/GWh
energy range (separate for both directions)	0 to ±999999 kWh/MWh/GWh
tolerance	8 % for U/U_N and I/I_N = 0.5 to 1.2 and cos $\varphi > 0.707$
– Metered value reactive energy	W_q in kvarh/Mvarh/Gvarh
energy range (separate for both directions)	0 to ±999999 kvarh/Mvarh/Gvarh
tolerance	8 % for U/U_N and I/I_N = 0.5 to 1.2 and cos $\varphi < 0.707$
– Thermal overload values	
calculated temperature rises	Θ/Θ_{trip}
measurement range	0 % to 300 %
tolerance	5 % referred to Θ_{trip}

– Long term mean values (demand values)

currents	I_{L1dmd}; I_{L2dmd}; I_{L3dmd}
powers	S_{dmd}; P_{dmd}; Q_{dmd}
ranges and tolerances as the corresponding measured values	
time interval	adjustable: 15 min; 30 min; 60 min

– Min/Max value log

currents	I_{L1}; I_{L2}; I_{L3}
voltages	U_{L-E}; U_E
powers	S; P; Q
power factor	cos φ
demand values	I_{L1dmd}; I_{L2dmd}; I_{L3dmd}; S_{dmd}; P_{dmd}; Q_{dmd}
ranges and tolerances as the corresponding measured values	

Display difference ±1 digit is possible in addition to the stated tolerances.

Fault event data log

Storage of annunciations of the last eight faults

Time tagging

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

Total storage time (fault detection or trip command = 0 ms)
total 5 s
incl. 3 s power-fail safe
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
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
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 multi-function time overcurrent protection SIPROTEC 7SJ602 is equipped with a powerful and proven 16-bit micro-controller. 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 MI 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 AI.

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

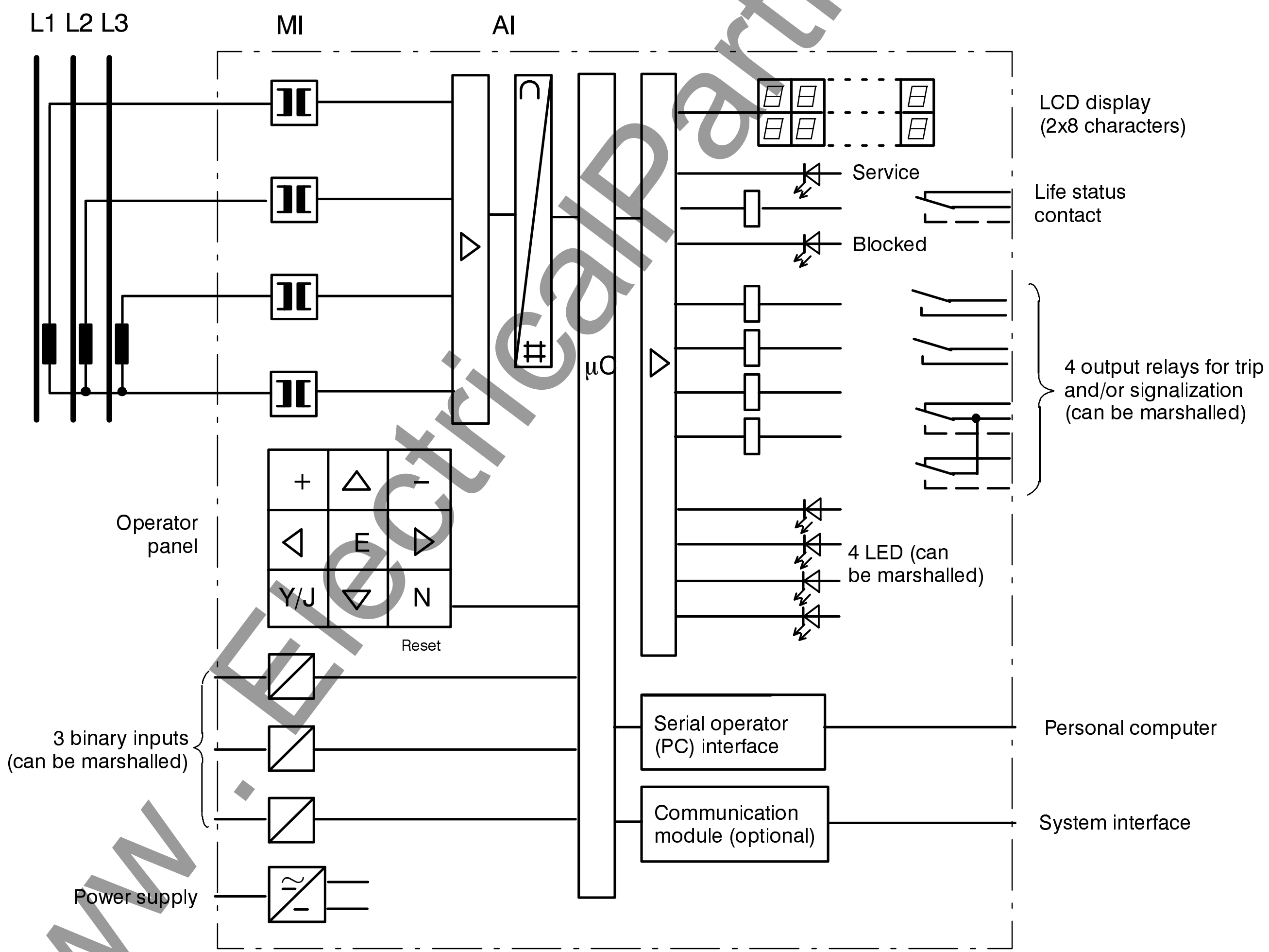


Figure 4.1 Hardware-structure of time overcurrent protection relay 7SJ602 (example with 4 current inputs)

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 LC 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 (see Section 3.1.1) 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. A number of standardized inverse time characteristics according to IEC 60255–3 and others as well as 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 3.7, 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 of 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. For the earth current input, either the residual current of the phase current transformers can be used, or a separate summation current transformer can be connected.

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

4.2.2 Definite time overcurrent protection 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. A highly sensitive earth fault protection can be provided instead of these earth current stages, refer to Section 4.3.

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.

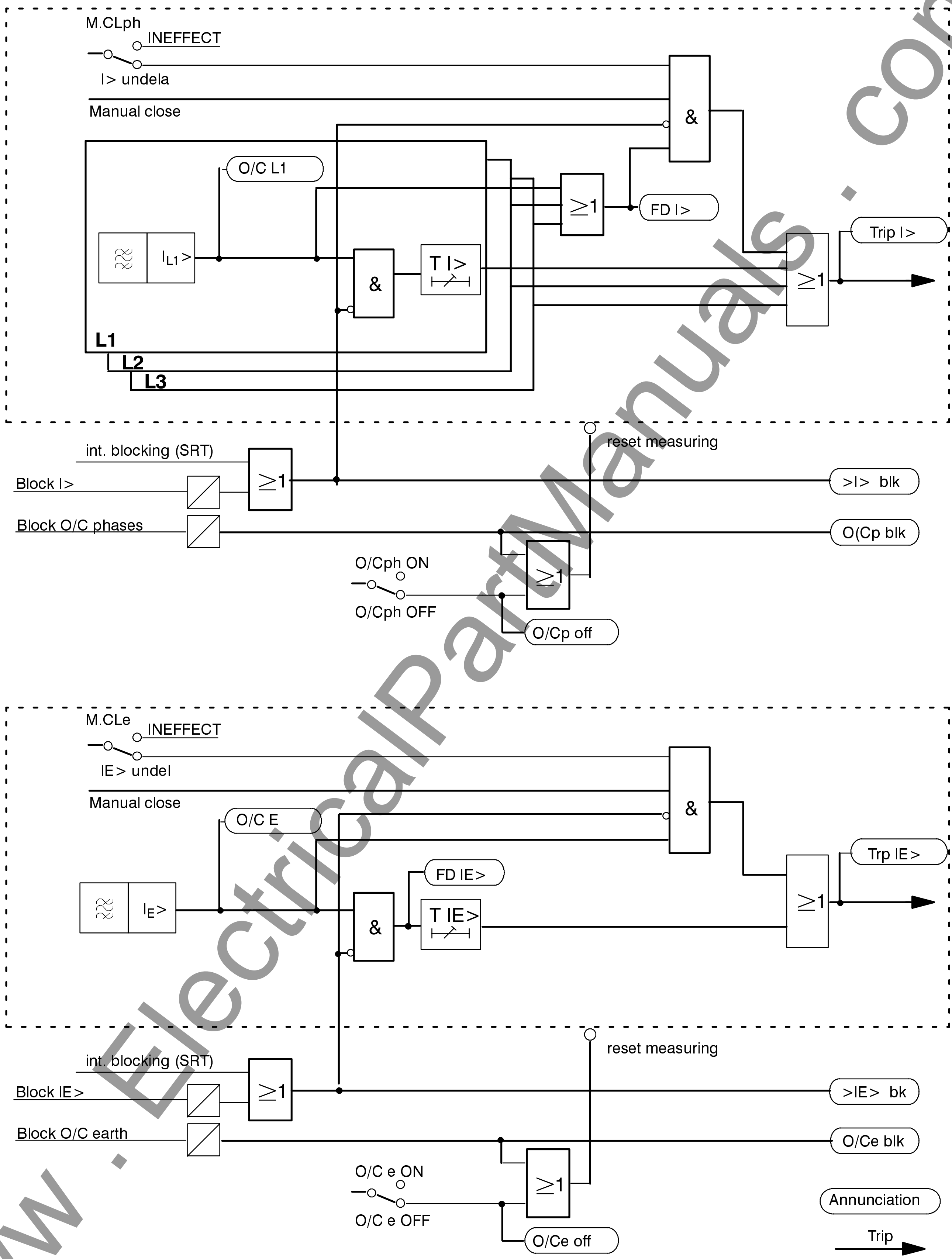


Figure 4.2 Simplified logic diagram of the definite time overcurrent stages I> (phase currents) and I_E> (earth current with normal sensitivity)

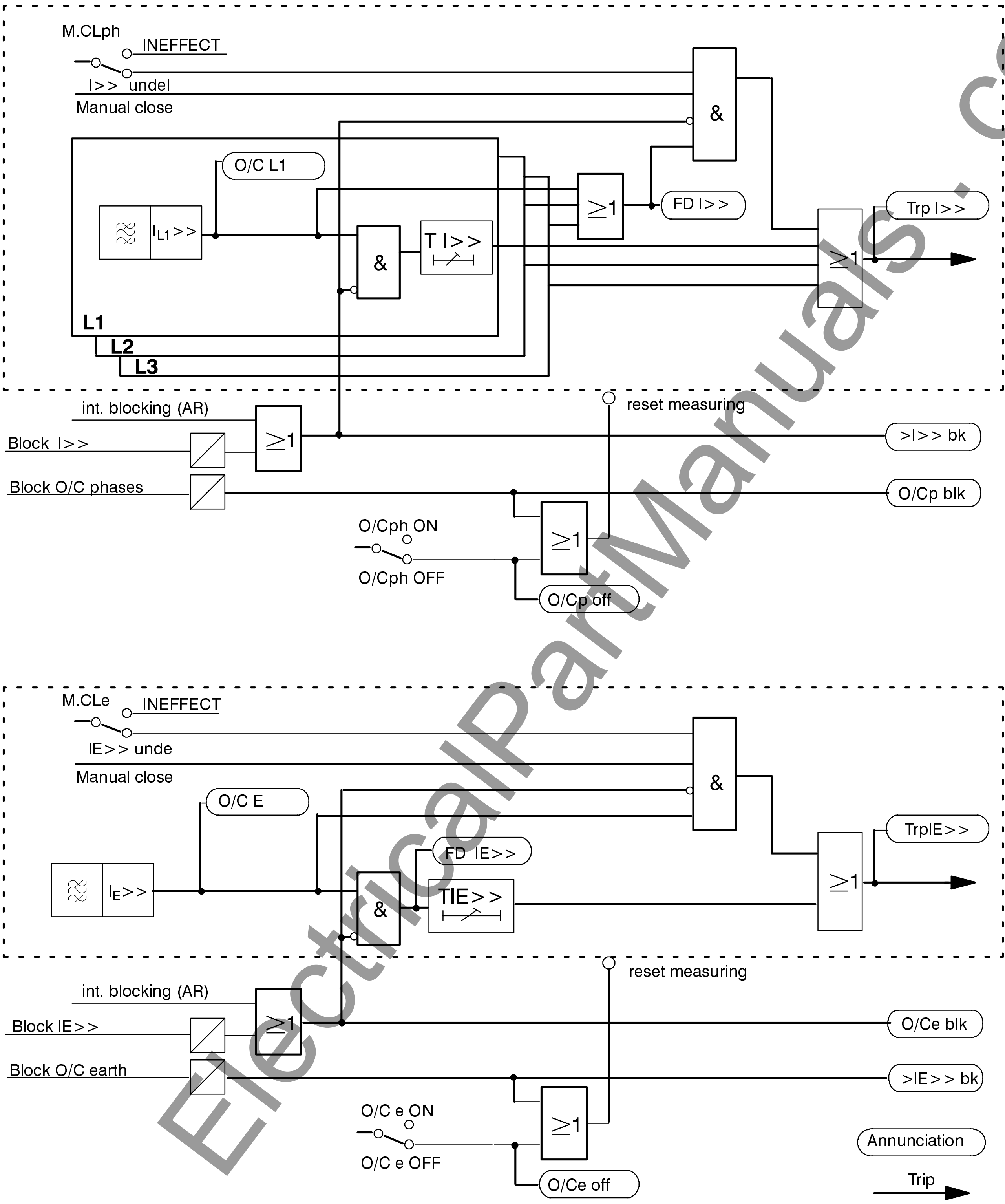


Figure 4.3 Simplified logic diagram of the definite time high-set stages I>> (phase currents) and I_E>> (earth current with normal sensitivity)

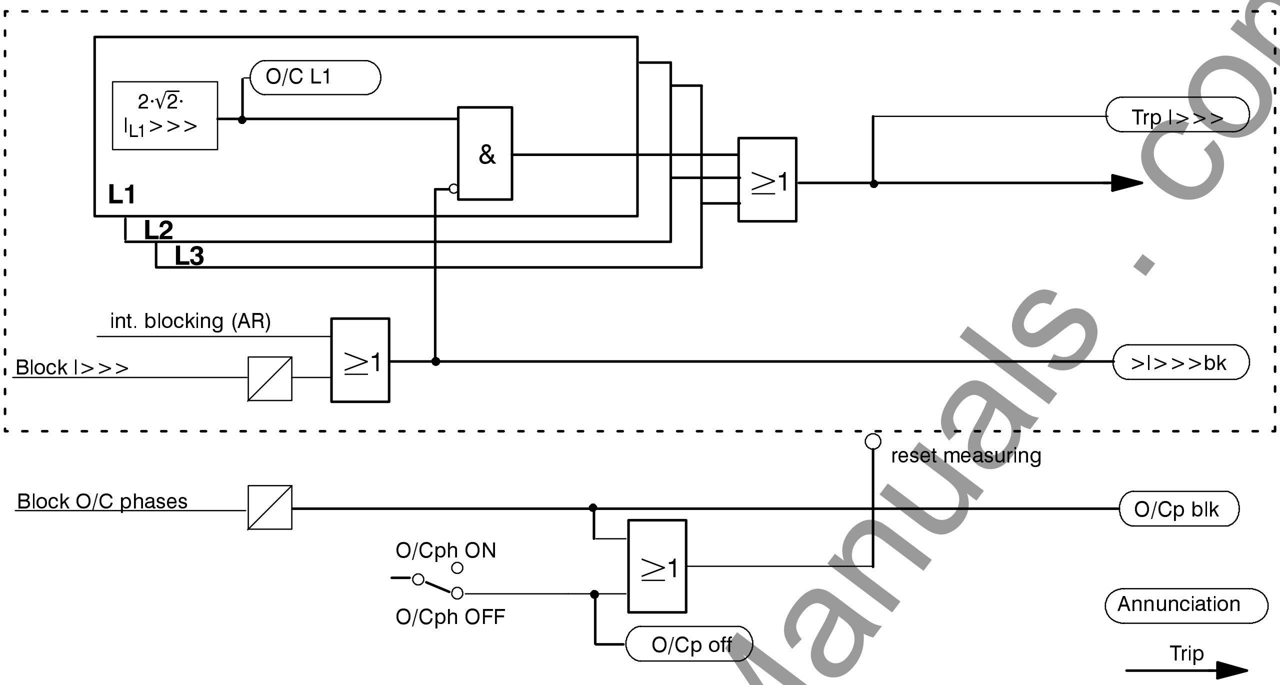


Figure 4.4 Simplified logic diagram of the high-speed stages I>>> (only phase currents)

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 (separate setting).

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.

You can determine for the standardized IEC- and ANSI-characteristics whether the dropout of a stage is to follow right after the threshold undershot or whether it is evoked by disk emulation (not for RI-/RD-curves and I^2t). “Right after” means that the pickup drops out when the pickup value of approx. 95 % is undershot. For a new pick-up the time counter starts at zero.

The disk emulation evokes a dropout process (time counter is decrementing) which begins after de-energization. This process corresponds to the back turn of a Ferraris-disk (explaining its denomination “disk emulation”). In case several faults occur successively, it is ensured that due to the inertia of the Ferraris-disk the “history” is taken into consideration and the time behaviour is adapted. As soon as 90 % of the setting value is undershot, the pickup signal disappears and the reset process begins in correspondence to the dropout curve of the characteristic. Within the range of the pickup value and 90 % of the setting value, the incrementing and the decrementing processes are in idle state. If 5 % of the setting value is undershot, the dropout process is being finished, i.e. when a new pickup is evoked, the timer starts again at zero.

The disk emulation offers its advantages when the grading coordination chart of the time overcurrent protection is combined with other devices (on electro-mechanical or induction base) connected to the system.

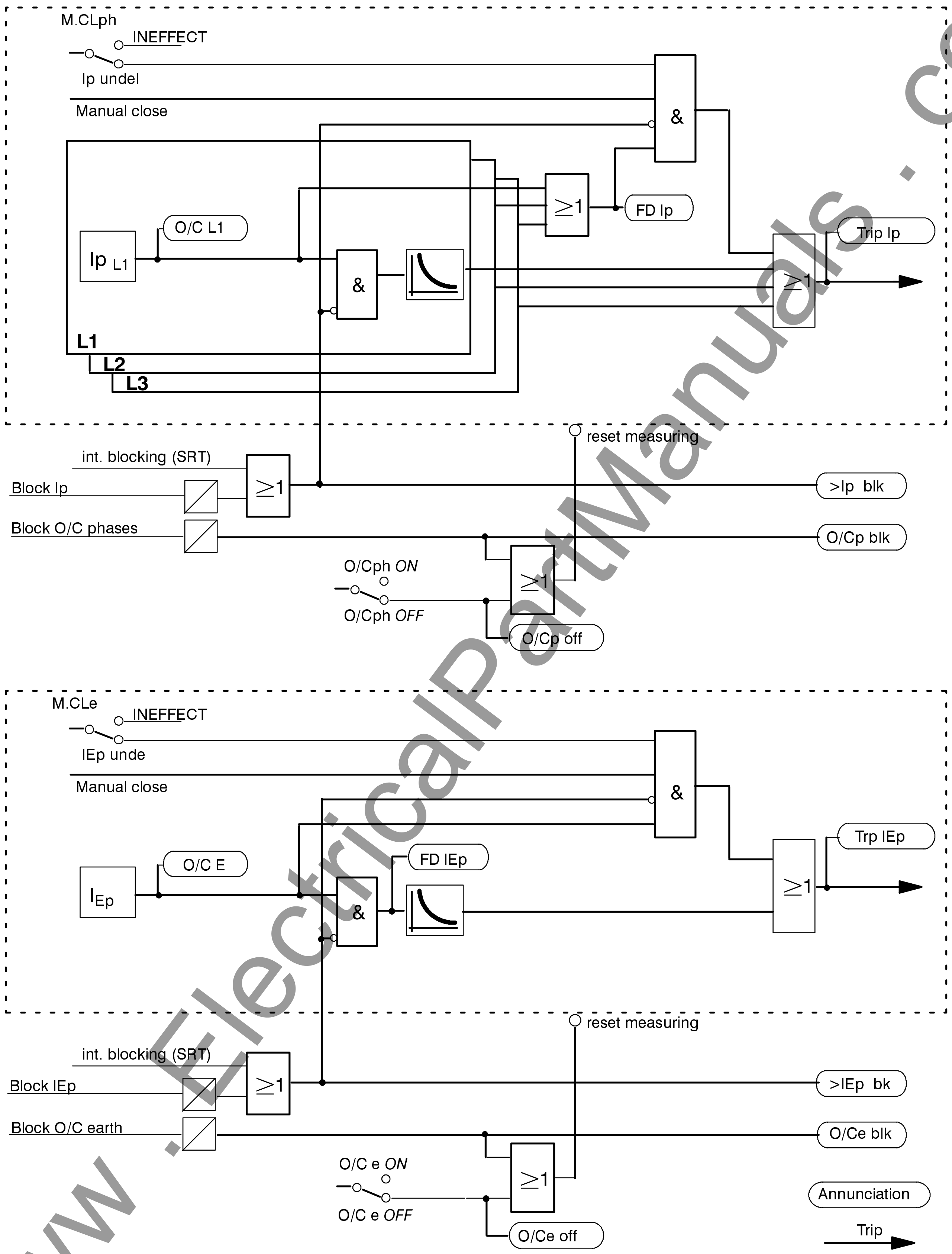
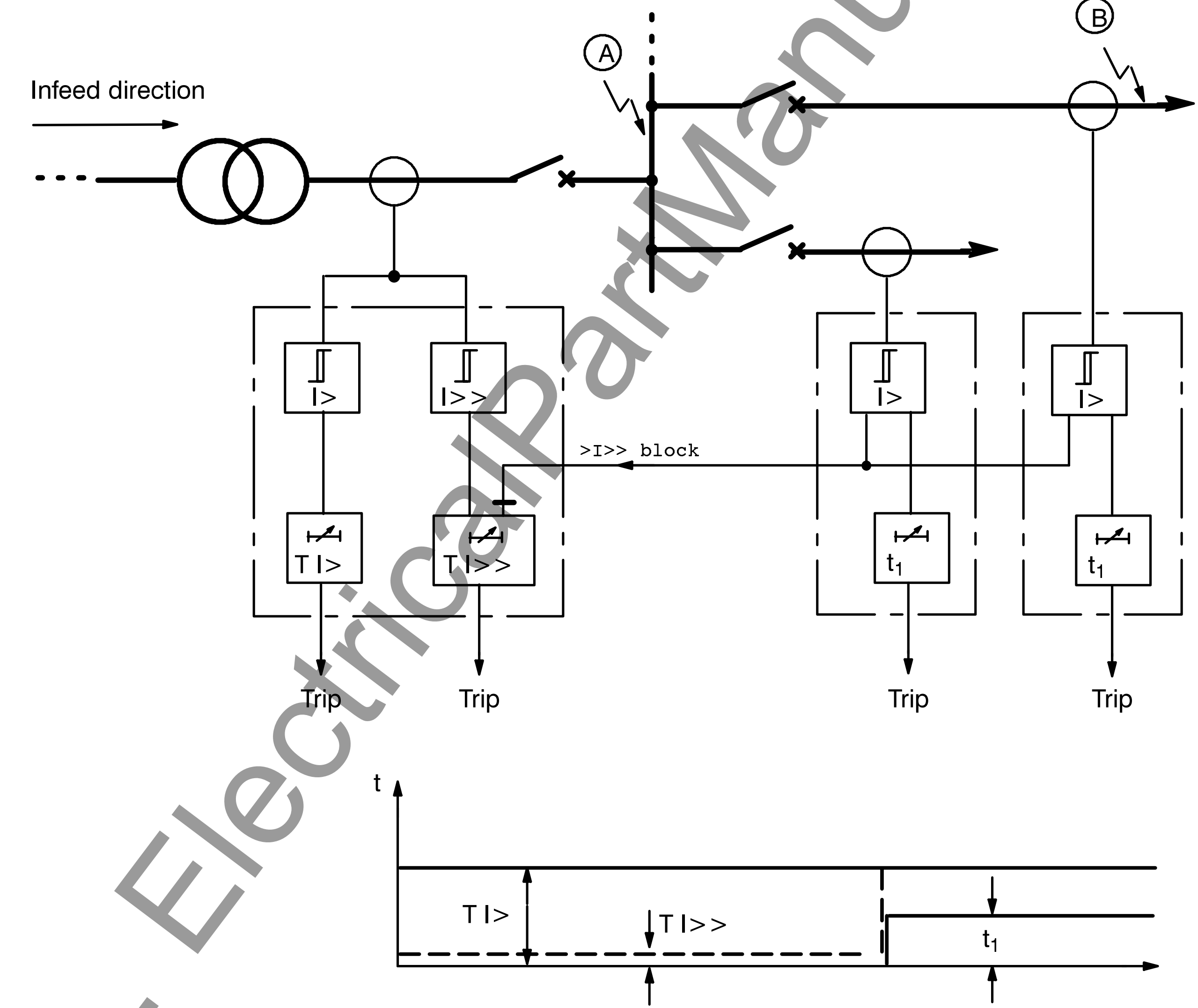


Figure 4.5 Simplified logic diagram of the inverse time overcurrent protection stages I_p (phase currents) and I_{Ep} (earth current with normal sensitivity)

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 Sensitive earth fault protection

The sensitive earth fault protection is only possible in the device versions with accordingly sensitive measured current input (7SJ602**2**–... or 7SJ602**6**–...). It replaces then the “normal” time overcurrent protection for earth current as described in Section 4.2.

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

Because of its sensitivity it is not suited for detection of higher earth fault currents (from $1.6 \cdot I_N$ and above at the relay terminals for high-sensitivity earth fault protection). For those applications use the time overcurrent protection for earth currents as described in Section 4.2.

4.3.1 Sensitive earth current stages

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

In order to detect earth currents, a two-stage current time characteristic can be set. Each stage can operate directional (7SJ602*–*****–**B*) or non-directional (7SJ602*–*****–**B* or **J*).

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

The low-value stage can operate with a definite time lag or inverse time lag characteristic. For inverse time, a choice can be made between one of the predefined characteristics (refer to Figures 3.1 to 3.7 under Technical data).

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

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

The function of the sensitive earth fault protection is, in principle, the same as that of the time overcurrent protection for earth current (Section 4.2) but without a special manual-close stage. The device provides, in this version, a special measured current input that allows for processing of earth current in from 3 mA and higher.

4.3.2 Displacement voltage stage

In devices with input for the displacement voltage, this voltage V_E is one condition for release of direction determination according to Section 4.3.3. In this aspect, V_E is the voltage fed to the corresponding device input. Normally, the transformation ratio of the voltage transformers is

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

If the device is connected to the open-delta voltage windings of a voltage transformer set, the following applies:

$$V_E = (V_{L1} + V_{L2} + V_{L3}) / \sqrt{3}.$$

With an earth fault in an isolated system, the displacement voltage amounts to the magnitude of the (healthy) phase-to-phase-voltage, i.e. $1 \cdot V_N$ at rated system voltage. In an earthed system, the magnitude depends on the earth point conditions and the feeding locations.

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

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

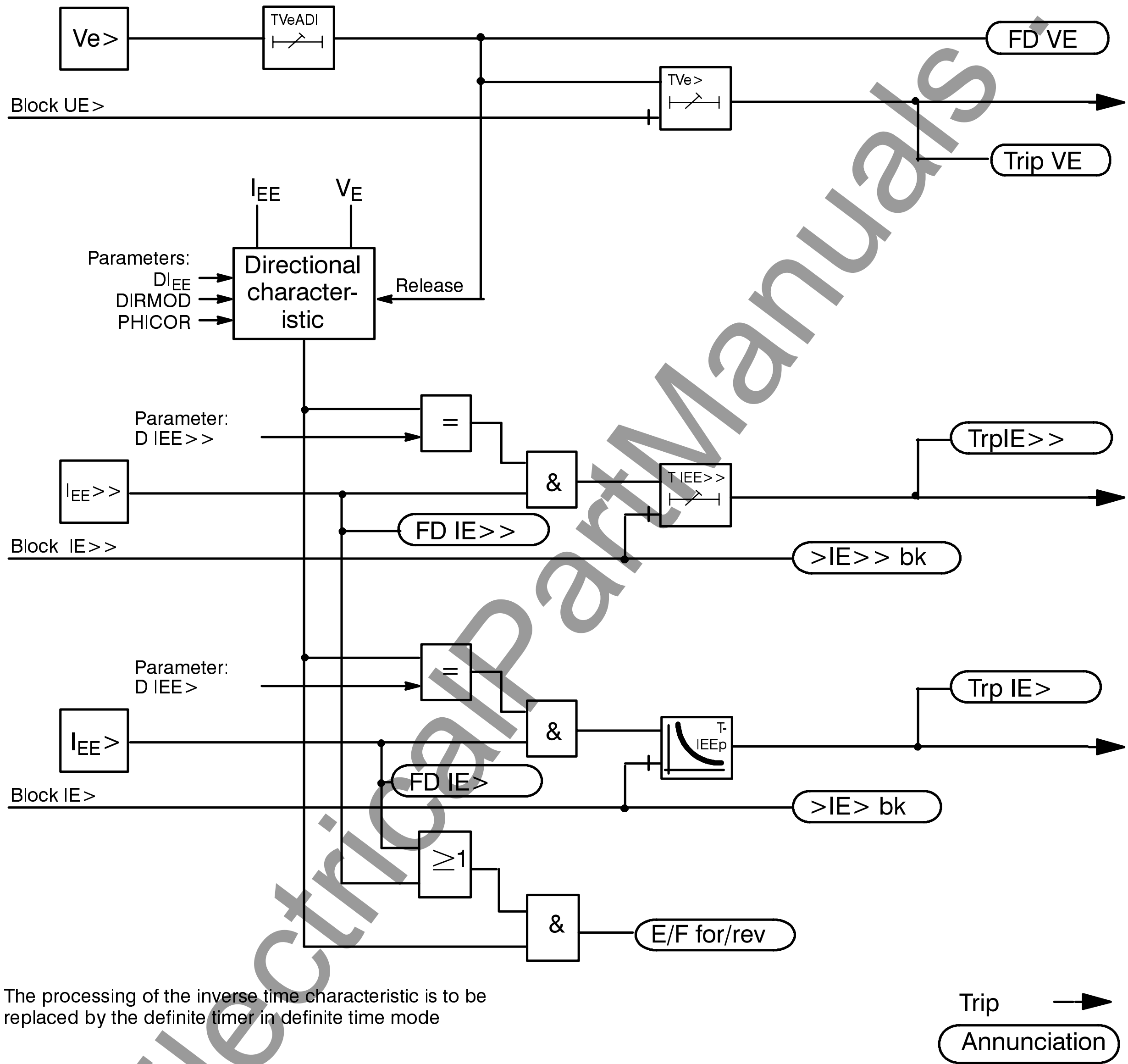


Figure 4.7 Simplified logic diagram of the highly sensitive directional earth fault protection – illustrated with inverse time characteristic according to IEC for the low-value stage

4.3.3 Sensitive direction discrimination

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

Figure 4.8 shows an example in the complex phasor diagram, in which V_E forms the real axis. In this example, the active component I_{Ea} of the earth current $\underline{I}_E$, related to the displacement voltage V_E, is decisive and is compared with the set threshold value I_{EEdir}. Thus, this example is valid for directional earth fault determination in an compensated system, where the quantity $I_E \cdot \cos\varphi$ is the determining factor. The symmetry axis is identical with the I_{Ea} axis. The current magnitude threshold appears as a circle (dotted circle IEE> in the figure).

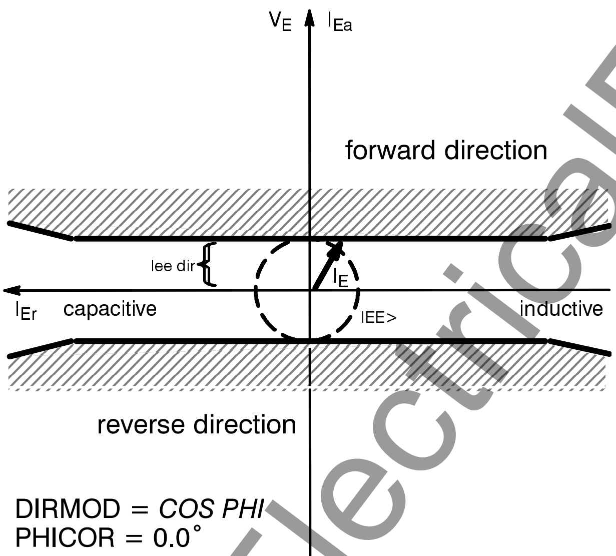


Figure 4.8 Directional characteristic with cos φ measurement

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

The symmetry axis can also be set in the direction of the reactive current component. Thus, the component $I_E \cdot \sin\varphi$ is decisive. This enables to detect earth faults and their direction in isolated systems.

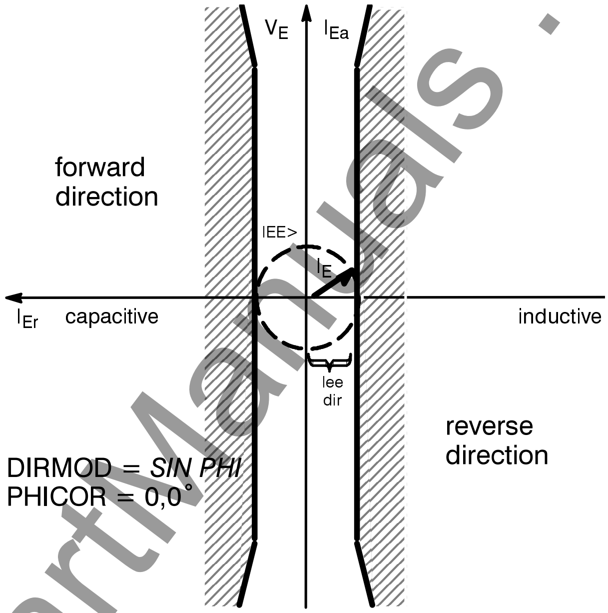


Figure 4.9 Directional characteristic with sin φ measurement

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

Active power:

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

Reactive power:

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

where T equals period of integration.

The use of an efficient calculation algorithm and simultaneous numerical filtering allows the directional determination to be achieved with high accuracy and sharply defined threshold limits (see Figure 4.10) and insensitivity to harmonic influences – particularly the frequently strong third and fifth harmonics which occur particularly in earth fault currents. The directional decision results from the signs of active and reactive power.

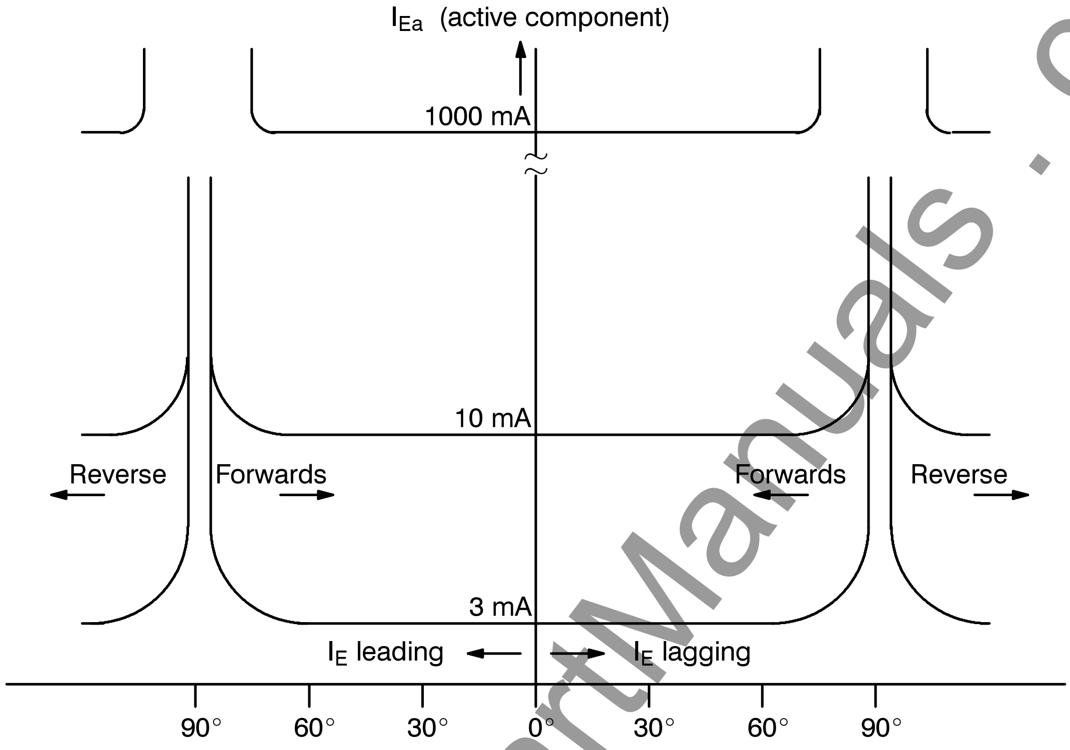


Figure 4.10 Directional earth fault measurement characteristic – example I · cos φ

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

With cos φ measurement (for compensated systems):

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

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

With sin φ measurement (for isolated systems):

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

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

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

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

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

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

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

Further explanation concerning the characteristic and symmetry axis are given in the setting hints in Section 6.3.6.

4.3.4 Earth fault location

By means of the directional indication of the network, the earth-faulted line can often be located. In isolated radial networks, location of the faulted line is relatively simple. Since all circuits on a busbar (Figure 4.11) carry a capacitive partial current, the measuring point on the faulted line in an isolated network sees almost the entire prospective earth fault current of the network; in compensated networks the wattmetric residual current from the Petersen coil flows through the measuring point. For the faulted line or cable, a definite “forwards” decision will result, whilst in the remaining circuits a “reverse” indication will be given unless the earth current is so small that no measurement can be taken. In any case the faulted cable can be clearly determined.

In meshed or ring networks the measuring points at the ends of the faulted cable equally see a maximum of earth fault (capacitive or ohmic) current. Only in this cable will the direction “forwards” be indicated on both line ends (Figure 4.12). Even the remaining directional indications in the network can aid location of the earth fault. But under certain circumstances one or more indications may not be given due to insufficient earth current.

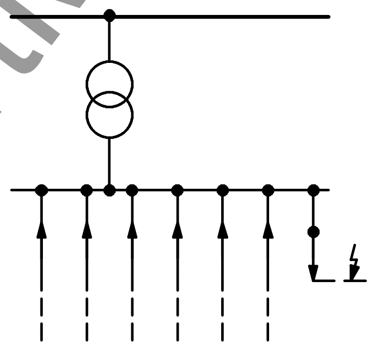


Figure 4.11 Faulted line location in radial network

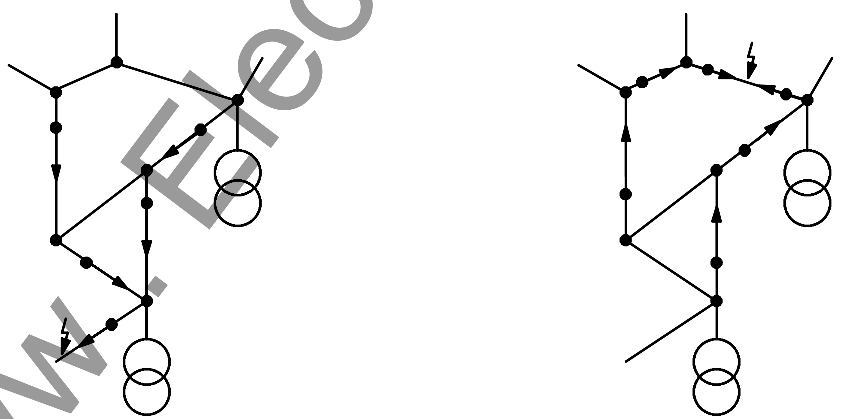


Figure 4.12 Location of earth fault based on the directional indicators in a meshed network

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

τ_{th} – thermal time constant for heating-up of the protected object

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

When the temperature rise reaches 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 τ_{th} as well as the alarm temperature Θ_{warn} must be entered into the protection unit.

The tripping time is derived from the actually flowing current and the pre-load condition according to the formula in Section 3.5.1.

When the warning threshold Θ_{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

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

τ_{th} – thermal time constant for heating-up of the protected object

I – actual current (r.m.s. value) referred to 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 an adjustable current.

$$t_{close} = k_\tau \cdot \tau_{th} \cdot ln \frac{\Theta}{\Theta_{warn}}$$

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

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

k_τ – prolongation factor for cooling down

Θ – actual temperature rise referred to the final temperature rise

Θ_{warn} – set warning temperature rise

7SJ602 allows to include the ambient or cooling medium temperature from an external RTD-box via the serial system interface (order option). In this way, the thermal overload protection is able to calculate not only the temperature rise but also the total temperature in the protected object. Thus, it is taken into account that the permissible thermal current through the protected object depends on the ambient temperature: With decreased ambient temperature, the protected object can carry a higher current than with a higher ambient temperature.

The ambient or cooling medium temperature is considered in the thermal differential equation by an additional term:

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

where Θ_{amb} – ambient or cooling medium temperature at the measuring point of RTD, referred to the temperature at rated current of the protected object I_N

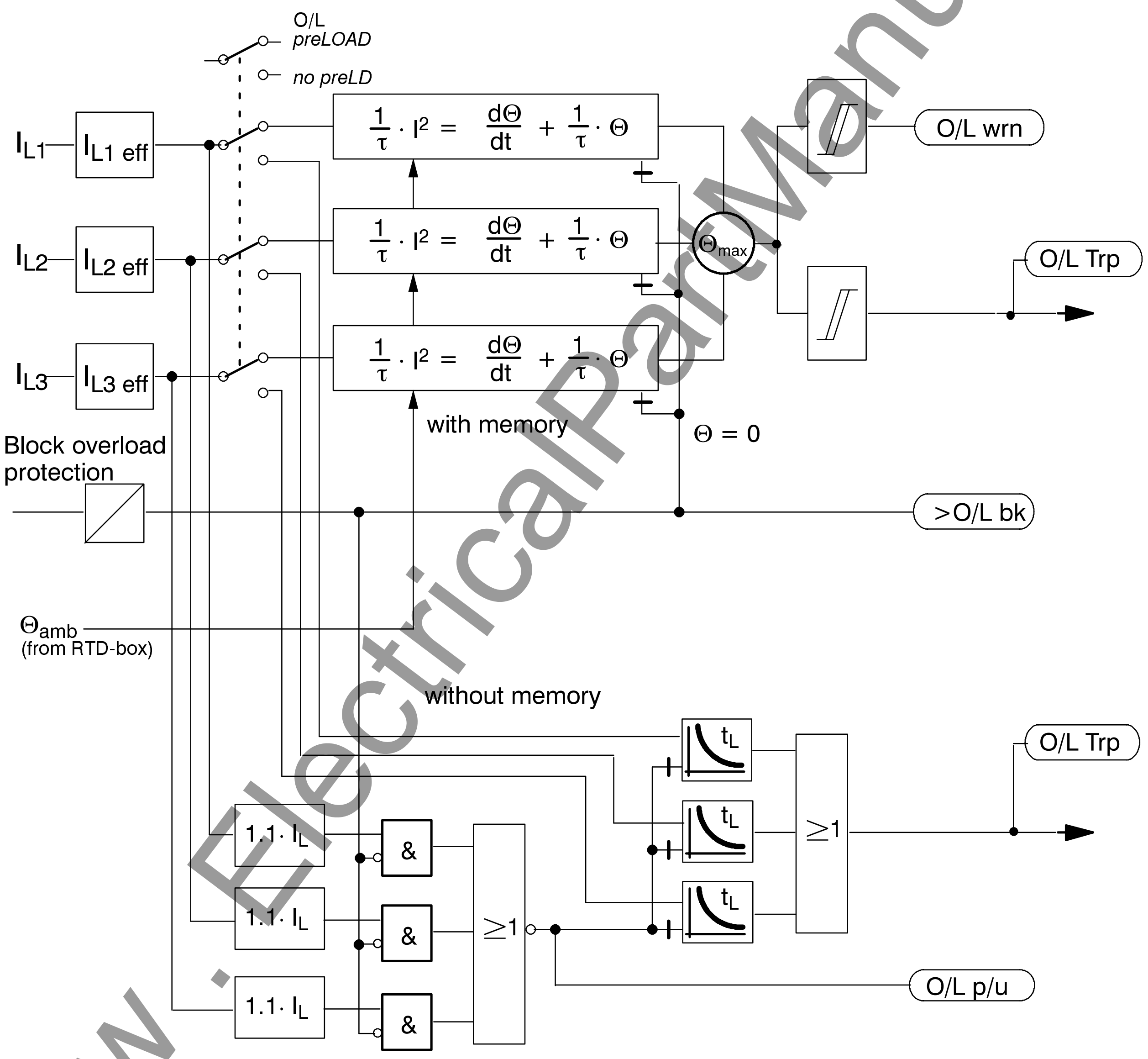


Figure 4.13 Simplified logic diagram of overload protection

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 (t_6-time = 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 4.13 shows the logic diagram of the overload protection with and without memory.

4.5 Circuit breaker failure protection

The circuit breaker failure feature provides rapid back-up clearance of fault, in the event that the local circuit breaker fails to respond to a trip command from a feeder protection function.

Whenever a protection function issues a trip command to the breaker, a timer T–B/F, in the breaker failure protection, is started. The timer runs as long as a tripping command is present and current continues to flow through the breaker poles (Figure 4.14).

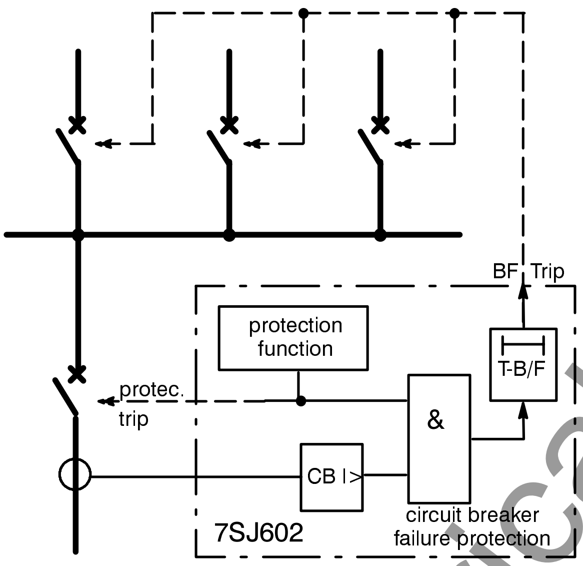


Figure 4.14 Simplified function scheme of circuit breaker failure protection

Normally, the breaker will open and interrupt the fault current. The current monitoring stage quickly resets and stops the timer T–B/F.

If the tripping command is not carried out (breaker failure case), current continues to flow and the timer runs to its set value. The breaker failure protection then issues a command to trip the back-up breakers and interrupt the fault current.

The reset time of the feeder protection is of no importance because the breaker failure feature itself recognizes the interruption of the current.

For protection functions for which the tripping criteria are not dependent on current (e.g. displacement voltage during earth fault), current flow is not a reliable criterion for proper operation of the breaker.

In such cases, the circuit breaker position can only be read from feed-back of the breaker by an auxiliary contact on the breaker. Therefore, instead of monitoring the current, the feed-back condition is monitored. For that purpose, the output from the breaker auxiliary contact must be fed to at least one binary input on the relay.

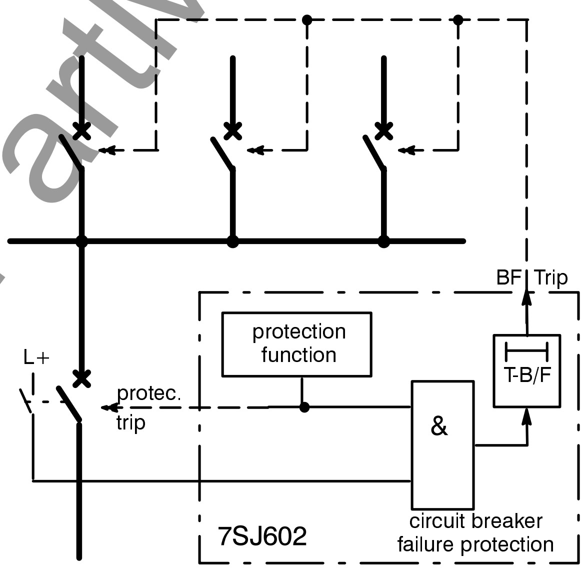


Figure 4.15 Simplified function scheme of circuit breaker failure protection controlled by circuit breaker auxiliary contact

If feed-back information from the breaker is available it is used as an additional criterion even for tripping by a short-circuit protection function. This means that the breaker is assumed to be closed as long as either current flow is detected and it is not indicated as closed.

But, if there is no feed-back information to a binary input of the device, i.e. if no auxiliary contact is connected, the current flow criterion is the only criterion for the breaker response as no feed-back information is available. The same applies if the feed-back criterion is intentionally to be ignored by a corresponding parameter (setting BF−AC). In this case, failure of the breaker cannot be detected without current flow, and the breaker failure protection function will not operate in this case.

The current criterion is always decisive when, at the instant of trip command by the feeder protection, current is registered.

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

– internal protection functions in the 7SJ602,
– external starting signals via binary input.

Each of the sources creates a pick-up annunciation of its own, time delay and trip command are common.

Figure 4.16 shows the logic diagram of the circuit breaker failure protection. The complete circuit breaker failure protection can be switched on or off via parameters and binary inputs.

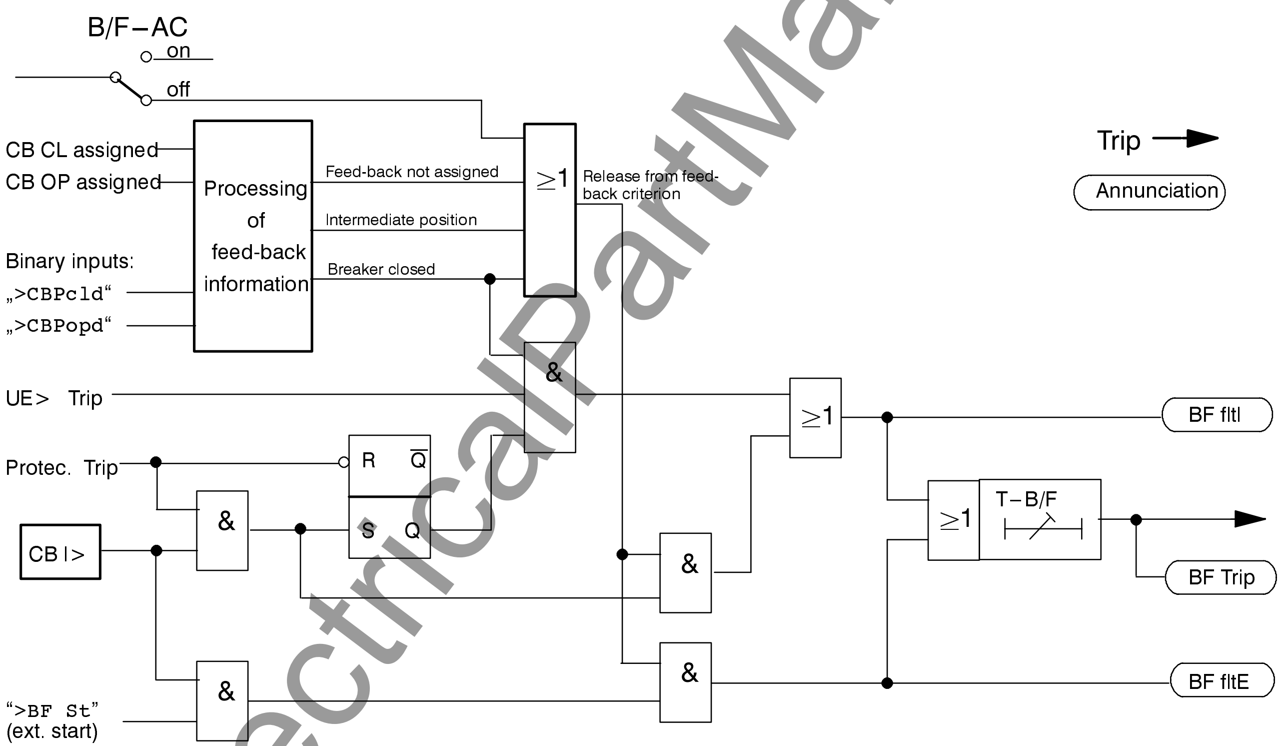


Figure 4.16 Simplified logic diagram of the circuit breaker failure protection

4.6 Unbalanced load / negative sequence protection

The unit is equipped with an unbalanced load protection, which is advantageous for protection of motors, particularly those 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 7SJ602, the fundamental wave of the phase currents is filtered out and separated into symmetrical components (negative sequence I_2 and positive sequence I_1). The ratio I_2/I_N (I_N = rated relay current) is evaluated for unbalanced load detection.

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

Filtering of the negative sequence current is possible as long as the highest of the three phase currents is at least 0.1 times rated current of the relay.

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

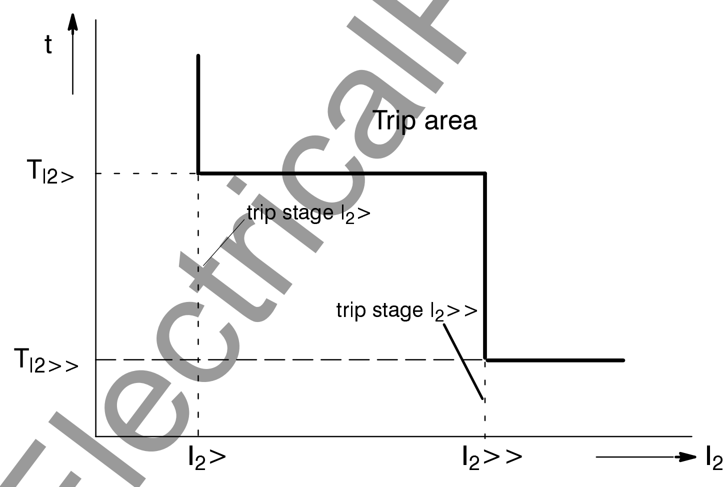


Figure 4.17 Trip time characteristic of the unbalanced load protection

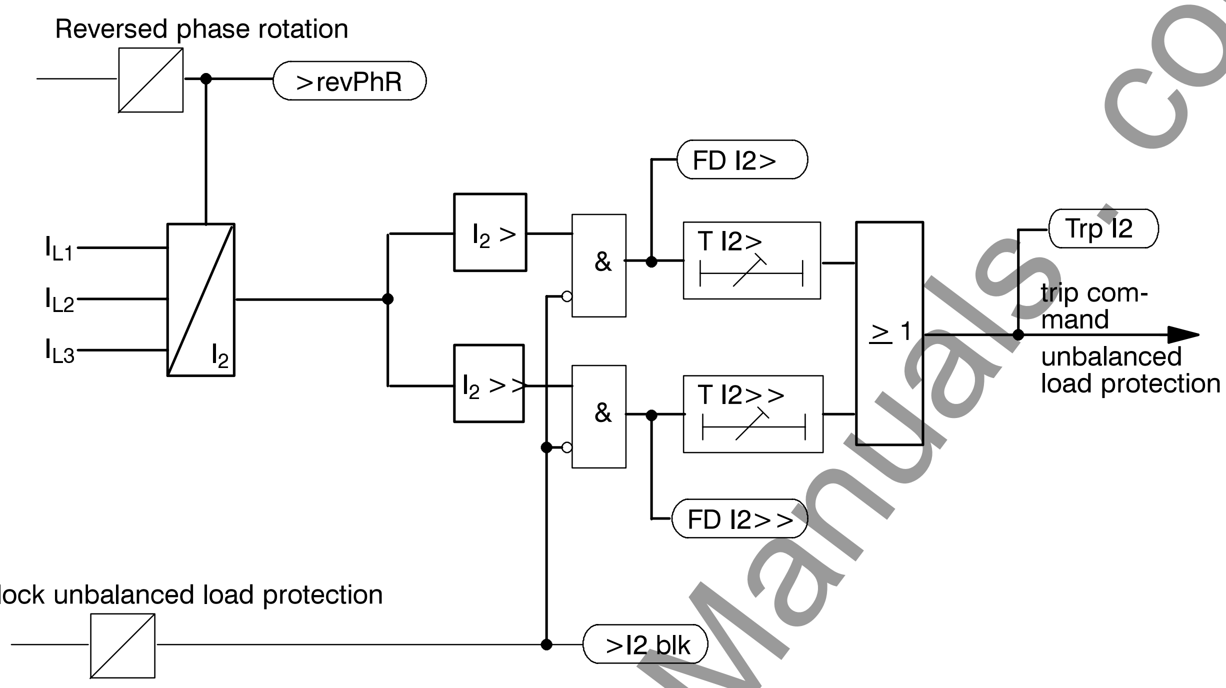


Figure 4.18 Simplified logic diagram of the unbalanced load protection

4.7 Automatic reclosure

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.

7SJ602 allows automatic three-pole as well as single- and multi-shot reclosure. Up to nine auto-reclose attempts are possible (settable).

It can be freely arranged which protection function should initiate the auto-reclosure function (refer also to Section 5.5.5). 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 end(s) 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 chart 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.

4.8 Start-up time monitoring for motors

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:

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

with t – tripping time
I_{rms} – actual current (r.m.s.)
I_{strt} – parameterized start-up current
t_{StUp} – parameterized start-up time

Figure 4.19 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).

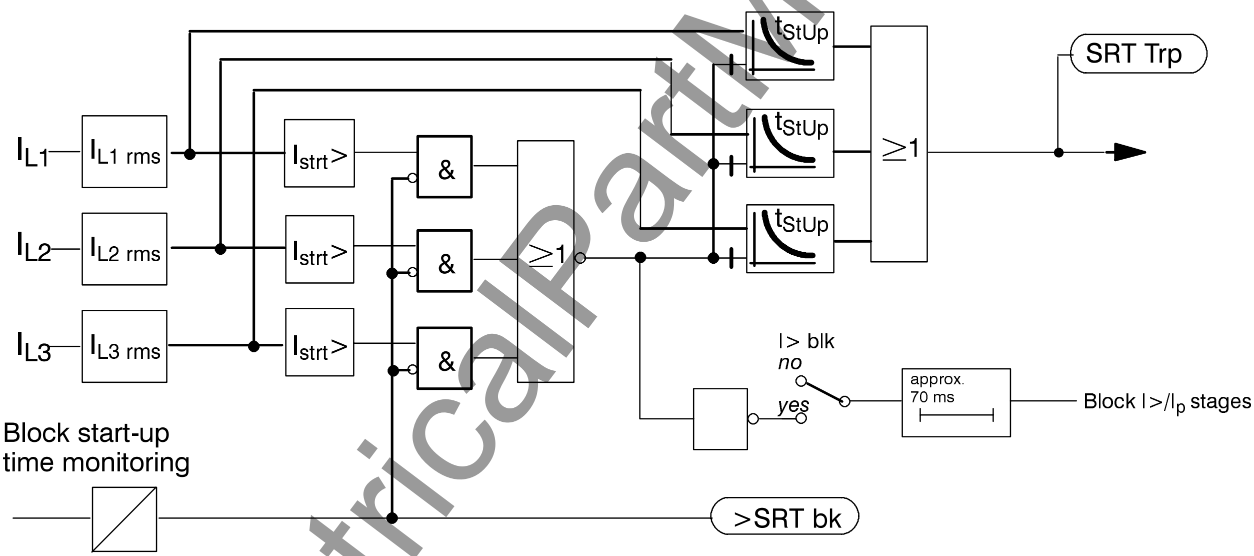


Figure 4.19 Simplified logic diagram of start-up time monitoring

4.9 Restart inhibit for motors

The rotor temperature of a motor lies far away from the critical temperature limits during normal operation, even with increased load. In contrast, during start-up of the motor, the rotor is thermally endangered rather than the stator because of its smaller time constant in connection with the excessively high start-up currents. Therefore, it is advisable that the motor start is avoided when overheating of the rotor is expected during run-up.

The rotor current cannot be measured directly. Thus, the restart lockout function of 7SJ602 approximates the rotor temperature rise from the stator currents. It is assumed, that the limit temperature of the rotor is reached, when the motor is energized with the rated start-up current as much time as it is permissible according to the data stated by the manufacturer of the motor. The relay calculates from this data the thermal characteristics which are decisive for thermal replica of the rotor. Restart of the motor is locked as long as the calculated restart limit (see Figure 4.20) is exceeded. Only when this limit is undershot, restart is released.

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

It is of no concern that the heat distribution on the rotor cage bar is much different and produces several hot spots; but it is decisive that the thermal replica of the protection corresponds to the thermal state of the motor after run-up. Figure 4.20 shows, as an example, the heating-up progress during repeated start-up of a motor and the progress of the calculated thermal replica of the protection.

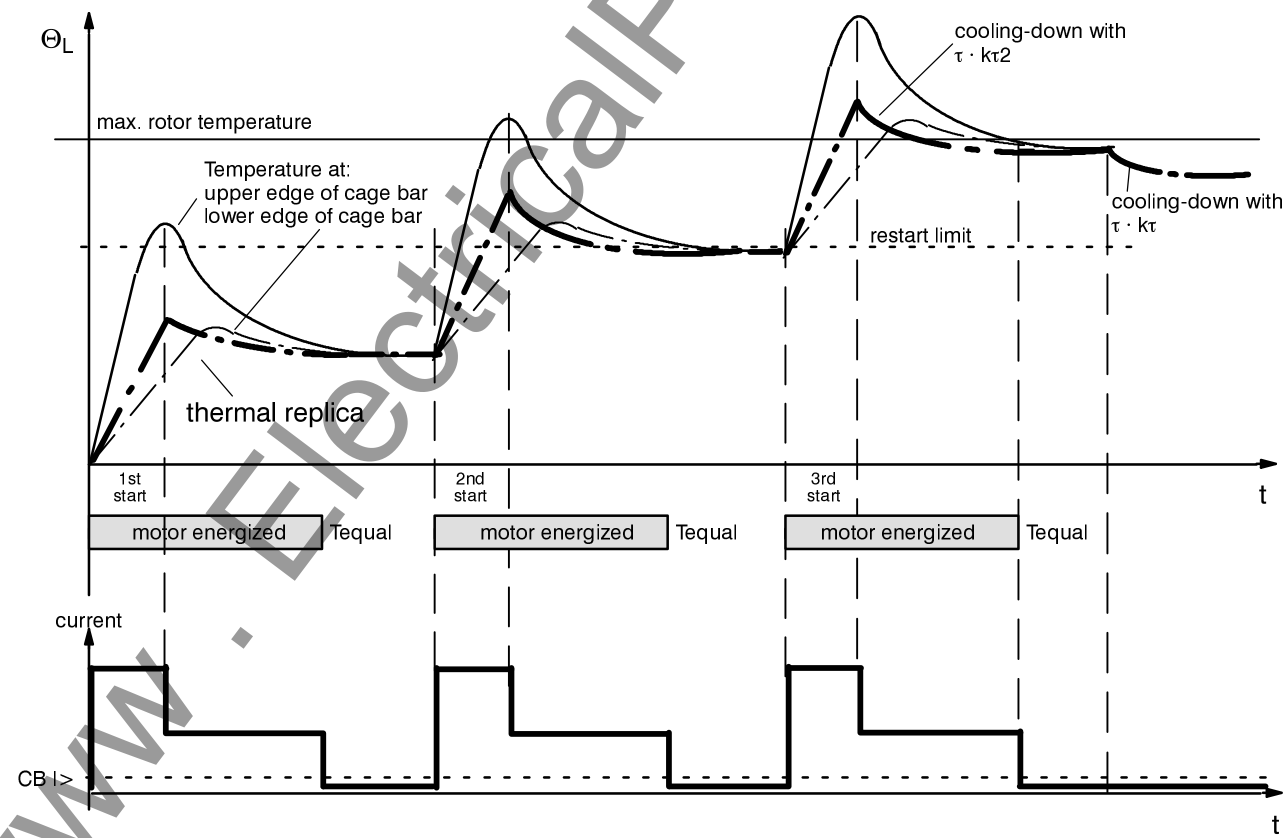


Figure 4.20 Temperature progress in the rotor and the thermal replica during repeated motor run-up

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

The time of thermal equilibrium Tequal is started each time the motor is switched off. The motor is assumed to be off when the current has fallen below the breaker-closed criterion CB I>. The thermal replica is not actualized during this time but kept constant in order to simulate temperature equalizing. The total lockout time is composed of the time calculated by the thermal replica plus the time of equilibrium Tequal as explained before.

As long as the motor is running, heating-up is simulated with the thermal time constant τ whereas cooling down is assumed to take place with the cooling-down time constant $\tau \cdot k\tau 2$.

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

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

Some motor manufacturers require, regardless of thermal profiles, a minimum lock-out time after the maximum number of permissible starting attempts has been reached. Restart is definitely locked as long as this minimum lock-out time is running even when the calculated lock-out time is shorter.

The thermal replica can be set to zero by blocking signal via the binary input ">MSP RTI". In doing this, a possible lock-out signal is cancelled.

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

Figure 4.21 shows the logic diagram of the restart inhibit.

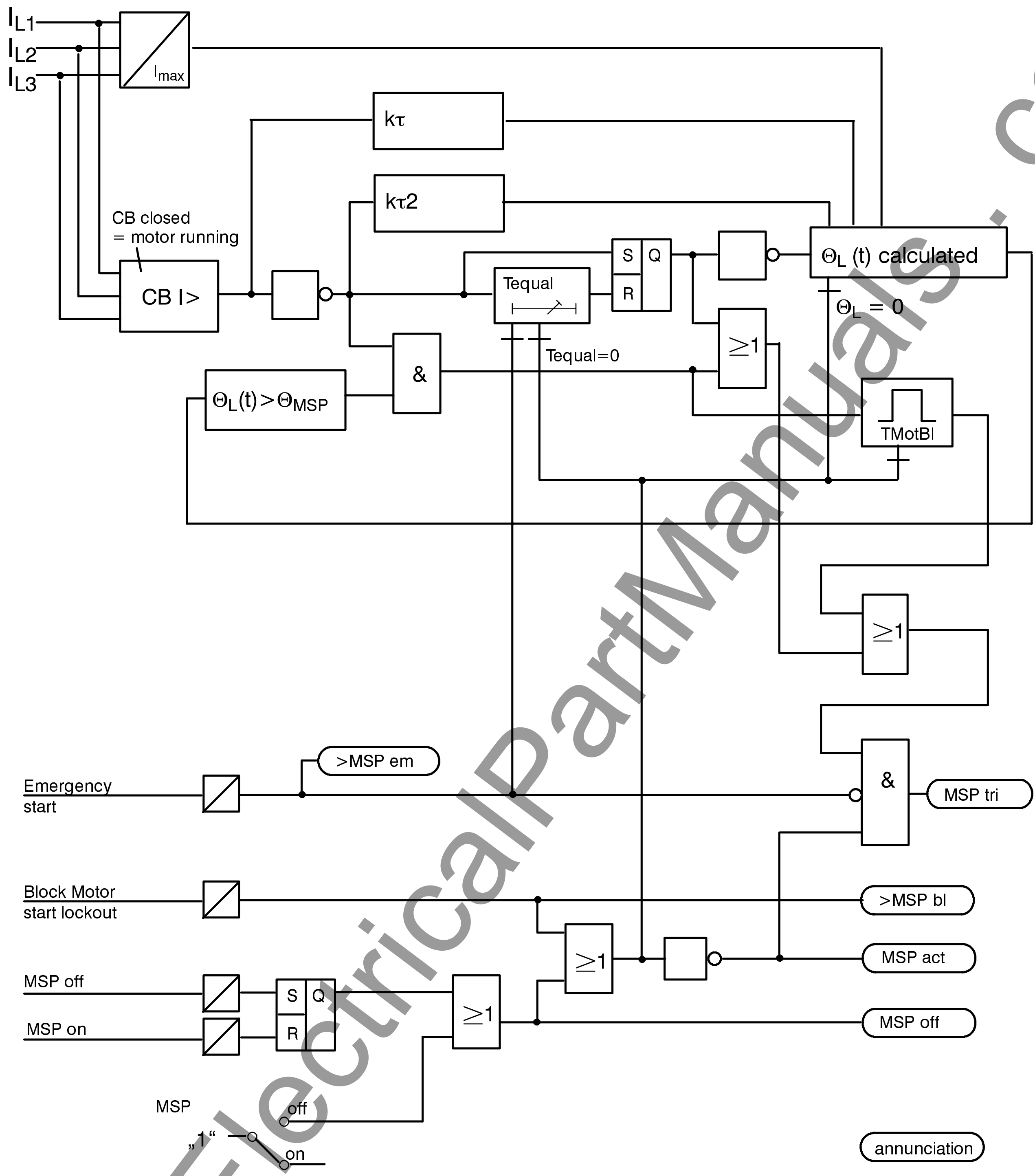


Figure 4.21 Simplified logic diagram of the motor restart lock-out

4.10 Undercurrent monitoring for motors

This function can be used for a variety of protection and supervisory tasks. It can serve, for example, as loss-of-load supervision or to recognize disconnected or interrupted lines. Furthermore, control and regulating tasks are feasible.

The three phase currents are numerically filtered so that only the fundamental wave of the currents is used for the measurement. When one of the phase currents lies below the set threshold the delay time is started after which an output signal is issued.

If the current of phase L2 is not connected to the relay it is calculated from the sum of the remaining currents:

$$I_{L2} = - \left| \underline{I}_{L1} + \underline{I}_{L3} + \underline{I}_{E} \right|$$

The logic diagram of the undercurrent monitoring is illustrated in Figure 4.22.

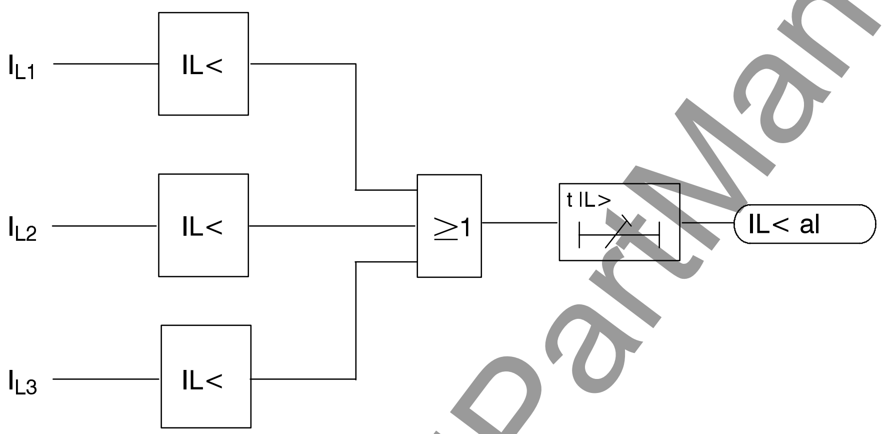


Figure 4.22 Simplified logic diagram of the undercurrent monitoring

4.11 Temperature detection via RTD-box

The version 7SJ602*–***8*–**** allows to connect an external RTD-box via the serial interface to the relay. This box comprises 6 RTD-inputs (RTD = Resistance Temperature Detector). The resistance temperature detectors (Pt100, Ni100 or Ni120) are connected to the RTD-box via a 2-wire or 3-wire cable. The RTD-box acquires these analog temperature values from the temperature detectors in the protected object and converts them into numerical values and offers these at the serial interface. Of course, the serial system interface of the 7SJ602 cannot be used for other purposes in this case.

The RTD-box allows the 7SJ602 to indicate and process the ambient or cooling medium temperature in the protected object. For instance, a temperature detector may be installed in the transformer tank, in the environment of a cable, or at a motor winding or a motor bearing. The device indicates the temperatures and can supervise the temperatures as to excess of a given threshold value.

The temperature value of the 1st RTD can be included in the thermal overload protection thus allowing not only to calculate the temperature rise caused by the current heat losses in the protected object but also to process the total temperature, consisting in the ambient temperature plus the temperature rise, e.g. in a cable or a winding.

The remaining temperature values can be displayed in 7SJ602 among the measured values and can be supervised for excess of settable threshold values. Temperatures can be expressed in degrees Celsius or in degrees Fahrenheit (can be set).

The RTD-box itself provides thresholds of each RTD. The information is then passed on via an output relay of the box. For further information refer to the instruction manual of the RTD-box.

The RTD-box is designed to convert the temperatures according to the temperature/resistance characteristic of a Pt100 detector. If other types of detectors are used (i.e. Ni100 or Ni120), the device 7SJ602 corrects the values according to a correction curve. That means that the values indicated by 7SJ602 are correct temperature values regardless which type of the three possible detectors is used provided the relay is informed about the RTD type.

4.12 Trip circuit supervision

The 7SJ602 includes a 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 4.25 shows the logic diagram of the annunciations generated by the trip circuit supervision.

4.12.1 Supervision using two binary inputs

When two binary inputs are used, they are connected according to Figure 4.23: 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.

In 7SJ602, the first input must be BI1 or BI2. Both must belong to the same electric circuit because of the common positive electrode.

The second input must be volt-free. In 7SJ602 the input BI3 is suitable.

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.

4.12.2 Supervision using one binary input

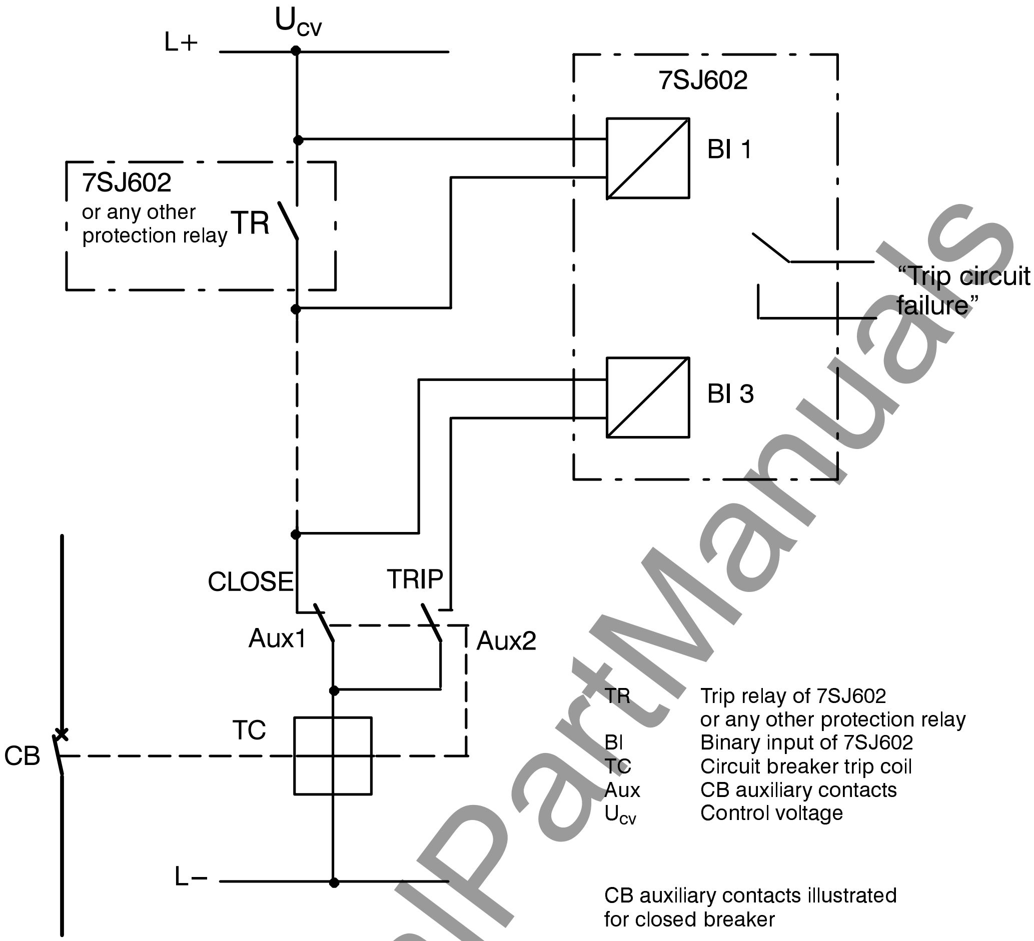
When one binary input is used, this is connected according to Figure 4.24: in parallel to the trip relay the circuit of which is to be supervised.

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

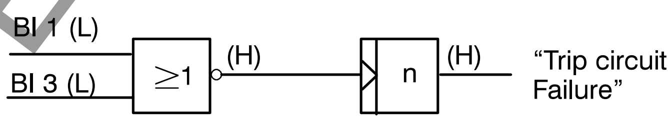
When the binary input is not energized (logical “L”), this indicates that either the trip contact is closed or the trip circuit is interrupted, or the trip circuit is short-circuited, or the control voltage for tripping is absent. As the trip contacts may be closed during healthy trip circuit condition, 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 4.24, compare with Figure 4.23). 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 5.2.4.

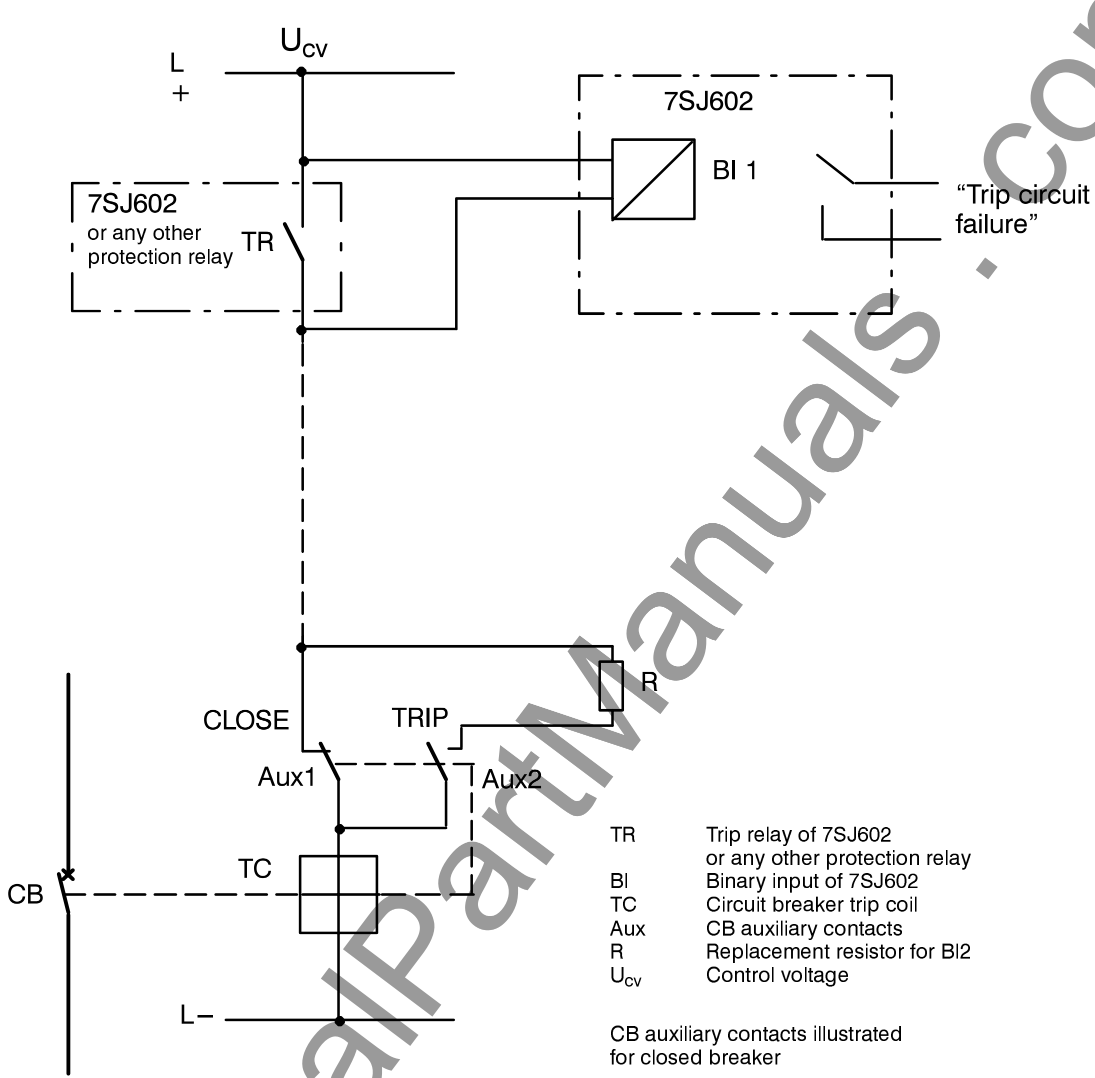


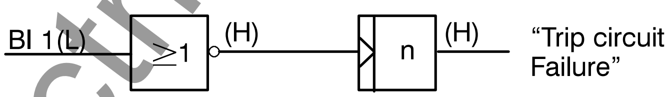
No	Trip relay	CB position	BI 1	BI 3
1	open	CLOSED	H	L
2	open	OPEN	H	H
3	closed	CLOSED	L	L
4	closed	OPEN	L	H



n number of repeated status checks = 3

Figure 4.23 Principle of trip circuit supervision with two binary inputs





n number of repeated status checks = 3

Figure 4.24 Principle of trip circuit supervision with one binary input

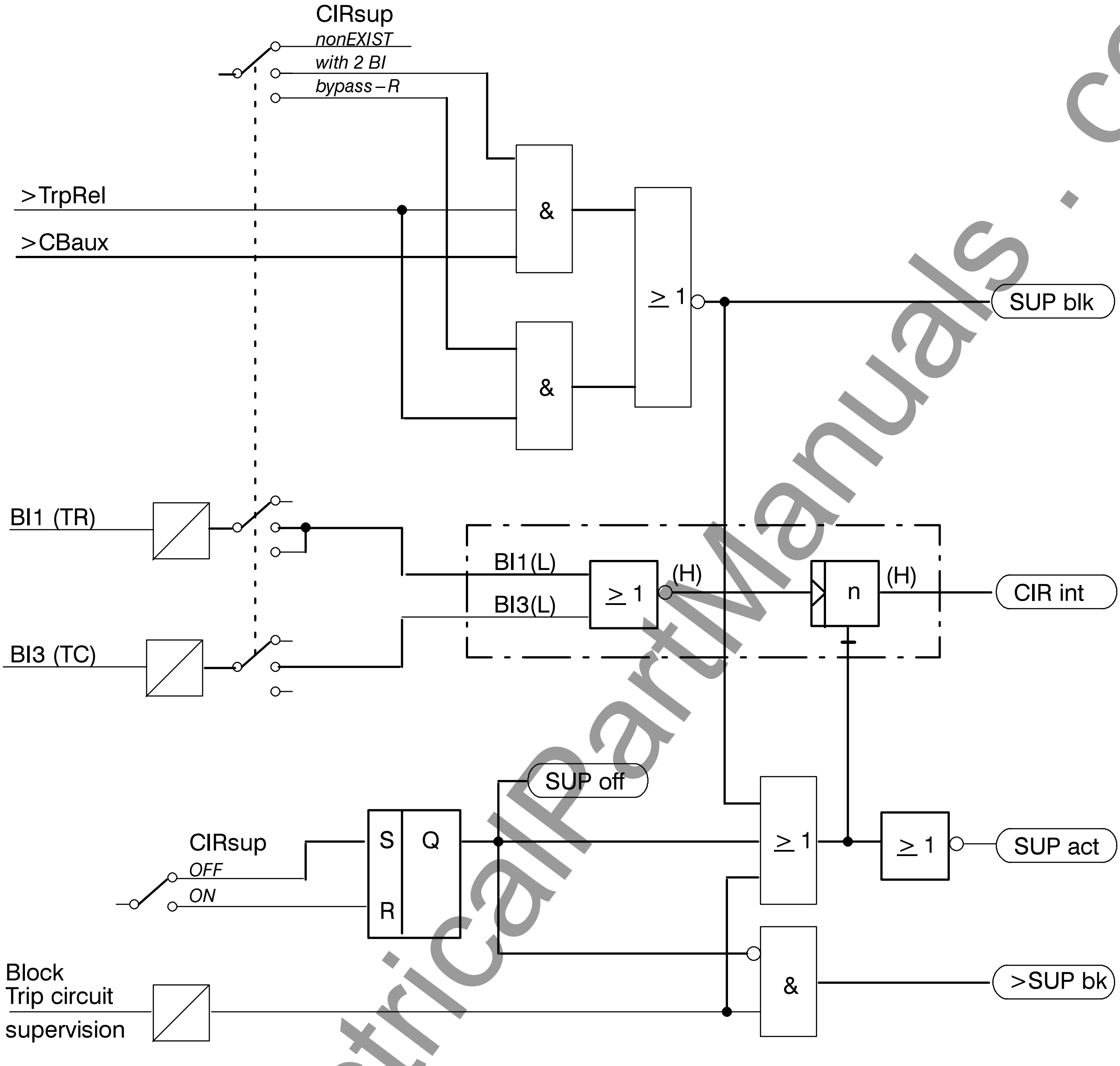


Figure 4.25 Simplified logic diagram of trip circuit supervision

4.13 Ancillary functions

The ancillary functions of the numerical time overcurrent protection 7SJ602 include:

– processing of annunciations,

– storage of short-circuit data for fault recording,

– operational measurements,

– test routines,

– monitoring functions.

4.13.1 Processing of annunciations

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

4.13.1.1 Indicators and binary outputs (signal relays)

Important events and conditions are indicated by optical indicators (LED) on the front plate. The 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.

4.13.1.2 Information on the display panel or to a personal computer

Events and conditions can be read off in the display on the front plate of the device. Additionally, a personal computer, for example, can be connected via the 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 4.13.1.1.

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 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.

4.13.2 Data storage and transmission for fault recording

The instantaneous values of the measured values

i_{L1}, i_{L2}, i_{L3}, i_E or
i_{L1}, i_{L3}, i_{EE}, v (v_{L1-E} or v_{EN})
(depending on the ordered version)

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”.

4.13.3 Operating measured, metered, and statistical values

For local recall in the display, or transmission of data, a variety of measured values and calculated values is available as long as the relay is not dealing with a fault.

The possible values depend on the version of the device. The maximum available items are listed in the following:

- I_{L1}, I_{L2}, I_{L3} phase currents in % of rated current and in A or kA primary;
- I_E earth current (residual current) in % of rated current and in A or kA primary,

  or
- I_{EE} earth current at the high-sensitivity earth current input in % of rated current and in A or kA primary (models with high-sensitivity earth fault protection);
- I_{Ea}; I_{Er} active and reactive component of the earth current, related on the displacement voltage (models with displacement voltage input, high-sensitivity earth fault protection and earth fault direction discrimination);
- V_E displacement voltage in % of the rated voltage and in V or kV primary (models with displacement voltage input);
- V_{L1-E} voltage line to earth in % of rated voltage/$\sqrt{3}$ and in V or kV primary (models with phase voltage input);
- S, P, Q apparent, active, and reactive power in % of the rated apparent power ($S_N = \sqrt{3} \cdot V_N \cdot I_N$) and in kW/kVA/kVAR or MW/MVA/MVAR primary (models with phase voltage input);
- cos φ power factor (models with phase voltage input).

The power values are integrated to electrical energy values:

- Wp, Wq active and reactive energy in kWh/kVARh or MWh/MVARh or GWh/GVARh (models with phase voltage input), separated for positive and negative energy components.

Minimum, maximum, and mean values are indicated as far as they can be established:

- Min-/Max-values of the line currents I_{L1}, I_{L2}, I_{L3}, of the voltage V_E (models with displacement voltage input) or V_{L1-E} (models with phase voltage input) as well as of the power components S, P, Q and the power factor cos φ (models with phase voltage input);
- Demand mean values of the line currents I_{L1dmd}, I_{L2dmd}, I_{L3dmd} and of the power components S_{dmd}, P_{dmd}, Q_{dmd} (models with phase voltage input) as well as the minima and maxima thereof.

When the overload protection with total memory is in operation the calculated temperature rise can be read out.

- Θ/Θ_{trip} calculated temperature rise referred to trip temperature rise.
- t_{trip} the calculated time period until trip will occur assuming constant current continuation;
- t_{close} the time period after trip until reclosing will be possible (cooling-down period).

If an RTD-box is connected to the relay:

- Theta1 to Theta6 the ambient or cooling medium temperatures calculated from the values given through the RTD-box.

4.13.4 Control functions

7SJ602 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 one of the serial interfaces 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 generates the "manual close" information so that the protection functions operate in the same way as it is by energizing the binary input "manual close" (">mCLOSE", FNo 356). 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 trip command of this control function does not initiate the auto-reclose function (if available).

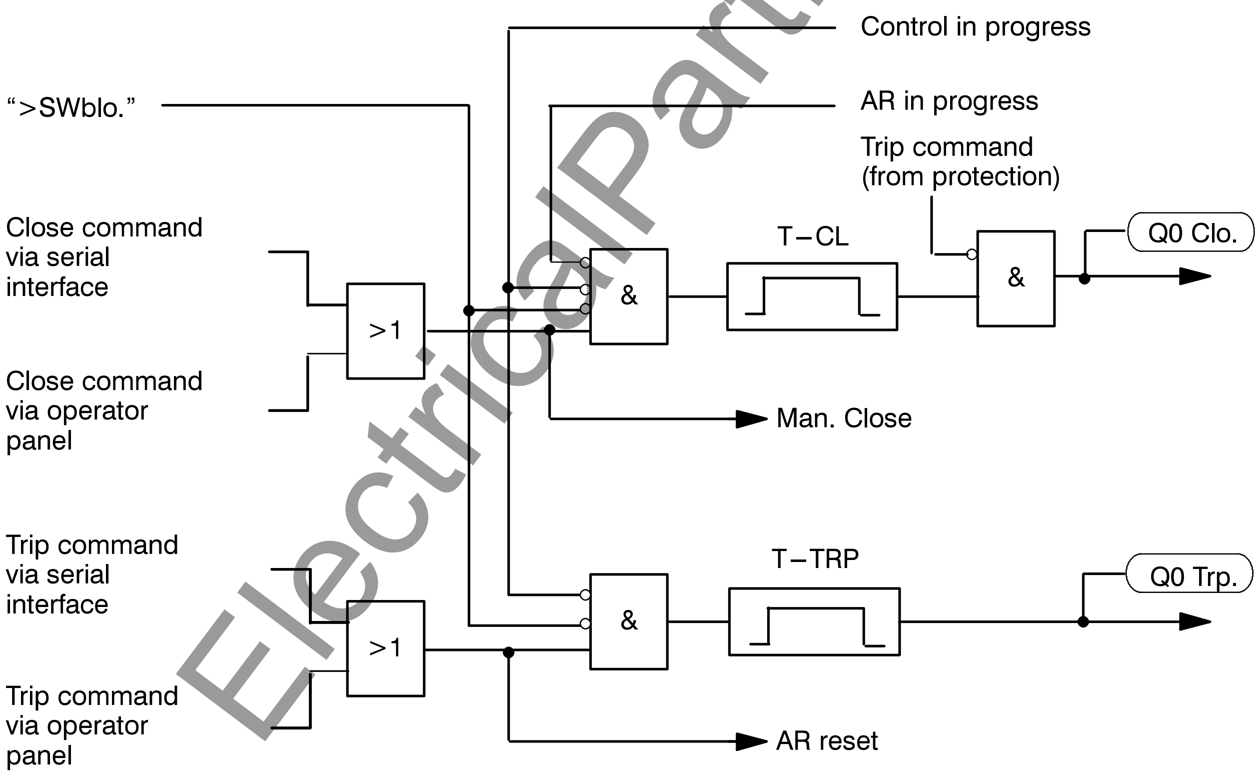


Figure 4.26 Simplified logic of circuit breaker control

4.13.5 Test facilities

Numerical time overcurrent protection SIPROTEC 7SJ602 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 6.7.1 and 6.7.10).

4.13.5.1 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.

4.13.5.2 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.

4.13.6 Monitoring functions

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

4.13.6.1 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.

– 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.

4.13.6.2 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.

4.13.6.3 Measured value supervision

For the device variants 7SJ6021 and 7SJ6025, there are four input converters in the current path. The digitized sum of the outputs of these must always be zero. A fault in the current path is recognized when

$$|i_{L1} + i_{L2} + i_{L3} + k_I \times i_E| > \text{SUM.Th} \times I_N + \text{SUM.Fa} \times I_{max}$$

An adjustable factor k_I (parameter Ie/Iph) can be set to correct the different ratios of phase and earth current transformers (e.g. summation transformer for earth fault detection). If the residual earth current is derived from the current transformer starpoint, $k_I = 1$. SUM.Th and SUM.Fa are setting parameters (see Section 6.3.10). The component SUM.Fa x I_{max} takes into account permissible current proportional transformation errors in the input converters which may particularly occur under conditions of high short circuit currents (Figure 4.27).

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

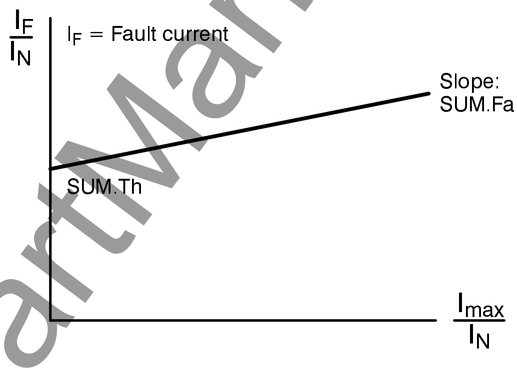


Figure 4.27 Current sum supervision (current plausibility check)

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 installation of electrical high-voltage equipment 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**lectro-**s**tatically endangered **d**evices (ESD) must be observed.

In installed conditions, the modules are in no danger.

5.2.1 Mounting and connections

5.2.1.1 Model 7SJ602⋆–⋆B⋆⋆⋆ for panel surface mounting

– Secure the unit with four screws to the panel. For dimensions refer to Figure 2.1 in Chapter 2.

– Connect the earthing screw of the device with the earthing system of the panel. The cross-section of the earthing wire must be greater than or equal to the cross-section of any other control conductor connected to the device, but at least 2.5 mm^2.

– Make connections via the screwed terminals; observe labelling of the individual terminals; observe the maximum permissible cross-sections and torque (see Section 2.3). Use copper conductors only!

– If an optical interface is used, observe the permissible bending radius (Section 2.3).

5.2.1.2 Model 7SJ602⋆–⋆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 4 holes in the fixing angle.

– Insert the unit into the panel cut-out or the cubicle rack and secure it with 4 fixing screws. For dimensions refer to Figure 2.2 in Chapter 2.

– Replace the covers.

– Make a solid low-resistive 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 system of the panel or cubicle. The cross-section of the earthing wire must be greater than or equal to the cross-section of any other control conductor connected to the device, but at least 2.5 mm^2.

– Make connections via the screwed 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 2.3). Use copper conductors only!

– If an optical interface is used, observe the permissible bending radius (Section 2.3).

5.2.2 Checking the rated data and hardware matching

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. Further adaptation facilities relate to the serial system interface.

If you will carry out certain alterations on the printed circuit board, observe the notes given in Section 5.2.2.7.

5.2.2.1 Auxiliary voltage

Three different ranges of auxiliary voltage can be delivered (cf. Section 2.4 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 Vdc and 110/125/220/250 Vdc differ from each other by different plug jumpers. The model for 110/125/220/250 Vdc is suitable for 115/230 Vac, too. The assignment of these jumpers is shown in Table 5.1, their location on the p.c.b. in Figure 5.1. 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.

Jumper	24/48 Vdc	60/110 Vdc	110/125/220/250 Vdc; 115/230 Vac
X51	none	1 – 2	2 – 3
X52	none	1 – 2, 3 – 4	2 – 3
X53	none	1 – 2	2 – 3

Table 5.1 Jumper position for auxiliary voltage

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 1 A or 5 A can be adapted by correct location of plug jumpers on the p.c.b. Devices with high-sensitivity input (7SJ602**2**–... or 7SJ602**6**–...) can be matched to 1.6 A or 8 A maximum current for this input. The assignment of the jumpers is shown in Table 5.2 for models with 4 normal current inputs (7SJ602**1**–... or 7SJ602**5**–...), in Table 5.3 for models with a high-sensitivity current input (7SJ602**2**–... or 7SJ602**6**–...). The jumper location on the p.c.b. is shown in Figure 5.1.

Jumper	I_N = 1 A	I_N = 5 A
X21 to X24	1 A	5 A

Table 5.2 Jumper position for rated currents on models 7SJ602**1**–... or 7SJ602**5**–...

Jumper	I_{NPh} = 1 A $I_{EE} = \leq 1.6$ A	I_{NPh} = 5 A $I_{EE} = \leq 8$ A
X21, X22	1 A	5 A
X24	1.6 A	8 A

Table 5.3 Jumper position for rated currents on models 7SJ602**2**–... or 7SJ602**6**–...

5.2.2.3 Control d.c. voltage of binary inputs

When the device is delivered from the factory, the binary inputs are set to operate with a dc control voltage that corresponds to the rated dc voltage of the power supply. In general, to optimize the operation of the inputs, the pick-up voltage of the inputs should be set to most closely match the actual control voltage being used. Each binary input has a pick-up voltage that can be independently adjusted; therefore, each input can be set according to the function performed.

A jumper position is changed to adjust the pick-up voltage of a binary input. Table 5.4 shows the assignment of these jumpers, Figure 5.1 their location on the p.c.b.

Jumper	Rated control voltage 24/48/60/110/ 125 Vdc Pick-up at 19 V	Rated control voltage 110/220/ 250 Vdc 115/230 Vac Pick-up at 88 V
X11 to X13	L	H

Table 5.4 Jumper position for the rated control voltages of binary inputs

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.

5.2.2.4 Contact mode of the “Live status” contact

The contact of the live status supervision relay can be operated in normally open (NO) or normally closed (NC) mode. Normally, the NC mode is used but the contact mode can be changed according to Table 5.5.

Jumper	NO contact	NC contact
X15	1–2	2–3 *)

*) default setting

Table 5.5 Jumper position for the contact mode of the live status contact

5.2.2.5 Contact mode of the output relays

The contacts of the output (command) relays CMD1 and CMD2 can be operated in normally open (NO) or normally closed (NC) mode. The contact mode can be changed according to Table 5.6.

for	Jumper	Normally open (NO)	Normally closed (NC)
CMD1	X18	1–2 *)	2–3
CMD2	X19	1–2 *)	2–3

*) default setting

Table 5.6 Jumper position for contact mode of the output relays CMD1 and CMD2

5.2.2.6 Matching facilities for the serial system interface

If the device is equipped with an electrical system interface, this may be according to RS232 or RS485 – depending on the ordered device version.

The system interface is assembled on a plug-on module located on the p.c.b. The RS232 interface can be converted into a RS485 interface and vice versa, by plug jumpers.

Figure 5.2 shows a simplified illustration of the layout of the interface module, configured as RS232, in Figure 5.3 the RS485 variant is illustrated. When the device is delivered, the jumpers are fitted according to the ordering code. The following facilities exist:

RS232:

Using RS232 (Figure 5.2), jumper X11 allows to activate or not the CTS control (clear-to-send). This is important for communication with modem:

Jumper	/CTS triggered by /RTS	/CTS from interface RS232
X11	2 – 3 *)	1 – 2

*) default setting

Jumper position 2 – 3 means: Connection to the modem is usually done with star coupler or optical fibre converter. Therefore the modem control signal according to RS232 standard DIN 66020 is not available. Modem signals are not required since communication to the SIPROTEC® devices is always carried out in the half duplex mode. Use connection cable with ordering number 7XV5100 – 4.

Jumper position 1 – 2 means: The modem signal is available, i. e. for a direct RS232 connection between the SIPROTEC® device and the modem this setting can be selected optionally. We recommend to use a standard RS232 modem connection cable (converter 9-pin to 25-pin).

Note: For a direct connection to DIGSI with interface RS232, jumper X11 must be plugged into position 2 – 3.

RS485:

The RS485 interface (Figure 5.3) is capable of half-duplex service with the signals A/A' and B/B' with a common relative potential C/C' (GND).

For interfaces with bus capability, the last devices on the bus must be provided with terminating resistors, Verify that only the last devices on the bus have the terminating resistors enabled, and that the other devices on the bus have not.

With default setting, jumpers are plugged in such a way that terminating resistors are disconnected. Both jumpers have always to be plugged in the same way.

The jumpers are situated on the interface module RS485 (Figure 5.3) or Profibus/Modbus (Figure 5.4). If the bus is extended, make sure again that only the last device on the bus has the terminating resistors effective, and that all other devices on the bus have not.

The terminating resistors can also be connected externally, e.g. in the plug box or on the connection element (Figure 5.5). In this case, the terminating resistors located on the interface module must be disconnected.

5.2.2.7 Performing alterations on the p.c.b.s

– 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.

– If the device has a communication interface at the bottom, the six screws of the communication module must be loosened and the module must be removed.

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

⚠ **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 jumpers according to the Figures 5.1 to 5.4.

– Insert module into the housing;

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

– If the device has a communication interface, the communication module must be re-inserted. Slightly tighten all screws before fixing them finally.

– Re-insert covers.

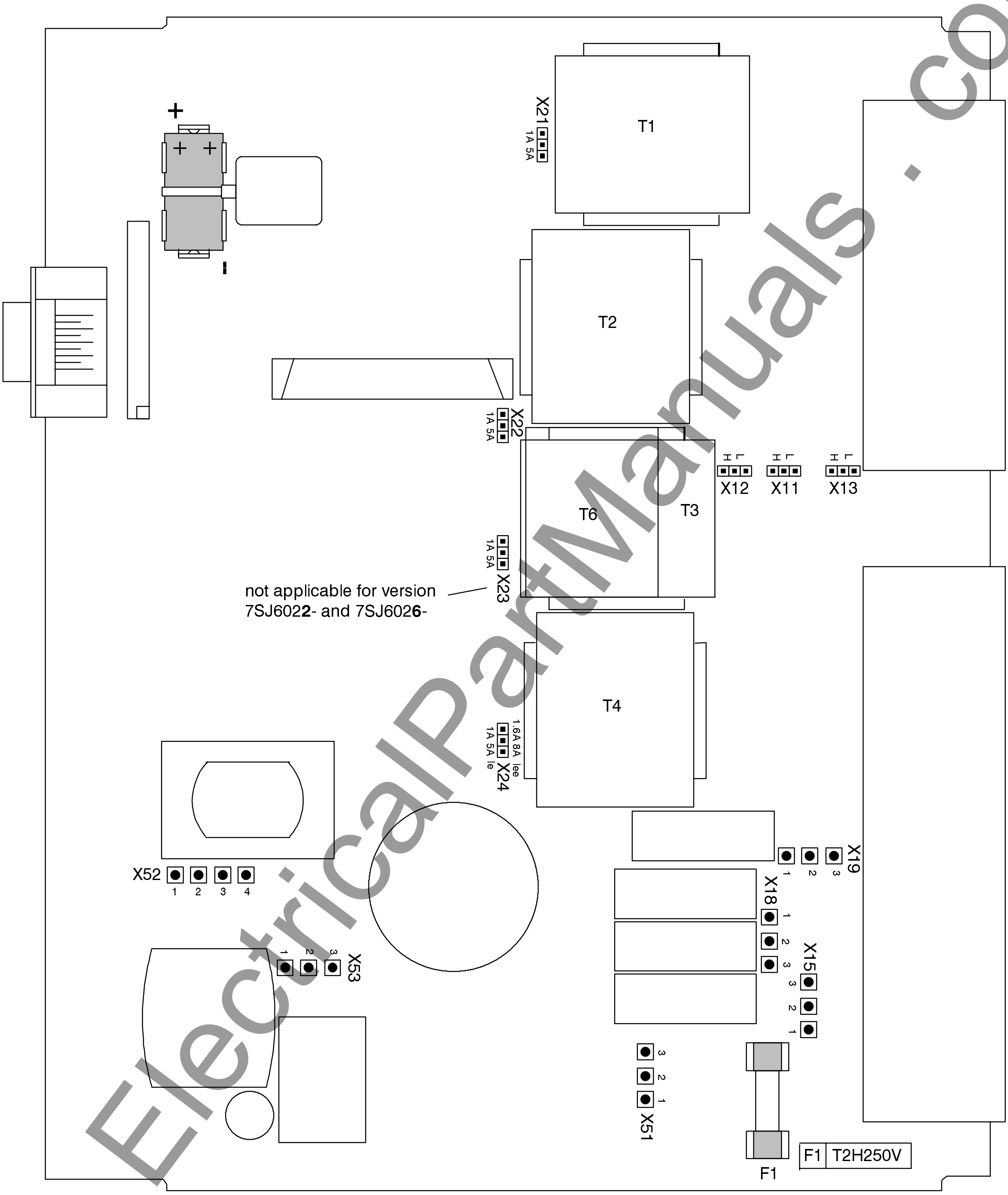


Figure 5.1 CPU602V2 module – illustration of the jumpers on the printed circuit board

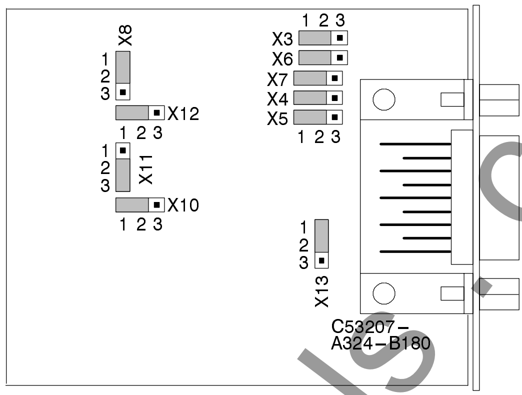


Figure 5.2 Interface module, configured as RS232 port

Jumper	Terminating resistors connected	Terminating resistors disconnected
X3	2–3	1–2 *)
X4	2–3	1–2 *)

*) Default setting

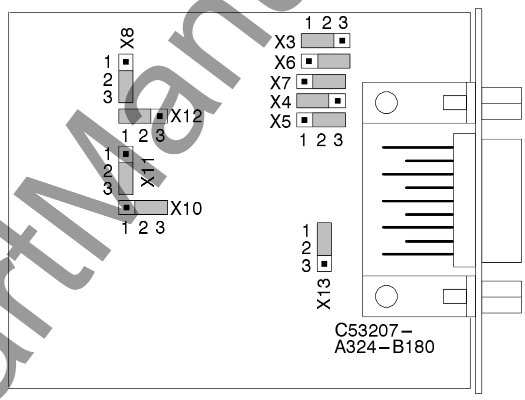


Figure 5.3 Interface module, configured as RS485 port

Jumper	Terminating resistors connected	Terminating resistors disconnected
X3	1–2	2–3 *)
X4	1–2	2–3 *)

*) Default setting

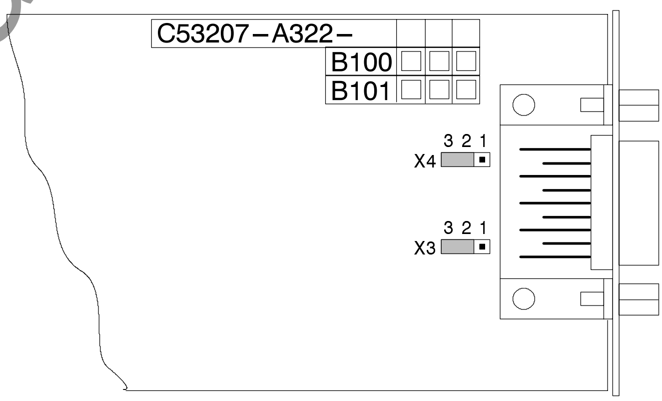


Figure 5.4 Interface module Profibus/Modbus, configuration of terminating resistors

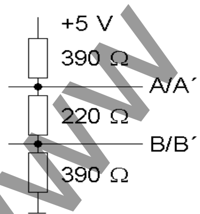


Figure 5.5 Termination of the RS485 interface with external resistors

5.2.3 Checking the serial data transmission link

For models with system interface for a central data processing station these connections must be checked. It is important to visually check the allocation of the transmitter and receiver channels. Since each connection is used for one transmission direction, the transmit connection of the relay must be connected to the receive connection of the central unit and vice versa.

If the RS232 interface is used, the connections are marked in sympathy with ISO 2110 and DIN 66020:

TxD	Transmit line of the respective unit
RxD	Receive line of the respective unit
RTS	Request to send signal
CTS	Clear to send signal
GND	signal ground

The conductor shield and the common overall shield must be earthed at both line ends.

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

5.2.4 Connections

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

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 4.12, 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 5.6), 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 4.12.2). 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 5.6).

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:

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

$I_{BI\,(High)}$	constant current which operates the binary input (approx. 1.8 mA)
$U_{BI\,min}$	minimum control voltage for the binary input (approx. 19 V at delivery, approx. 88 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:

$I_{BI\,(High)}$ 1.8 mA (protection relay data)

$U_{BI\,min}$ 19 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)

$$R_{max} = \frac{110\ V - 19\ V}{1.8\ mA} - 500\ \Omega$$

$$R_{max} = 50\ k\Omega$$

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

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

$$R = \frac{R_{max} + R_{min}}{2} = 38.5\ k\Omega$$

The nearest standard value is selected: 39 kΩ.

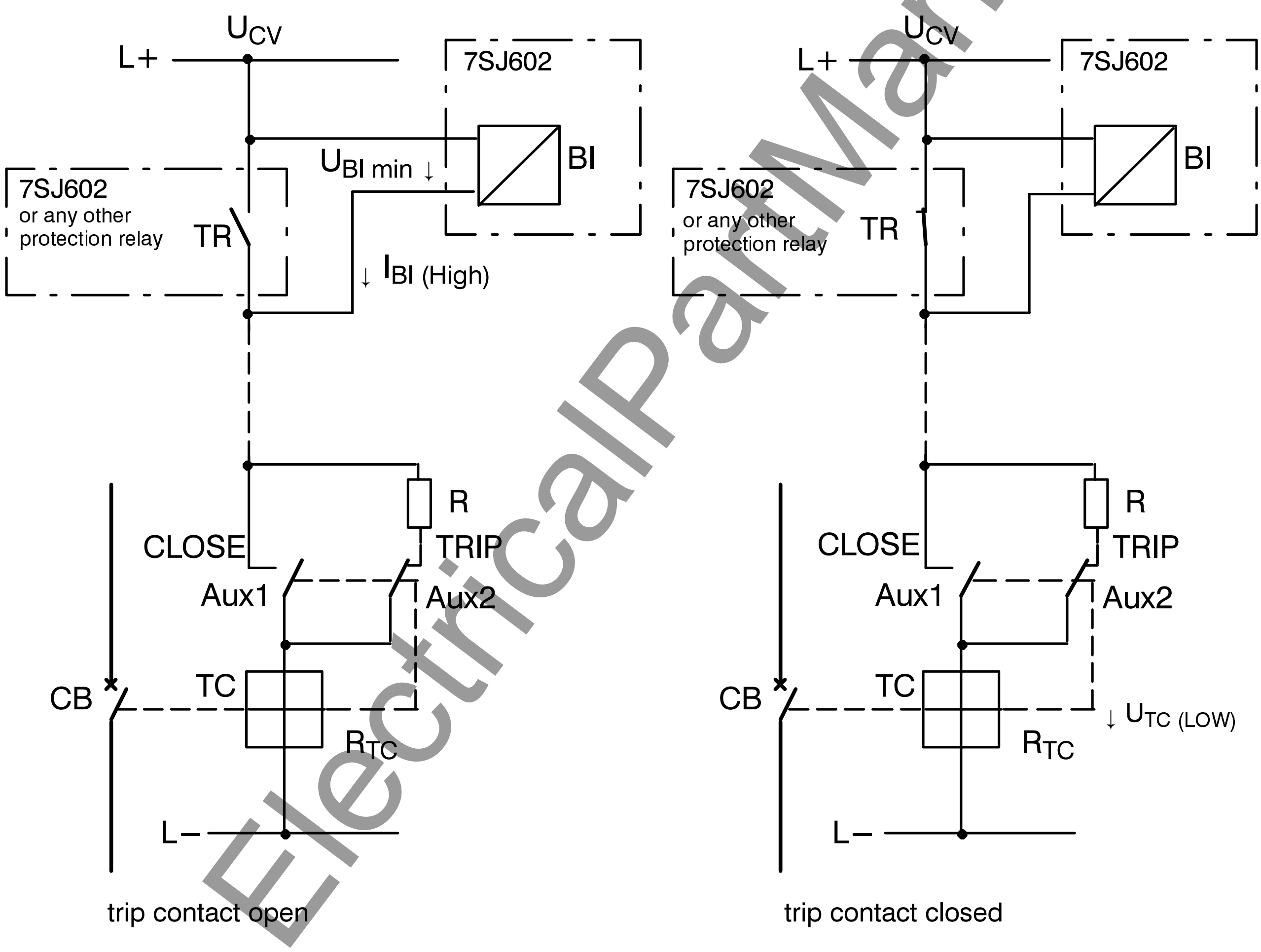


Figure 5.6 Dimensioning the external resistor R when one single binary input is used

5.2.5 Checking the connections

Warning

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

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

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

– 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?
  - Are the polarities of the current transformer connections consistent?
  - Is the polarity of the earth current transformer correct (if used)?
  - Are the voltage transformers correctly earthed (if used)?
  - Is the polarity of the voltage transformer circuit correct (if used)?
  - Is the connected phase (L1 – E) of the voltage transformers correct (if used)?
  - Is the polarity of the open delta winding on the voltage transformers and the connection correct (if used)?

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

– Fit an ammeter in the auxiliary power circuit; range approx. 1 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 1 to 3 W/VA (dependent on version). 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 after approximately 0.5 s, the red LED gets off after at most 7 sec.

– Open the miniature 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.

– If the serial port with bus capability is used, ensure that the termination resistors are enabled at the last devices on the bus but not at the other devices.

If an RTD-box is connected the termination resistors must be enabled at the RTD-box as well as at the system interface of the 7SJ602 device.

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** once more 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.

```
CW :
@ @ @
```

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.

```
CW  OK_
```

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

```
CW  WRONG
```

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 5.7 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).

△ ▽
```
71INT.OP
```
▷

[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.

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 5.7. 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 5.7). 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 ⊟.

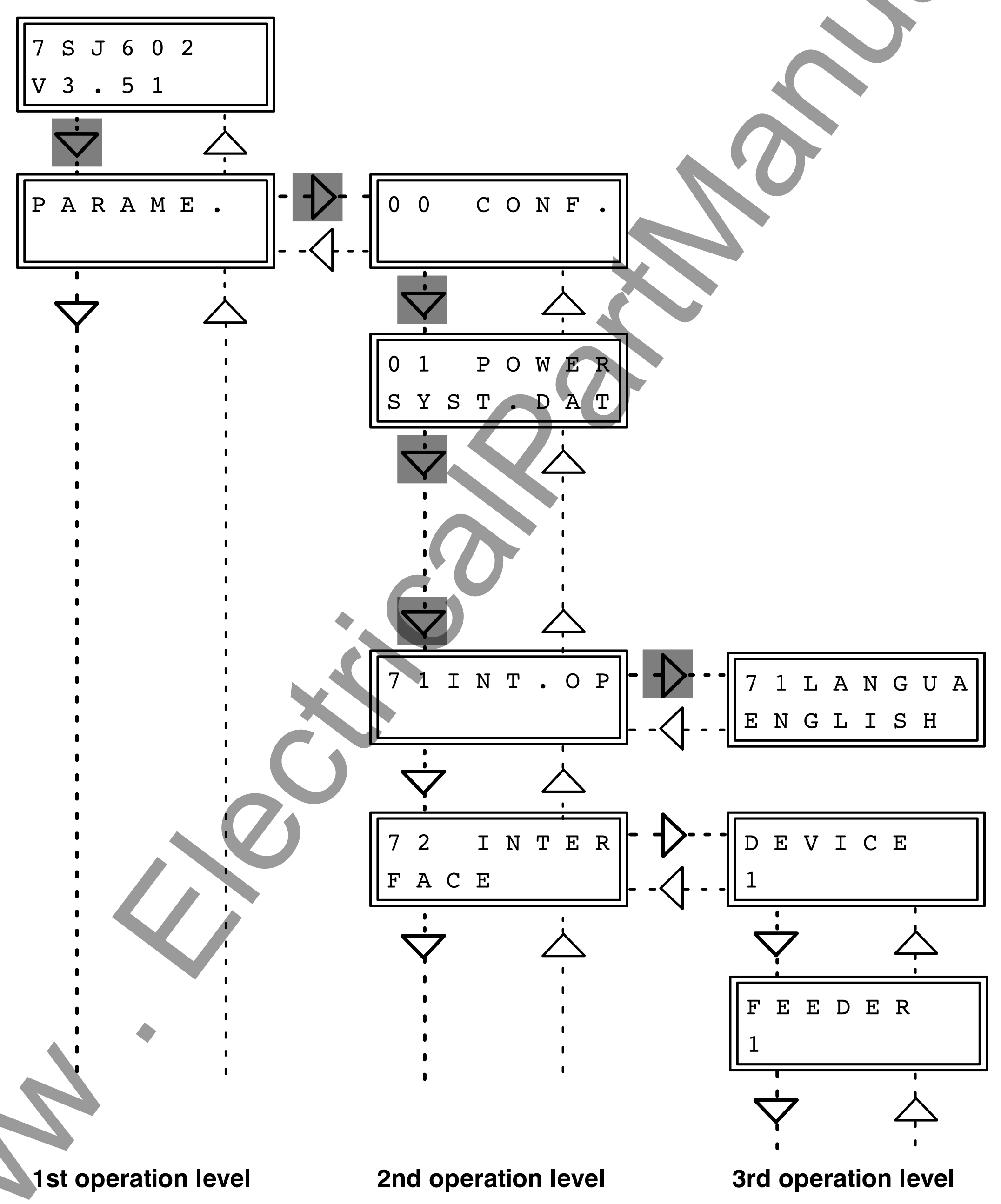


Figure 5.7 Extract from the operation structure and illustration of selection of the configuration blocks

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.

If no operation has taken place for more than 10 minutes, the relay terminates the setting mode and reverts to the default display, i.e. indication of the measured values. Alterations which have not yet been saved are lost. With the ◁ -key the last used operating level is reached.

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   |
   | P Y C C K       |
```

[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 interfaces – address block 72

The device provides a serial operator interface (or PC interface) and – dependent on the version – a serial system interface. Communication via this interfaces requires some data prearrangements like 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.

In the actual relay, only those parameters are requested which are relevant for the concrete version. For instance, settings for Profibus configuration are only requested if the relay is equipped with a Profibus interface.

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.

5.3.3.1 General settings

```
7 2   I N T E R
F A C E
```

[7200]
Beginning of the block “PC-interface and system interface”

```
7 2 D E V I C E
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**

```
7 2 F E E D E R
1
```

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

```
7 2 S U B S T A
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**

```
72F-TYPE
160
```

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

```
72PC-INT
DIGSI V3
```

[7211]
Data format for the PC (operating) interface:

format for Siemens protection data processing program *DIGSI*® Version *V3* or V4

```
+ ASCII
```

ASCII format

```
72 GAPS
1.0 s
```

[7214]
Maximum time period of data gaps which may occur during data transmission via modem

Smallest setting value: **0.0** s
Largest setting value: **5.0** s

```
72PCBAUD
9600BAUD
+ 19200 BD
1200BAUD
2400BAUD
4800BAUD
```

[7215]
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 Baudrate with the entry key **E**.

```
72PARITY
DIGSI V3
```

[7216]
Parity and stop-bits for the PC (operating) interface:

format for Siemens protection data processing program *DIGSI*® Version *V3* or V4 with even parity and 1 stop-bit

```
+ 8O1
```

8 bit transmission with *O*dd parity and *1* stop-bit

```
8N2
```

8 bit transmission with *N*o parity and *2* stop-bits

```
8N1
```

8 bit transmission with *N*o parity and *1* stop-bit

5.3.3.2 Settings for protocol IEC 60870--5−103

7 2 S Y S I N T / I E C c o m .	[7221] Data format for annunciations via system interface *com*patible with *IEC* 60870−3−105
+ I E C e x t .	compatible with *IEC* 60870−3−105 and *ext*ended
D I G S I V 3	Format for *DIGSI*® version *V3* or V4

7 2 S − M E A S / I E C c o m .	[7222] Data format for measured values via system interface *com*patible with *IEC* 60870−3−105
+ I E C e x t .	compatible with *IEC* 60870−3−105 and *ext*ended
D I G S I V 3	Format for *DIGSI*® version *V3* or V4

7 2 S − G A P S / 1 . 0 s	[7224] Transmission gaps for system interface Smallest setting value: **0.0** s Largest setting value: **5.0** s

7 2 S − B A U D / 9 6 0 0 B A U D	[7225] The transmission baud rate for system interface can be adapted. The available possibilities can be displayed by repeatedly depression of the key **+** or **--**. Confirm the desired baud rate with the entry key **E**.
+ 1 9 2 0 0 B D	
1 2 0 0 B A U D	
2 4 0 0 B A U D	
4 8 0 0 B A U D	

7 2 S − P A R I / I E C / D I G S	[7226] The parity of the system interface can be adapted: format for Siemens protection data processing program *IEC*/*DIGS*I/LSA with even parity and 1 stop-bit
+ 8 O 1	*8* bit transmission with *O*dd parity and *1* stop-bit
8 N 2	*8* bit transmission with *N*o parity and *2* stop-bits
8 N 1	*8* bit transmission with *N*o parity and *1* stop-bit

```
7 2 S - S W I T
N O
```
\+ `Y E S`

[7227]
Online switchover between IEC and DIGSI enabled

```
7 2 O F F s i g
O F F
```
\+ `O N`

[7228]
Character idle state for optical fibre interface

idle state light *OFF*

idle state light *ON*

```
7 2 S - T O U T
1 . 0   s
```

[7233]
Monitoring time for system interface
Smallest setting value: **1.0** s
Largest setting value: **600,0** s
and ∞ (no time-out monitoring)

```
7 2 S - P A R A
N O
```
\+ `Y E S`

[7235]
Parameterizing via system interface allowed

```
7 2 S W . R E M
O N
```
\+ `O F F`

[7240]
Switching authorization for remote control via the system interface:
ON is permitted
OFF is not permitted

5.3.3.3 Settings for protocol Profibus-DP

Note: Details about the specifications concerning Profibus DP can be found in the documentation C53000–L1876–B012–03.

```
7 2 D p S l A d
1
```

[7250]
Address for Profibus-DP Slave. The number can be freely chosen, but must be used only once within the plant system
Smallest setting value: **1**
Largest setting value: **126**

```
7 2 D p T s E n
N O
+ Y E S
```

[7251]
Profibus-DP Time Synchronization Enable
NO – disabled
YES – enabled

```
7 2 D p O M o d
V 2 M o d e 0
+ V 2 M o d e 1
  V 3 M o d e 0
  V 3 M o d e 1
```

[7252]
Profibus-DP OLM version and operation mode
V2Mode0 – operation mode *0* with OLM *V2*: send echo
V2Mode1 – operation mode *1* with OLM *V2*: no echo
V3Mode0 – operation mode *0* with OLM *V3*: send echo
V3Mode1 – operation mode *1* with OLM *V3*: no echo

```
7 2 D p O R e d
o n
+ o f f
```

[7253]
Profibus-DP OLM redundancy
on – redundancy on
off – redundancy off

```
7 2 D p O N e t
S t d
+ E x t
```

[7254]
Profibus-DP extension of the OLM network
Std – standard
Ext – extended

5.3.3.4 Settings for protocol Modbus

Note: Details about the specifications concerning Modbus ASCII/RTU can be found in the documentation C53000–L1876–C012–03.

```
7 2 M b S l A d
1
```

[7270]
Address for Modbus Slave. The number can be freely chosen, but must be used only once within the plant system
Smallest setting value: **1**
Largest setting value: **247**

```
7 2 M b M o d e
R T U
+ A S C I I
```

[7271]
Modbus operation mode
RTU – RTU format
ASCII – ASCII format

7 2 M b B a u d 1 9 2 0 0	[7272] Modbus transmission Baudrate *19200* Baud
+ 3 0 0	*300* Baud
6 0 0	*600* Baud
1 2 0 0	*1200* Baud
2 4 0 0	*2400* Baud
4 8 0 0	*4800* Baud
9 6 0 0	*9600* Baud

7 2 M b P a r R N O N E	[7273] Modbus parity **only for Modbus RTU** *NONE* no parity
+ E V E N	*EVEN* even parity
O D D	*ODD* odd parity

7 2 M b P a r A E V E N	[7274] Modbus parity **only for Modbus ASCII** *EVEN* even parity
+ O D D	*ODD* odd parity

7 2 M b T s e t 0	[7275] Modbus Time Set / Use of Registers *0* – no: date and time are adopted immediately
+ 1	*1* – yes: date and time are adopted after the following command

5.3.4 Settings for fault recording – address block 74

The relay 7SJ602 is equipped with a fault data store (see Section 4.13.2). 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 time periods s are related on a system frequency of 50 Hz. They are to be matched, accordingly, for different frequencies.

```
74 FAULT
RECORDER
```

[7400]
Beginning of block “Fault recordings”

```
74 RECini
RECbyFT
+
RECbyTP

SRTwitTP
```

[7402]
Data storage is initiated:
- fault detection is reference instant
  fault detection is storage criterion
- fault detection is reference instant
  trip command is storage criterion
- trip command is reference instant
  trip command is storage criterion

```
74  T-MAX
1.00  s
```

[7410]
Maximum time period of one fault record
Smallest setting value: **0.30** s
Largest setting value: **5.00** s

```
74  T-PRE
0.10  s
```

[7411]
Pre-trigger time before the reference instant
Smallest setting value: **0.05** s
Largest setting value: **0.50** s

```
74  T-POS
0.10  s
```

[7412]
Post-fault time after the storage criterion disappears
Smallest setting value: **0.05** s
Largest setting value: **0.50** s

5.4 Configuration of the protective functions

5.4.1 Introduction

The device 7SJ602 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 time overcurrent 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 5.8).

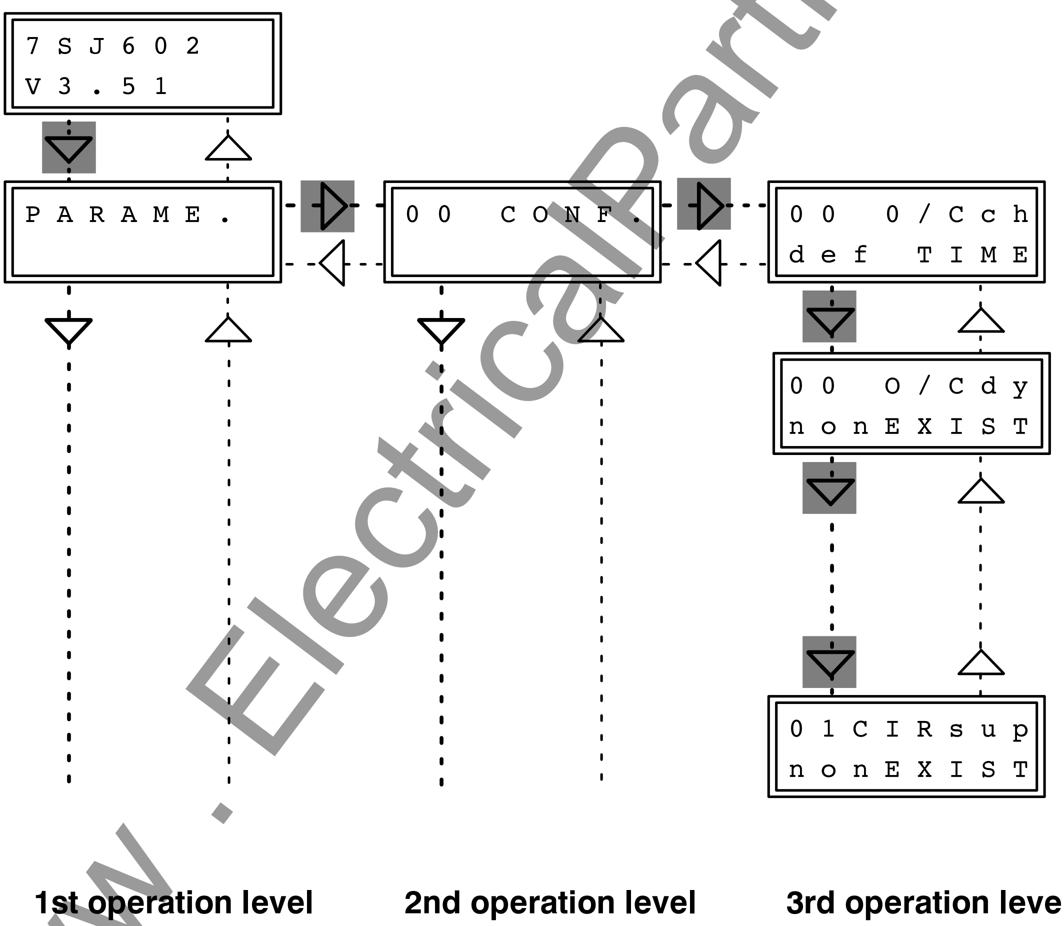


Figure 5.8 Extract from the operation structure and illustration of selection of the configuration block

Within the block 00 one can page with key ▷ to the third operation level and scroll on with key ▽ or scroll back with key △. 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 △ 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 Configuring 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 7SJ602: 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.

◁ ▽ `00 CONF.` ▷

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

[7801] Overcurrent protection for phase currents:
Preselection of tripping characteristic

0 0 O / C p c h d e f T I M E	[7801] Only definite time characteristics are available, besides the high-current and very high current stages
+ I E C i n v .	The 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
A N S I i n v	The inverse time characteristics according ANSI are available (refer to Figures 3.4 and 3.5, Section 3.3), besides the high-current and very high current stages
I E C O / C	The definite time stages as well as the 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
A N S I O / C	The definite time stages as well as the inverse time characteristics according ANSI are available (refer to Figures 3.4 and 3.5, Section 3.3), besides the high-current and very high current stages
n o n E X I S T	No overcurrent protection is available

[7807] Overcurrent protection for earth current or sensitive earth fault protection:
Preselection of tripping characteristic

0 0 O / C e c h d e f T I M E	[7807] Only definite time characteristics are available, besides the high-current stage
+ I E C i n v .	The inverse time characteristics according IEC are available (refer to Figures 3.1 and 3.2, Section 3.3), besides the high-current stage
A N S I i n v	The inverse time characteristics according ANSI are available (refer to Figures 3.4 and 3.5, Section 3.3), besides the high-current stage
I E C O / C	The definite time stage as well as the inverse time characteristics according IEC are available (refer to Figures 3.1 and 3.2, Section 3.3), besides the high-current stage
A N S I O / C	The definite time stage as well as the inverse time characteristics according ANSI are available (refer to Figures 3.4 and 3.5, Section 3.3), besides the high-current stage
n o n E X I S T	No overcurrent protection is available

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

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

[7806] Direction determination for sensitive earth fault protection:

```
00  DirSE
nonEXIST
+ EXIST
```

[7803] Unbalanced load protection:

```
00  UNB.L
nonEXIST
+ EXIST
```

[7804] Thermal overload protection:

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

preLOAD: with total memory (preload considered)

no preLD: without memory (no preload)

[7834] Automatic reclosure:

```
00  AR
nonEXIST
+ EXIST
```

[7835] Circuit breaker failure protection:

```
00  B/F
nonEXIST
+ EXIST
```

[7839] Trip circuit supervision:

```
00CIRsup
nonEXIST
+ with 2BI
bypass-R
```

[7805] Start-up time monitoring:

```
00  STRT
nonEXIST
+ EXIST
```

[7841] Restart inhibit for motors:

```
00MotPro
nonEXIST
+ EXIST
```

[7840] Undercurrent monitoring for motors:

```
00  IL<
nonEXIST
+ EXIST
```

[7842] Only Profibus/Modbus for information:

```
00  BUS
```

[7843] RTD-Box for overload detection:

```
00RTDbox
nonEXIST
+ EXIST
```

[7844] Temperature unit for RTD-temperatures:

```
00Tunit
° C
+ ° F
```

° C: Degrees Celsius

° F: Degrees Fahrenheit

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 5.9):

– key ▽ (forwards),

– key ▷ (second operation level),

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

[6000]
Beginning of marshalling blocks

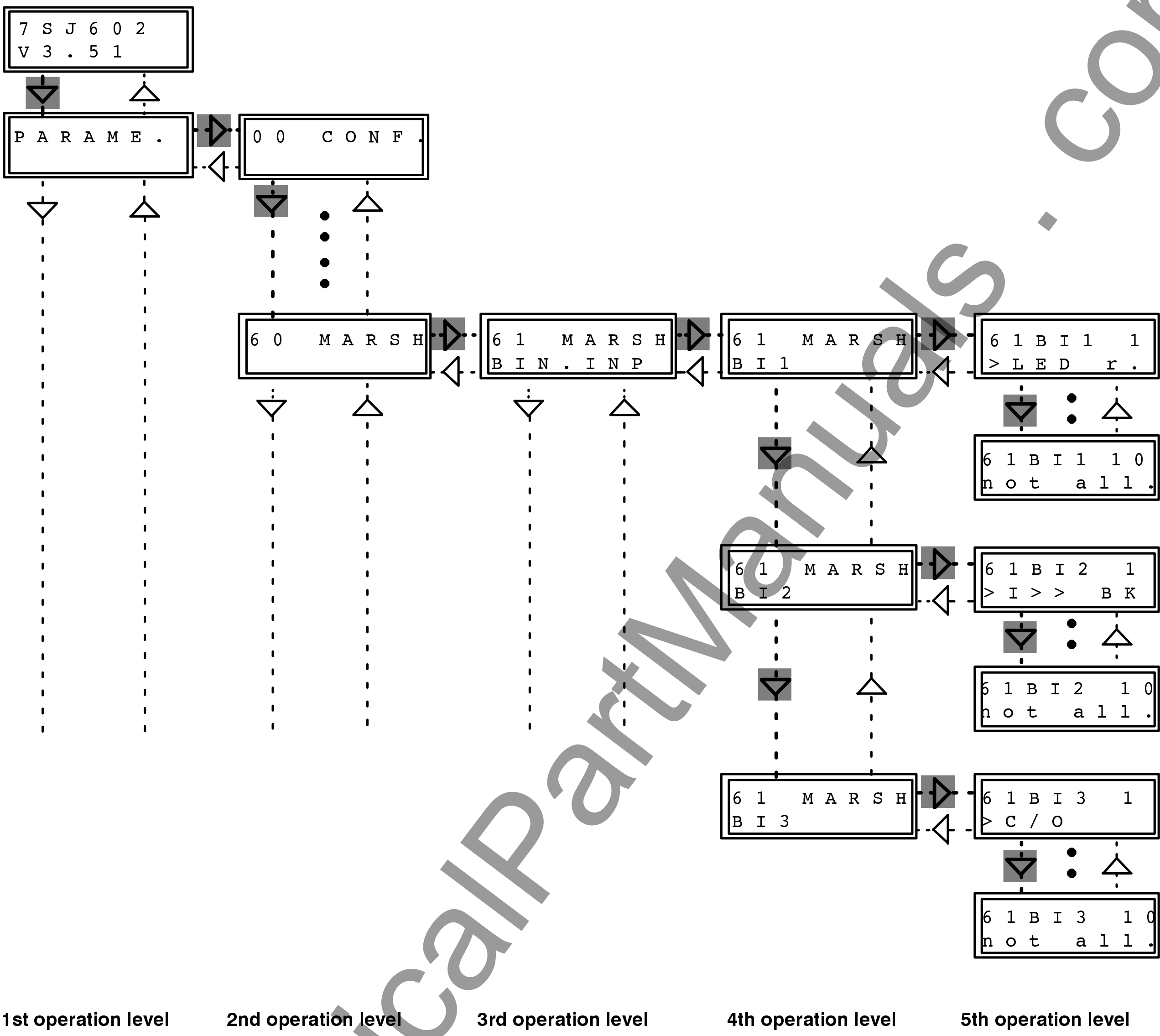


Figure 5.9 Extract from the operation structure and illustration of selection of the marshalling blocks

You may, for example, change with the key ▷ to the next operation menu level (e.g. to block 61 for marshalling the binary inputs) then with key ◁ back to the previous operation menu level, as shown in Figure 5.9. 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 sections, 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 BI 1 to BI 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 5.9).

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

Apart from the logical function, each individual input function can be marshalled to operate either in the "normally open" mode or in the "normally closed" mode when proceeding with the key ⊞.
Whereby:

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

n – "normally closed" mode: the input acts like a NC contact, i.e. control voltage present at the terminals turns off the function, control voltage absent activates the function.

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

Table 5.7 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 5.8 shows all binary inputs as preset from the factory.

```
◁  | 6 1   M A R S H |  ▷
▽  | B I N . I N P   |
```

[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
16	`>SysMMb`	Blocking of monitoring direction via system interface
356	`>mCLOSE`	Circuit breaker is manually closed (from discrepancy switch)
415	`>ResMax`	Reset minimum/maximum of measured values
418	`>RemBlk`	Block remote control
1157	`>CBclo`	Circuit breaker closed (from CB auxiliary contact)
1201	`>VE bl`	Block displacement voltage stage V_E>
1403	`>BF blo`	Block circuit breaker failure protection
1431	`>BF St`	Initiate (start) circuit breaker failure protection from external
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

Table 5.7 Marshalling possibilities for binary inputs (continued next page)

FNo	Abbreviation	Description
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
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
4601	>CBPcld	Feed-back information for circuit breaker closed
4602	>CBPopd	Feed-back information for circuit breaker open
4632	>SWblo.	Block control facility
4822	>MSP bl	Block motor restart inhibit
4823	>MSP em	Emergency start information for motor restart inhibit
4828	>MSPRTI	Reset thermal replica of motor restart inhibit
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 monitoring
6851	>SUP bk	Blocking trip circuit supervision
6852	>TrpRel	Trip circuit supervision: Trip relay
6853	>CBaux	Trip circuit supervision: CB auxiliary

Table 5.7 Marshalling possibilities for binary inputs

The complete pre-settings are listed in Table 5.8.

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

Table 5.8 Preset binary inputs

5.5.3 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 ▽ leads to address block "63 MARSH LED IND" (marshalling LED indicators).

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 memorized mode or the non-memorized 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 those listed in Table 5.10. 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**.

Note as to Table 5.10: Annunciations which are indicated by a leading ">" sign, represent the direct confirmation of the binary inputs and are active as long as the corresponding binary input is energized.

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 5.9 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 ▷:

```
63LED1   1
O/C  L1  M
```

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

```
63LED1   2
not all.
```

[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
63 MARSH LED 1	63LED1 1 O/C L1 M	1762	Fault detection of time overcurrent protection phase L1; memorized
63 MARSH LED 2	63LED2 1 O/C L2 M	1763	Fault detection of time overcurrent protection phase L2; memorized
63 MARSH LED 3	63LED3 1 O/C L3 M	1764	Fault detection of time overcurrent protection phase L3; memorized
63 MARSH LED 4	63LED4 1 DEV.TrpM	511	General trip of device; memorized

Table 5.9 Preset LED indicators

5.5.4 Marshalling of the output relays – address block 64

The unit contains 4 binary outputs (output relays for commands and signalling). These output relays are designated CMD.RE 1 to CMD.RE 4 and can be marshalled in 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); key ▽ leads to address block “64 MARSH CMD REL” (marshalling command/signal relays).

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 output relays (see also Section 5.5.1).

Table 5.10 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 to Section 5.4.2).

The assignment of the output relays as delivered from factory is shown in the general diagrams in Appendix A. The following boxes show an example for marshalling for output relay 1. Table 5.11 shows all output relays as preset from the factory.

Note as to Table 5.10: 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.

◁ ▽ | 64 MARSH
CMD.REL | ▷

[6400]
Beginning of the block “Marshalling of the output signal relays”

The first signal relay is reached with the key ▷ :

```
6 4   M A R S H
C M D . R E   1
```

[6401]
Allocations for output relay 1

Change over to the selection level with ▷ :

```
6 4 C M D 1   1
T r p   I > >
```

[6402]
Output relay 1 has been preset for:
1st: Trip by overcurrent stage I>> (phases)

```
6 4 C M D 1   2
T r p   I >
```

[6402]
Output relay 1 has been preset for:
2nd: Trip by overcurrent stage I> (phases)

```
6 4 C M D 1   3
n o t   a l l .
```

[6404]
no further functions are preset for output 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 output 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 output 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)
16	`>SysMMb`	Block annunciations and measured values to system interface
52	`operat.`	At least one protection function is operative
61	`Meas.Bl`	Annunciations and measured values to system interface blocked
162	`FailΣI`	Failure: Current summation supervision
177	`BatFail`	Battery failure; low battery
203	`REC del`	Fault recording data deleted
235	`RemBlk`	Remote control is blocked

Table 5.10 Marshalling possibilities for output relays and LEDs (continued next page)

FNo	Abbreviation	Description
236	OfProfi	Operation fault of Profibus interface
237	OfOlmCA	Operation fault of OLM Channel A
238	OfOlmCB	Operation fault of OLM Channel B
239	OfClkSy	Operation fault of clock synchronization
264	FailRTDb	Failure of RTD-box connection
284	IL< al	Undercurrent alarm IL<
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)
415	>ResMax	Reset minimum/maximum of measured values
416	iResMax	Internal automatic reset of minimum/maximum of measured values
417	ResMax	Minimum/maximum of measured values have been reset
418	>RemBlk	Block remote control
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
1201	>VE bl	Block displacement voltage stage V_E>
1215	FD VE	Pick-up (fault detection) of displacement voltage stage V_E>
1217	Trip VE	Trip by displacement voltage stage V_E>
1276	EFfor	Earth fault (non-earthed system) in forward direction
1277	EFrev	Earth fault (non-earthed system) in reverse direction
1278	EFundef	Earth fault (non-earthed system) direction undefined
1403	>BF blo	Block circuit breaker failure protection
1431	>BF St	Initiate (start) circuit breaker failure protection from external
1456	BF fltI	Circuit breaker failure protection internally initiated
1457	BF fltE	Circuit breaker failure protection externally initiated
1471	BF Trip	Trip by circuit breaker failure protection
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
1514	StATE	Thermal overload protection: Ambient temperature input failed
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 time overcurrent protection for phase currents
1702	>O/Cpof	Switch off time overcurrent protection for phase currents
1704	>O/Cpbk	Block time overcurrent time 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
1721	>I>>blk	Block I>> stage of time overcurrent 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 time overcurrent 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)

Table 5.10 Marshalling possibilities for output relays and LEDs (continued next page)

FNo	Abbreviation	Description
1727	>C/O	Dynamic change-over of overcurrent fault detection pick-up values
1751	O/Cpoff	Time overcurrent protection phase is switched off
1752	O/Cpblk	Time overcurrent protection phase is blocked
1753	O/Cpact	Time overcurrent protection phase is active
1756	O/Ceoff	Time overcurrent protection earth is switched off
1757	O/Ceblk	Time overcurrent protection earth is blocked
1758	O/Ceact	Time overcurrent protection earth is active
1762	O/C L1	Fault detection of time overcurrent protection phase L1
1763	O/C L2	Fault detection of time overcurrent protection phase L2
1764	O/C L3	Fault detection of time overcurrent protection phase L3
1765	O/C E	Fault detection of time overcurrent protection earth fault
1800	FD I>>	Fault detection of time overcurrent protection stage I>> phase currents
1805	Trp I>>	Trip by high-set I>>stages for phase currents
1810	FD I>	Fault detection of time overcurrent protection stage I> phase currents
1815	Trip I>	Trip by overcurrent I> stage for phase currents
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	AR blMC	Internal auto-reclosure function is blocked by manual closure
2876	AR DT	Internal auto-reclosure function dead time is running
4601	>CBPcld	Feed-back information for circuit breaker closed
4602	>CBPopd	Feed-back information for circuit breaker open
4632	>SWblo.	Block control facility
4640	Q0 Clo.	Control close-command CB–Q0
4641	Q0 Trp.	Control trip-command CB–Q0
4684	sw.a.rm	Switching authority remote
4822	>MSP bl	Block motor restart inhibit
4823	>MSP em	Emergency start information for motor restart inhibit
4824	MSP off	Motor restart inhibit is switched off
4825	MSP blk	Motor restart inhibit is switched on
4826	MSP act	Motor restart inhibit is active
4827	MSP tri	Trip by motor restart inhibit

Table 5.10 Marshalling possibilities for output relays and LEDs (continued next page)

FNo	Abbreviation	Description
4828	>MSPRTI	Reset thermal replica of motor restart inhibit
4829	MSP RTI	Thermal replica of motor restart inhibit is reset
4830	ThetaW	Warning of thermal replica of motor restart inhibit
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 time overcurrent protection is blocked
6801	>SRT bk	Block start-up time monitoring
6811	SRT off	Start-up time monitoring is switched off
6812	SRT blk	Start-up time monitoring is blocked
6813	SRT act	Start-up time monitoring is active
6821	SRT Trp	Trip by start-up time monitoring
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
14101	Fail RTD	Failure of any RTD (group annunciation)
14111	Fail RTD1	Failure of RTD No. 1
14112	Trp RDT1w	Pickup of RTD No. 1 warning stage
14113	Trp RDT1a	Pickup of RTD No. 1 alarm/trip stage
14121	Fail RTD2	Failure of RTD No. 2
14122	Trp RDT2w	Pickup of RTD No. 2 warning stage
14123	Trp RDT2a	Pickup of RTD No. 2 alarm/trip stage
14131	Fail RTD3	Failure of RTD No. 3
14132	Trp RDT3w	Pickup of RTD No. 3 warning stage
14133	Trp RDT3a	Pickup of RTD No. 3 alarm/trip stage
14141	Fail RTD4	Failure of RTD No. 4
14142	Trp RDT4w	Pickup of RTD No. 4 warning stage
14143	Trp RDT4a	Pickup of RTD No. 4 alarm/trip stage
14151	Fail RTD5	Failure of RTD No. 5
14152	Trp RDT5w	Pickup of RTD No. 5 warning stage
14153	Trp RDT5a	Pickup of RTD No. 5 alarm/trip stage
14161	Fail RTD6	Failure of RTD No. 6
14162	Trp RDT6w	Pickup of RTD No. 6 warning stage
14163	Trp RDT6a	Pickup of RTD No. 6 alarm/trip stage

Table 5.10 Marshalling possibilities for output relays and LEDs

1st display line	2nd display line	FNo	Remarks
MARSH	CMD.REL		Heading of the address block
64 MARSH 64CMD1-1 64CMD1-2	CMD1 Trp I>> Trp I>	 1805 1815	Trip by overcurrent protection phase currents (definite time I>> stage or I> stage)
64 MARSH 64CMD2-1 64CMD2-2	CMD2 TrpIE>> Trp TE>	 1833 1836	Trip by overcurrent protection earth current (definite time I_E>> stage or I_E> stage)
64 MARSH 64CMD3-1 64CMD3-2 64CMD3-3	CMD2 DEV.Trp Q0 Trp. CBtpTST	 511 4641 1185	General trip of the device: protection trip, control trip, and trip test
64 MARSH 64CMD4-1	CMD2 FT det	 501	General fault detection of the device

Table 5.11 Preset annunciations for output relays

5.5.5 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 time overcurrent 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).

In principle, all annunciation functions according to Table 5.10 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       |  ▷
▽  | 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 |  ▷
▽  | 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
Trp  I>>
```

Conditions for start of the AR may be for example:

[6502]
1st: Trip signal given by the phase time overcurrent protection high-set I>> stage

```
65  ARS01
TrpIE>>
```

[6503]
2nd: Trip signal given by the earth time overcurrent protection high-set I>> stage

```
65  ARS01
TrpI>>>
```

[6504]
3rd: Trip signal given by the phase time overcurrent protection instantaneous I>>> stage

```
65  ARS01
not  all.
```

[6505]
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 ▽.

The conditions for static blocking of the auto-reclosure are defined in the same way as described above. The same applies for the conditions for blocking of the initiation of the auto-reclose function.

```
65AR  MAR
ST.BLOCK
```

[6522]
Allocations for the conditions to inhibit the initiation of the auto-reclose function

---

```
65AR  MAR
CL.BLOCK
```

[6543]
Allocations for the blocking conditions of the auto-reclose command

---

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 or optical data carrier (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 2.4 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 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,

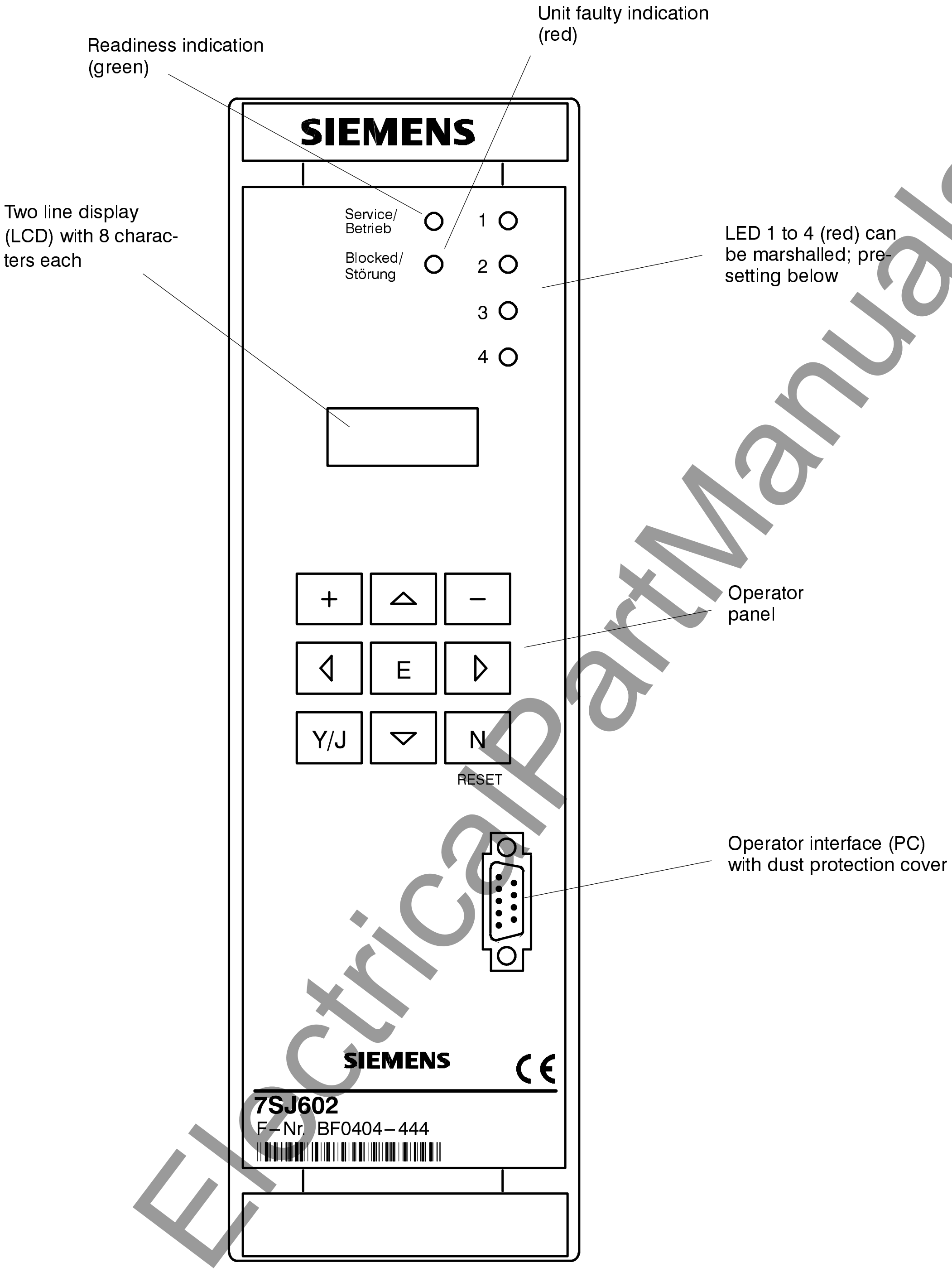
– configuration parameters for operation language, interface and device configuration,

– 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 obtained. 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 second 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 △ as far as the functions are available and have been configured as exiting.

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

If no user operation has taken place for more than 10 minutes, the relay terminates the setting mode and reverts to the default display, i.e. indication of the measured values. Alterations which have not yet been saved are lost. With the ◁ -key the last used operating level is then reached.

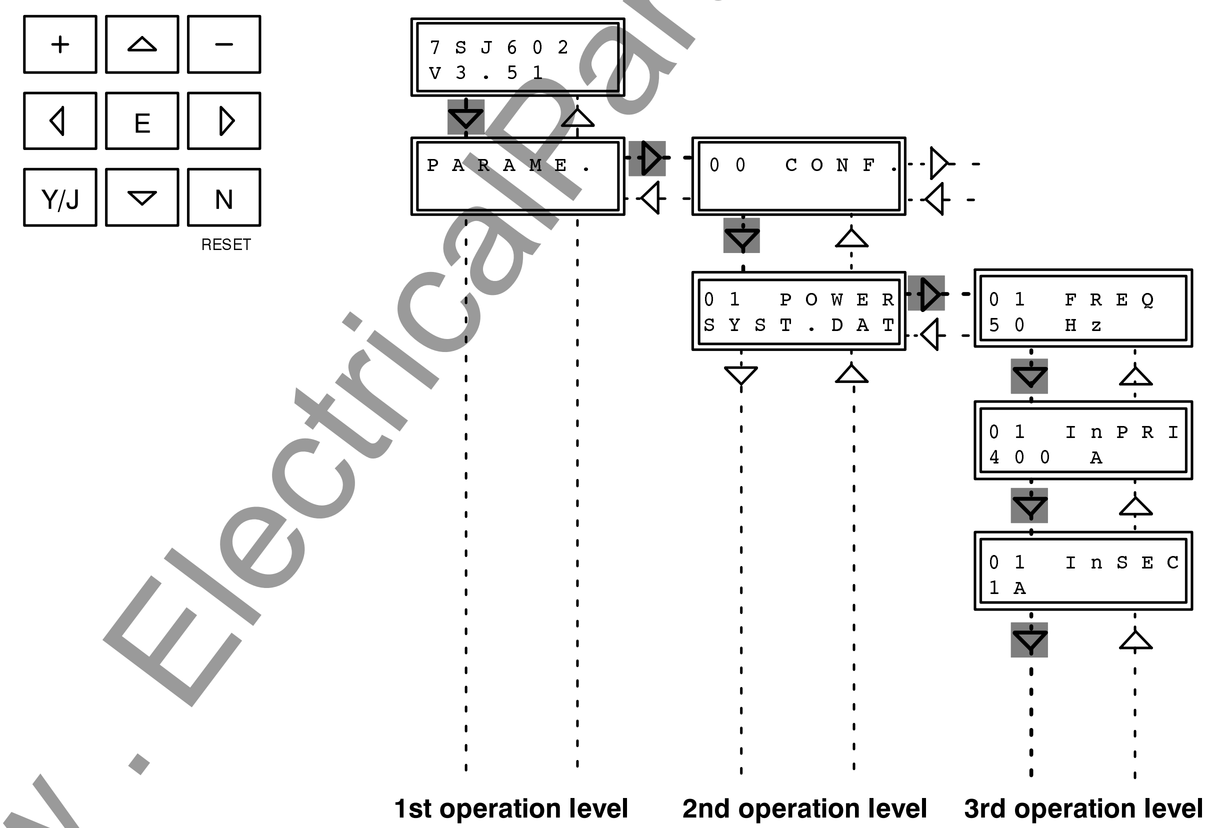


Figure 6.2 Selection of the power system data

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 ∞ 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

From the initial display, press the key ▽ three times until the menu item "ADDITION FUNCTION" ("additional functions") is displayed. Press the key ▷ 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.

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 has been 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.

◁
```
T I M E
S E T T I N G
```
▷

[8100]
Beginning of the block "Setting the real time clock"

◁
```
0 1 . 1 2 . 0 3
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 9 . 0 1 . 0 4
```

[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]
Use the key ▽ to come to the time setting. Enter the new time: 2 digits for hour (24 hours), 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 2
V 3 . * *
```

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 following rated currents are used only for scaling of the primary measured values and fault recording data:

```
◁  0 1   I n P R I  △▽
   4 0 0   A
```

[1105]
Current transformer primary rated current
Setting range: **10** A to **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 device provides four analog inputs for measured quantities. The use of these inputs depends on the ordered variant of the relay. Two inputs acquire always the measured phase currents I_{L1} and I_{L3}. Make sure that the primary and secondary rated current of the assigned current transformer set meet the settings of the rated values above (addresses 1105 and 1106). Different possibilities exist for the other inputs:

– Version 7SJ602*–*****–**A* (15th digit)

One measured value input is assigned to the phase current I_{L2}, the 4th input acquires the residual current I_E from the star-point of the current transformer set (standard circuit arrangement, see also Appendix B, Figure B.1):

The rated currents as stated above (addresses 1105 and 1106) are valid for all three phase currents. If the earth current originates from the same current transformer set (residual current from the star-point of the CTs, see also Appendix B, Figure B.1), set the factor Address 1110:

$$\text{Ie/Iph} = 1.000$$

But, if the earth current is derived from a separate earth current transformer (e.g. summation current transformer, refer to Figure B.2 in Appendix B) with a ratio which differs from that of the CTs of the phases, the relation of these ratios has to be set for Ie/Iph, i.e.

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

Example:

current transformers phase current	500 A/5 A
current transformer earth current	400 A/5 A

$$\text{Ie/Iph} = \frac{400/5}{500/5} = 0.800$$

– Version 7SJ602*–*****–**B* or –**J* (15th digit)

One measured value input is the sensitive earth current input for earth fault detection. It may acquire its input quantity from the star-point of the current transformer set or from a separate earth current transformer (e.g. window-type summation CT, refer to Figure B.5 in Appendix B). A matching factor has to be set in address 1111 which represent the possible difference between the CT transformation ratios.

If the earth current originates from the phase current transformer set set the factor Address 1111:

$$\text{Iee/Iph} = 1.000$$

If the earth current originates from a separate earth current transformer, set the relation of the ratios of this earth current CT to that of the phase current CTs:

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

Example:

current transformers phase current	500 A/5 A
summation current transformer	60 A/1 A

$$\text{Iee/Iph} = \frac{60/1}{500/5} = 0.600$$

– Version 7SJ602*–*****–**B* (15th digit)

The 4th measured value input is in this version a voltage input which acquires the displacement voltage V_{EN} (see also Figure B.4 in the Appendix B). In order to enable referred values to be calculated, set the primary and secondary rated voltage of the voltage transformers in addresses 1113 and 1114.

– Version 7SJ602*–*****–**J* (15th digit)

The 4th measured value input is in this version a voltage input which acquires the line-to-earth voltage V_{L1-E} (see also Figure B.3 in the Appendix B). This serves for output of the measured voltage, calculation of powers and metered energy demand. In order to enable referred values to be calculated, set the primary and secondary rated voltage of the voltage transformers in addresses 1113 and 1114.

When the relay is delivered, the powers and metered values are defined such that the values are positive when power is flowing into the protected object. For the power factor cos φ, the definition is correspondingly. In some applications it is desired to define the opposite direction positive, i.e. the power demand from the protected object to the bus-bar. The setting parameter in address 1115 PQinv can be used to invert the sign of these values.

```
01Ie/Iph
1.000
```

Only for version 7SJ602*–*****–**A*
[1110]

Matching factor Ie/Iph for earth current
Setting range: **0.010** to **5.000**

```
01Iee/Ip
1.000
```

Only for version 7SJ602*–*****–**B* or –**J*
[1111]

Matching factor Ie/Iph for earth current
Setting range: **0.003** to **1.500**

```
01IEESEC
1A
+
5A
```

Only for version 7SJ602*–*****–**B* or –**J*
[1112]

Rated current for the sensitive earth current input I_{EE}

1 A or *5 A*

```
01 VNPRI
10.00kV
```

Only for version 7SJ602*–*****–**B* or –**J*
[1113]

Rated primary voltage of the voltage transformers
Setting range: **0.10** kV to **400** kV

```
01 VNSEC
100 V
```

Only for version 7SJ602*–*****–**B* or –**J*
[1114]

Rated secondary voltage of the voltage transformers
Setting range: **100** V to **125** V

```
01 PQinv
OFF
+
ON
```

Only for version 7SJ602*–*****–**J*
[1115]
Inversion of the sign of the powers, power factor, and energy metering

OFF or *ON*

The following addresses refer to such statements which relate to several protection or other functions of the relay and are commonly used.

Address 1116 asks for the threshold value of current CB I>, above which the circuit breaker is surely closed. This setting can be very sensitive provided that no parasitical currents are expected during dead condition (e.g. caused by induction). Otherwise a higher value must be chosen. The default value is adequate in most cases.

If the relay is use as motor protection then observe the following:

The motor data are, generally, referred to the rated values of the motor. The settings of motor protection functions should, therefore, be entered as referred motor values. A pre-condition is that the relay is informed about the rated motor data. This is achieved with address 1118 where the ratio of rated motor current to rated primary current of the current transformer set is defined.

Example:

Motor with	rated power	4.5 MVA
	rated voltage	6 kV
Current transformers		500 A/5 A

The rated current of the motor is

$$I_{Nmotor} = \frac{4.5\ \text{MVA}}{\sqrt{3} \cdot 6\ \text{kV}} = 433\ \text{A}$$

This results in the setting of address 1118:

$$Im = \frac{433\ \text{A}}{500\ \text{A}} = 0.87$$

Further motor data are requested in addresses 1119 and 1120. They describe the start-up process of the motor.

The start-up current of the motor is set in address 1119. Since the relay has been informed about the rated motor current under address 1118 (see above) the per-unit start-up current is adequate here. It depends on the size and characteristics of the motor. Under normal load-free start-up conditions, 5 times the rated motor current is convenient.

Address 1120 requests for the start-up time of the motor. The start-up current must have been undershot after this time period has been elapsed. Consider also the information given under Start-up time monitoring in Section 6.3.12.

```
01 CB  I>
0.10  In
```

[1116]
Current threshold which is safely undershot when the circuit breaker is open
Setting range: **0.04** · I_N to **1.00** · I_N

```
01  Im
1.00
```

[1118]
Ratio rated motor current on rated primary CT current
Setting range: **0.20** to **1.20** · I_N

```
01  Istrt
5.0
```

[1119]
Motor start-up current referred to rated motor current
Setting range: **0.4** to **20.0** · Im

```
01 tStUp
10.0  s
```

[1120]
Maximum start-up time of the motor at start-up current
Setting range: **1.0** s to **360.0** s

Address 1121 determines whether or not the thermal replica of the thermal overload protection will be reset to zero each time the processor system of the relay re-starts. If set to *NO* the thermal replica will freeze the last valid state should the processor system restart (e.g. after the auxiliary power has failed).

```
01  ThRes
YES
+ NO
```

[1121]
Reset of the thermal replica of the thermal overload protection after re-start of the processor system
YES or *NO*

The minimum trip command duration T–TRP can be set in address 1134. 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.

```
01  T-TRP
0.15  s
```

[1134]
Minimum duration of the **trip** command
Setting range: **0.01** s to **32.00** s

```
01  T-CL
1.00  s
```

[1135]
Maximum duration of the **close** command
Setting range: **0.01** s to **60.00** s

The time interval of the long-term demand values established by the relay can be set in address 1136. Select one of the 3 usual time intervals.

You can reset the stored minimum and maximum measured values either manually or automatically. If you wish only manual reset (this applies also for reset via binary input or interface), you set address 1137 CYCLE to ∞.

Automatic reset is defined by the following parameters:

– CYCLE The memories are cleared automatically after periods of x days, where x can be a value from 1 to 365 days.

– START Automatic reset will take place on the x-th day from today. x may vary from 0 (i.e. today) to 365. Tomorrow will be "1".

– MINUTE Automatic reset will take place on the day defined by START and CYCLE at the beginning of the x-th minute. x may vary from 0 to 1439 minutes.

Note: If you have changed the system date of the device it is imperative to readjust these settings here since the instants of start and automatic reset are calculated from the internal system date. Refer also to Section 6.5.1.

```
01TINTER
15min
+
30min
60min
```

[1136]
Time interval for mean values of the long-term demand values:

15 min or *30 min* or *60 min*

```
01CYCLE
1  D
```

[1137]
Reset cyclically in days, e.g. every day (1 day)
Setting range: **1** D to **365** D
or ∞ (no automatic reset)

```
01START
2  D
```

[1138]
Start instant for cyclic reset in days, e.g. the day after tomorrow, i.e. after 2 days
Setting range: **0** D to **365** D

```
10MINUTE
360  min
```

[1139]
Minute of the day for automatic cyclic reset, e.g. at 6.00 o'clock a.m. = 6 · 60 minutes = 360 minutes
Setting range: **0** min to **1439** min

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 time overcurrent protection – address block 10

```
10  O/C
PHASE
```

[1300]
Beginning of the block "Time overcurrent protection for phase faults"

```
10  O/Cph
ON
```

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

```
+ OFF
```

Switching *OFF* of the phase fault time overcurrent 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

$$\frac{I>>>}{I_N} \approx \frac{I>>}{I_N} \approx 1.5 \cdot \frac{1}{u_{sc\ transf}} \cdot \frac{I_{N\ transf}}{I_{N\ CT}}$$

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 chart 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 application. 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 4.2.5). 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 stages I>>> and/or I>> are not used then set the pick-up values to ∞. This is accomplished by pressing the key [+] beyond the highest setting value.

```
1 0   T d y n
6 0 0 . 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

```
1 0   I > > >
∞
```

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

```
1 0   I > >
∞   I n
```

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

```
1 0   I > > d y
∞   I n
```

[1306]
Dynamic pick-up value of the high-set stage I>> (dyn)
Setting range: **0.1** · I_N to **25.0** · 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 chart 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** · I_N to **25.0** · I_N
and ∞ (no trip with I> for phase faults)

```
10  I>dy
2.0  In
```

[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** · I_N to **25.0** · 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 the following 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
RI
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)

RI

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 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** · I_N to **4.0** · I_N

```
10 Ip dy
2.0 In
```

[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** · I_N to **4.0** · I_N

If the function mode is *“ANSIinv”* or *“ANSI O/C”*, one of the following 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.

```
10 CHAph
inverse
+
short in
long inv
mode inv
very inv
extr inv
def inv
IsqaredT
never
```

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

normal *inverse*	time lag acc. ANSI/IEEE
*short inv*erse	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_p stages for phase currents operate *never*	

```
10 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

```
10  Ip
1.0  In
```

[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** · I_N to **4.0** · I_N

```
10  Ip  dy
2.0  In
```

[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** · I_N to **4.0** · I_N

Using an inverse time characteristics (excepted RI-curve) you can determine in address 1320 whether dropout of a stage is to follow immediately after the threshold undershot or whether it is evoked by disk emulation. "Immediately" means that the pickup drops out when the pickup value of approx. 95 % is undershot. For a new pickup the time counter starts at zero. If you set DOph = *DskEm* dropout is produced according to the dropout characteristic.

The disk emulation offers its advantages if the grading coordination chart of the time overcurrent protection is combined with other devices (on electro-mechanical or induction base) connected to the system.

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.

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 so that it is informed about manual closing of the breaker. *INEFFECT*ive means that the stages operate according to the settings.

```
10  DOph
Immediat
DskEm
```

[1320]
For inverse time overcurrent protection only:
Drop-out of the inverse time stages takes place immediately after switch-off of the current
Drop-out of the inverse time stages takes place with disk emulation, i.e. according to the drop-out characteristic

```
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

```
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

*INEFFECT*IVE, i.e. stages operate as parameterized

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

The time overcurrent protection for earth current is only possible in the corresponding device version (7SJ602*–*****–**A*) and if the respective configuration parameter (Section 5.4.2, address 7830) is set to an active group of characteristics. The other versions (7SJ602*–*****–**B* or **J*) provide a sensitive earth fault detection function which is described in Section 6.3.6.

```
1 1   O / C
E A R T H
```

[1400]
Beginning of the block "Time overcurrent protection for earth faults"

```
1 1   O / C   e
O N
```

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

```
+ O F F
```

Switching *OFF* of the earth fault time overcurrent 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, address 1302).

The high-set overcurrent stage IE>> is set, if used; if not used, set IE>> to ∞. 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.

```
1 1   I E > >
2 5 . 0 0 I n
```

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

```
1 1 I E > > d y
2 5 . 0 0 I n
```

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

```
1 1   T I E > >
0 . 1 0 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 of the phase current stage.

For earth faults, all parameters of the time overcurrent protection can be set separately and independently. This allows separate time grading for earth faults with e.g. shorter times. Again, a dynamic switch-over stage IE>dy is possible. For definite time protection, the minimum earth fault current determines the setting of the overcurrent stage IE>. 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 ∞.

```
11 IE>
0.20 In
```

[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** · I_N to **25.00** · I_N
and ∞ (no trip with I_E> for earth faults)

```
11 IE>dy
0.20 In
```

[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** · I_N to **25.00** · I_N
and ∞ (no trip with I_E>dyn)

```
11 TIE>
0.50 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

```
11 REPe
NO
+ YES
```

[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 the following 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 time overcurrent 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.

```
11 CHA e
inverse
+ short in
extr.inv
long inv
RI
RD
never
```

[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)

RI

RD

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

```
11  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
0.10  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** · I_N to **4.00** · I_N

```
11IEpdy
0.10  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** · I_N 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 I_{Ep} is not used then set "*never*" as inverse time characteristic for earth current.

```
11  CHA  e
inverse
```

[1411]
For inverse time overcurrent protection "ANSI O/C" or "ANSI inv" only:
Characteristic for earth 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
IsquaredT	*I−squared−T*	
never	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
0.10  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** · I_N to **4.00** · I_N

```
11IEpdy
0.10 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** · I_N to **4.00** · I_N

Using an inverse time characteristics (excepted RI- and RD-curve) you can determine under address 1428 whether the dropout of a stage is to follow immediately after the threshold undershot or whether it is evoked by disk emulation. "Immediately " means that the pickup drops out when the pickup value of approx. 95 % is undershot. For a new pickup the time counter starts at zero. If you set DOec = *DskEm* dropout is being produced according to the dropout characteristic.

The disk emulation offers its advantages if the grading coordination chart of the time overcurrent protection is combined with other devices (on electro-mechanical or induction base) connected to the system.

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.

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 7SJ602 so that it is informed about manual closing of the breaker. *INEFFECT*ive means that the stages operate according to the normal settings.

```
10 DOEc
Immediat
```

```
DskEm
```

[1418]
For inverse time overcurrent protection only:
Drop-out of the inverse time stage takes place immediately after switch-off of the current
Drop-out of the inverse time stage takes place with disk emulation, i.e. according to the drop-out characteristic

```
11CALC e
noHARMON
```

```
HARMONIC
```

[1415]
For inverse time overcurrent protection only:
The fundamental wave of the measured current is evaluated
The true r.m.s. value of the measured current is evaluated

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

```
+ IE>undel
```

```
IEp unde
```

```
INEFFECT
```

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

IE>> i.e. I_E>> stage but undelayed

E> i.e. I_E> stage (definite time), but undelayed

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

*INEFFECT*IVE, i.e. stages operate as parameterized

6.3.6 Settings for sensitive earth fault protection – address block 30

6.3.6.1 Time overcurrent protection using the earth current magnitude

Sensitive earth fault protection is only possible in the corresponding device versions (7SJ602*–*****–**B* or –**J*) and if the respective configuration parameter (Section 5.4.2, address 7815) is set to to an active group of characteristics. It works then instead of the time overcurrent protection for earth current (Section 6.3.5).

This function can be used in isolated or compensated networks to detect an earth fault and to discriminate the earth fault direction (models with directional supplement and connection of the displacement voltage 7SJ602*–*****–**B*).

In effectively (solidly) grounded or low-impedance earthed networks, detection of high-resistance earth faults with very small fault currents is possible, either with direction determination, if applicable (7SJ602*–*****–**B*). Because of its high sensitivity it is not suited for detection of higher earth fault currents (from $1.6 \cdot I_N$ and above at the relay terminals for high-sensitivity earth fault protection). For those applications use the time overcurrent protection for earth currents as described in Section 6.3.5.

```
30  XMZ
SENSIV  E
```

[3000]
Beginning of the block “Sensitive earth fault protection”

```
30XMZ  EE
ON
```

[3001]
Switching *ON* the sensitive earth fault protection

\+
```
OFF
```

Switching *OFF* the sensitive earth fault protection

```
ARLMonly
```

Only earth fault alarm but no trip

In order to detect earth currents, a two-stage current time characteristic can be set. The magnitude of the earth current is decisive for pick-up of these stages. They are used in cases where the magnitude of the earth current is the mean criterion of the earth fault, therefore, preferably in **low-impedance earthed** systems, or for **electrical machines** in bus-bar connection with isolated systems, where a high capacitive current of the system can be expected in case of machine earth fault but only an insignificant earth current in case of a system earth fault because of the low machine capacitance.

If a stage is intended to operate directional (possible only in version 7SJ602*–*****–**B*, see below under “Direction discrimination”), shorter tripping times are possible, dependent on the fault direction.

The high-value stage is designated with IEE>> (pick-up value in address 3013). It can be delayed by TIEE>> (address 3014) and lead to annunciation or even to trip. The latter is only possible if trip has been set, i.e. under address 3001 XMZ SENSIV E = *ON*. If the I_{EE}>>-stage is not needed set the pick-up value to ∞.

If the dynamic switch-over facility is used and an adequate binary input has been assigned to this function, the appropriate threshold value is set as IEE>>dy (address 3003). The duration of the dynamic switch-over is the same as set for phase currents (Section 6.3.4, address 1302).

```
30   IEE>>
1.500   In
```

[3013]
Pick-up value of the high-set stage I_{EE}>> for earth faults
Setting range: **0.003** · I_N to **1.500** · I_N
and ∞ (no trip with I_{EE}>> for earth faults)

```
30IEE>>d
1.500   In
```

[3016]
Dynamic pick-up value of the high-set stage I_{EE}>> (dyn) for earth current
Setting range: **0.003** · I_N to **1.500** · I_N
and ∞ (no trip with I_{EE}>>dyn)

```
30TIEE>>
0.30   s
```

[3014]
Trip time delay of the high-set stage I_{EE}>>
Setting range: **0.00** s to **60.00** s

The lower value stage can be used as definite time overcurrent protection or inverse time overcurrent protection or both at the same time. This depends on the configuration setting according to Section 5.2.4 (address 7815 XMZech). Correspondingly, only those settings are available here which match the configuration. The minimum earth fault current determines the setting of the overcurrent stage I_{EE}>.

Again, a dynamic switch-over stage IEE>dy is possible. A stage not needed can be set to ∞.

```
30   IEE>
0.500   In
```

[3015]
For definite time overcurrent protection only (def TIME, IEC O/C, ANSI O/C):
Pick-up value of the overcurrent stage I_{EE}> for earth faults
Setting range: **0.003** · I_N to **1.500** · I_N
and ∞ (no trip with I_{EE}> for earth faults)

```
30   IEE>d
0.750   In
```

[3017]
For definite time overcurrent protection only (def TIME, IEC O/C, ANSI O/C):
Dynamic pick-up value of the stage I_{EE}> (dyn)
Setting range: **0.003** · I_N to **1.500** · I_N
and ∞ (no trip with I_{EE}>dyn)

```
30   TIEE>
5.00   s
```

[3018]
For definite time overcurrent protection only (def TIME, IEC O/C, ANSI O/C):
Trip time delay for the overcurrent stage I_{EE}>
Setting range: **0.00** s to **60.00** s

```
30   REPee
NO
+ YES
```

[3019]
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 the following 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 time overcurrent 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 inverse time overcurrent stage I_{Ep} is not to be used then set "*never*" as characteristic for earth current.

```
30CHAee
inverse
+ short in
  extr.inv
  long inv
  RI
  RD
  never
```

[3020]
For inverse time overcurrent protection "IEC O/C" or "IEC inv" only: Characteristic of the overcurrent stage I_{EEp} 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)
RI	
RD	
I_{EEp} stage operates *never*	

```
30TIEEp
0.50 s
```

[3021]
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

```
30IEEp
0.100 In
```

[3024]
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: **0.003** · I_N to **1.400** · I_N

```
30IEpdy
0.100 In
```

[3025]
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: **0.003** · I_N to **1.400** · I_N

If the function mode is "*ANSIinv*" or "*ANSI O/C*", one of the following 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_{EEp} is not used then set "*never*" as inverse time characteristic for earth current.

```
3 0 C H A e e
i n v e r s e
```

`short in`	*short in*verse	time lag acc. ANSI/IEEE
`long inv`	*long in*verse	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
`IsquaredT`	*I−squared−T*	
`never`	I_{EEp} stage for earth current operates *never*	

[3022]
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

```
3 0 D E E
0 . 5   s
```

[3023]
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

```
3 0 I E E p
0 . 1 0 0   I n
```

[3024]
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: **0.003** · I_N to **1.400** · I_N

```
3 0 I E E p d y
0 . 1 0 0   I n
```

[3025]
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: **0.003** · I_N to **1.400** · I_N

Using an inverse time characteristics (excepted RI and RD) you can determine under address 3026 whether the dropout of a stage is to follow immediately after the threshold undershot or whether it is evoked by disk emulation. “Immediately ” means that the pickup drops out when the pickup value of approx. 95 % is undershot. For a new pickup the time counter starts at zero. If you set DOsEc = *DskEm* dropout is being produced according to the dropout characteristic.

The disk emulation offers its advantages if the grading coordination chart of the time overcurrent protection is combined with other devices (on electro-mechanical or induction base) connected to the system.

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. 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.

The next parameter in address block 30 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 7SJ602 so that it is informed about manual closing of the breaker. *INEFFECTive* means that the stages operate according to the normal settings.

```
30DOsEc
Immediat

DskEm
```

[3026]
For inverse time overcurrent protection only:

Drop-out of the inverse time stage takes place immediately after switch-off of the current

Drop-out of the inverse time stage takes place with disk emulation, i.e. according to the drop-out characteristic

```
30CALCee
noHARMON

HARMONIC
```

[3027]
For inverse time overcurrent protection only:

The fundamental wave of the measured current is evaluated

The true r.m.s. value of the measured currents is evaluated

```
30M.CLee
IE>>unde

+ IE>undel

IEp unde

INEFFECT
```

[3028]
Earth overcurrent stage which is effective during manual closing of the circuit breaker:

IE>> i.e. I_{EE}>> stage but undelayed

E> i.e. I_{EE}> stage (definite time), but undelayed

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

*INEFFECT*IVE, i.e. stages operate as parameterized

6.3.6.2 Displacement voltage

Displacement voltage detection presumes the presence of the displacement voltage. It is only possible with models with displacement voltage input (7SJ602* – ***** – **B*).

The displacement voltage stage Ve> initiates earth fault detection and is one condition for release of directional determination. It can also be set as a time delayed zero sequence voltage protection with trip, non-directional or in conjunction with the preset direction.

Ve means the voltage at the input to the device.

Since, for earth faults in **compensated** or **isolated** networks or in **electrical machines** with non-earthed star-point, the full displacement voltage appears, the setting value is not critical in these applications; it should lie between $0.3 \cdot V_N$ and $0.6 \cdot V_N$. Earth fault is detected and annunciated only when the displacement voltage has been stayed for the duration TVeADl.

In **earthed** networks, the set value of the displacement voltage Ve> can be more sensitive (smaller); but it shall not be exceeded by operational asymmetry of the voltages of the power system.

Pick-up by the displacement voltage can be used for time delayed trip command. Pre-condition is that the trip facility has been switched on (XMZ EE = *ON* in address 3001). Trip delay is then set under address 3312 TVe>. Note, that the total command time is composed of the inherent measuring time (approximately 60 ms) plus pick-up delay TVeAD plus trip delay TVe>.

```
30  VE>
STAGE
```

[3300]
Beginning of the block “Displacement voltage stage”

```
30  Ve>
0.10  Un
```

[3309]
Threshold value for displacement voltage Ve>
Setting range: **0.02** V_N to **1.05** V_N

```
30TVeADl
1.00  s
```

[3311]
Duration of displacement voltage after which earth fault is detected and annunciated
Setting range: **0.04** s to **320.00** s
and ∞ (ineffective)

```
30TVe>
60.0  s
```

[3012]
Time delay for tripping with Ve> (only if set to trip: XMZ EE = *ON* in address 3001)
Setting range: **0.1** s to **40000.0** s
and ∞ (ineffective)

6.3.6.3 Direction discrimination

Determination of the earth fault direction is possible for all stages of the highly sensitive earth fault protection provided the device version is equipped with a measured voltage input and this is connected to the displacement voltage (7SJ602*–*****–****B***). High-accuracy processing of the active (I_{Ea}) and reactive (I_{Er}) component of the earth current is possible, too.

First, determine which earth fault protection stage is to operate in which direction.

```
30 DIR E
SENSITIV
```

[3100]
Beginning of the block “Sensitive directional earth fault protection”

```
30DIEE>>
forwds.
```

```
+ reverse
  non-dir.
```

[3115]
Operating direction for the I_{EE}>> stage

forwds forward direction, normally line, motor, or transformer

reverse reverse direction, normally bus-bar

non-dir in either direction; in this case, no displacement voltage is necessary

```
30DIEE>
forwds.
```

```
+ reverse
  non-dir.
```

[3122]
Operating direction for the I_{EE}> (definite time) and/or I_{EEp} (inverse time) stage

forwds forward direction, normally line, motor, or transformer

reverse reverse direction, normally bus-bar

non-dir in either direction; in this case, no displacement voltage is necessary

---

The shape of the directional characteristic is determined by the following settings. At first, decide whether the active or reactive component of the earth current, referred to the displacement voltage, should be evaluated.

– DIRMOD = *COS PHI*
  means that only the active component of the earth current $I_{EE} \cdot \cos \varphi$ is decisive for the threshold IEEDIR (Figure 6.3),

– DIRMOD = *SIN PHI*
  means that only the capacitive component of the earth current is decisive for the threshold IEEDIR (Figure 6.5).

Based on this definition, the directional characteristic can be shifted by ±45°.

In **compensated** systems earth fault measurement with *COS PHI* is used because the ohmic current is decisive for the earth fault direction (Figure 6.3).

In **earthed** systems earth fault measurement with *COS PHI* is used with a correction angle of PHICOR = –45° because the earth current is ohmic-inductive (Figure 6.4).

In **isolated** systems earth fault measurement with *SIN PHI* is used because the capacitive current is decisive for the earth fault direction (Figure 6.5).

On **electrical machines** in bus-bar connection with an isolated system, *COS PHI* measurement can be selected with a correction angle of approximately PHICOR = +45° because the earth current is often composed of a capacitive component from the system and an active component from a earth fault load resistor (Figure 6.6).

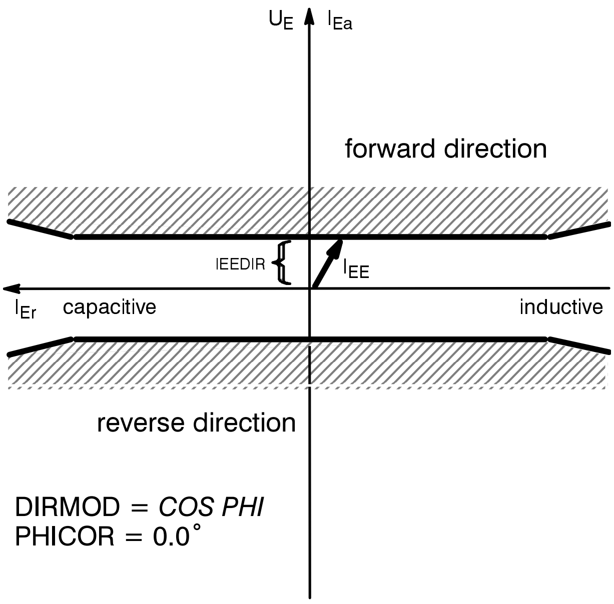


Figure 6.3 Directional characteristic with cos φ measurement

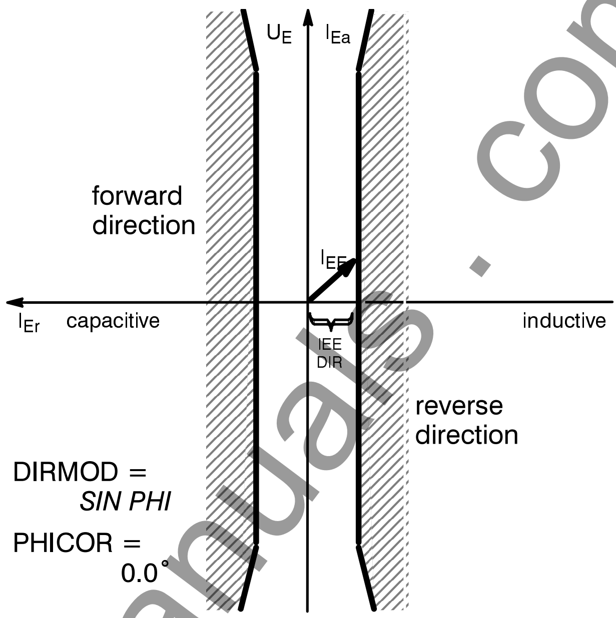


Figure 6.5 Directional characteristic with sin φ measurement

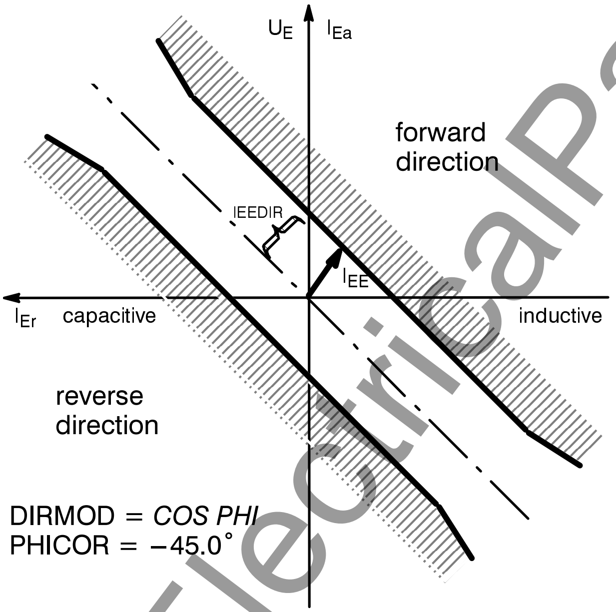


Figure 6.4 Directional characteristic with cos φ measurement and correction angle of −45°

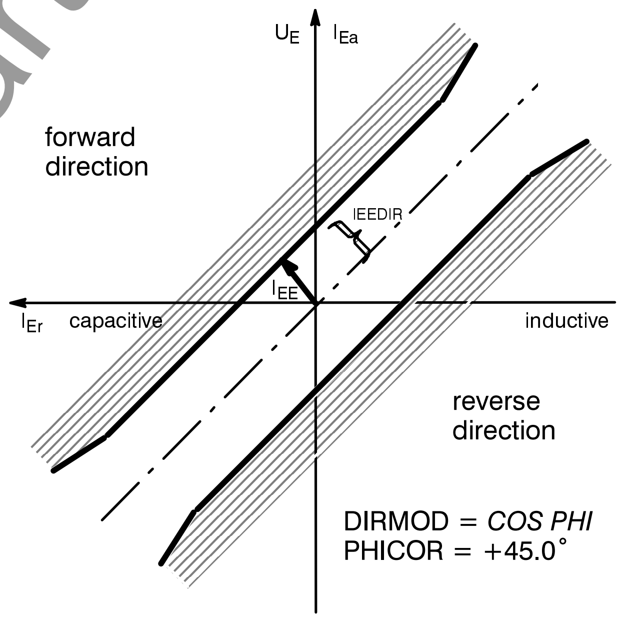


Figure 6.6 Directional characteristic with cos φ measurement and correction angle of +45°

```
3 0 D I R M O D
C O S   P H I

S I N   P H I
```

[3125]
Measurement mode for directional determination:

COS PHI the ohmic current component is decisive for directional determination; for use in compensated and earthed systems

SIN PHI the capacitive current component is decisive for directional determination; for use in systems with isolated neutral

```
3 0 P H I C O R
0 . 0   d e g
```

[3124]
Correction angle for directional determination, based on the measurement direction with cos φ or sin φ setting
Setting range: **−45.0** deg to **+45.0** deg

The current value IEEDIR represents the release threshold for directional determination. In this case, it is the current component which is rectangular to the directional characteristic as determined before.

Additionally, you can set a stabilization time TDirSt for direction discrimination, i.e. a direction determined once is maintained at least for this time. This prevents from intermittent direction indications in border cases.

For determination of the direction of the earth fault, in general, the threshold current (address 3123) should be such that faulty operation due to asymmetrical currents in the network and through the current transformers (particularly in Holmgreen connection) is avoided.

Generally the following applies: If directional determination is used in conjunction with one of the sensitive earth current stages as described above (IEE>> or IEE> or IEEp), then only a value smaller than or equal to the pick-up value of one of the above stages is meaningful for IEEDIR.

In **compensated** networks directional determination is more difficult since a much larger reactive current of capacitive or inductive nature is superimposed on the critical wattmetric current. The total earth current available to the relay can therefore, dependent upon the network configuration and location of the compensation coil, assume very different values in magnitude and phase angle. The relay, however, must evaluate only the active component of the earth fault current, that is, $I_E \cdot \cos\varphi$. This demands extremely high accuracy, particularly with regard to phase angle accuracy of all the instrument transformers. Also, the relay should not be set unnecessarily sensitive. When used in compensated networks, therefore, reliable directional determination is only expected when core balance or window-type summation transformers are used. Use half the value of the expected measured current, whereby only the residual wattmetric current is applicable. This residual wattmetric current is produced mainly by the losses in the Petersen coil.

In **earthed** networks the threshold IEEDIR is set slightly below the minimum expected earth fault current. Note that only the current component rectangular to the directional characteristic is decisive for pick-up of the IEEDIR stage.

In **isolated** networks an earth fault in a cable will allow the total capacitive earth fault currents of the entire electrically connected network, with the exception of the faulted cable itself, to flow through the measuring point. It is normal to use half the value of this earth fault current as the threshold value.

On **electrical machines** in bus-bar connection, only the earth current produced by the load resistor is taken in order to keep measurement independent of the switching conditions of the system.

```
30IEEDIR
0.200 In
```

[3123]
Threshold value for directional determination:

– ohmic earth fault current component for arc compensated systems
– ohmic-inductive component for earthed systems
– capacitive component of earth fault current for isolated systems
– ohmic-capacitive component for electrical machines

Setting range: **0.003** · I_N to **1.200** · I_N

```
30TDirSt
1 s
```

[3126]
Stabilization time for direction determination
Setting range: **1** s to **60** s

The high reactive current component in **compensated** networks and the unavoidable air gap of the window-type current transformer often make compensation of the angle error of the current transformer necessary. The angle error characteristic of the CT is entered to the device by two operating points, for the actually connected burden (Figure 6.7):

– The maximum angle error F1 of the c.t. with its associated current I1 and

– another c.t. operating point I2/F2 above which the angle error remains practically constant.

The device then approximates, with adequate accuracy, to the characteristic of the transformer. In **isolated** or **earthed** networks, and on **electrical machines** this angle error compensation is not necessary as angle accuracy is not requested, here.

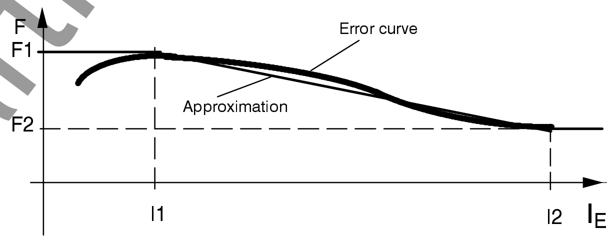


Figure 6.7 Example for angle error F dependent on the current I_E

```
30CTErI1
0.100 In
```

[3102]
Secondary current I1 for max. error angle of current transformer
Setting range: **0.003** · I_N to **1.600** · I_N

```
30CTErF1
0.0 deg
```

[3103]
Error angle of current transformer at I1
Setting range: **0.0** deg to **5.0** deg

```
30CTErI2
0.100 In
```

[3104]
Secondary current I2 above which the angle error is practically constant
Setting range: **0.003** · I_N to **1.600** · I_N

```
30CTErF2
0.0 deg
```

[3105]
Error angle of current transformer at I2
Setting range: **0.0** deg to **5.0** deg

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 time overcurrent protection, for example, must be set sufficiently high so as to only detect short-circuits. Only short delays are permitted for short-circuit protection. These short time delays, however, do not permit measures to unload the overloaded object nor to utilize its (limited) overload capacity.

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 thermal limit of the protected object is defined in IEC 60655–8 by a k-factor (address 2702) which determines the ratio between the continuous permissible current through the protected object and the rated primary current of the current transformers, i.e.:

$$k = \frac{I_{maxobj}}{I_{Npri}}$$

The permissible continuous current depends, in case of cables, on cross-section, insulation material, type of construction, in case of motors on the insulation material. In general, the magnitude of the current can be taken from widely available tables or otherwise is to be stated by the manufacturer. Note that the rated current of the protected object may differ from that of the current transformers.

<u>Example</u> for a motor:

Motor with	rated power	4.5 MVA
	rated voltage	6 kV
	permissible overload	10 %
Current transformers		500 A/5 A

The rated current of the motor is

$$I_{Nmotor} = \frac{4.5\ \text{MVA}}{\sqrt{3} \cdot 6\ \text{kV}} = 433\ \text{A}$$

The maximum permissible continuous current is

$$1.1 \cdot 433\ \text{A} = 476\ \text{A}$$

This results in a k-factor of:

$$\text{k-Fac} = \frac{476\ \text{A}}{500\ \text{A}} = 0.95$$

The heating-up time constant τ depends on the cross-section, insulation material, type of construction and method of installation of the cable, motor or transformer and cooling method if applicable. 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 τ [min] =

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

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

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

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 parameter in address 2704 which represents the factor how much times the cooling-down time constant exceeds the heating-up time constant. The criterion that the motor is at stand-still is that all currents are smaller than threshold CB I> which was set under the power system data.

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.

```
01  k-Fac
1.10
```

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

```
27  τ-CON
10.0min
```

[2703]
Time constant τ
Setting range: **1.0** to **999.9** min

```
27  f-τco
2.00
```

[2704]
Prolongation factor of the time constant at stand-still referred to the time constant during running
Setting range: **1.00** to **10.00**

```
27  Θ-ALM
90  %
```

[2705]
Thermal warning stage, in % of trip temperature rise $\Theta_{warn}/\Theta_{trip}$
Setting range: **50** % to **99** %

If an RTD-box is connected to the relay in order to include the ambient or cooling medium temperature via the serial system interface then this temperature can be considered in the thermal replica. The temperature of the 1st RTD is always decisive for calculation of the total temperature.

Since overload protection calculates exclusively in referred values, the ambient temperature is referred to the steady-state temperature at rated current of the protected object. This temperature under steady-state conditions at the 1st RTD is set under address 2708 Tnc. If, during configuration of the protective functions in address 7844 (refer to Section 5.4.2), you have decided to give temperatures in °C, the temperature value has to be entered in °C as shown in the example below. If you have selected °F as temperature unit, set the values in °F.

The object temperature at rated current is normally stated for an ambient temperature of ϑ_{amb} = 40 °C (104 °F). If it is stated for a different ambient temperature, this must be considered during setting.

Example:
ϑ_{nc} = 100 °C at ϑ_{amb} = 20 °C result in setting:
Tnc = 120 °C (at 40 °C ambient temperature)

Note: If you change the temperature unit under address 7844 after having made temperature setting here, you have to readjust the value here in the changed temperature unit. The values will not be converted automatically.

```
2 7   T n c
1 0 0 ° C
```

[2708]
Temperature in the protected object at nominal current
Setting range: **40** °C to **200** °C
or **104** °F to **392** °F

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 (address 2707):

Setting value $$\frac{I_L}{I_{N\,Device}} = \frac{I_{N\,mach}}{I_{Npri}}$$

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 n
```

[2707]
Base value I_L for overload stage without memory (pick-up at 1.1 times I_L)
Setting range: **0.4** · I_N to **4.0** · I_N

6.3.8 Settings for circuit breaker failure protection – address block 36

The circuit breaker failure protection is effective only if it has been configured as *EXIST* (refer to Section 5.4.2).

You can switch the breaker failure protection *ON* or *OFF* under address 3601 B/F.

```
3 6   B / F
```

[3600]
Beginning of the block "Circuit breaker failure protection"

```
3 6 B / F
O F F
```

[3601]
Switch *OFF* of the breaker failure protection

```
+ O N
```

Switch *ON* of the breaker failure protection

The threshold value for the current criterion is the same that is set for identification of the closed breaker CB I> in address 1111 under the power system data in Section 6.3.3.

The time delay is determined from the maximum operating time of the circuit breaker, the reset time of the current detectors plus a safety margin which covers also the spread of the timer.

The time sequence is shown in Figure 6.8.

You can determine under address 3603 B/F–AC whether the feed-back information of the breaker from its auxiliary contact and via a binary input should be considered in the breaker failure protection. If set to *ON*, the auxiliary contact criterion is processed. This has a meaning if the current through the closed breaker may be lower than the current threshold CB I>. This is the case when trip by relay functions can occur which are not initiated by current flow, e.g. overvoltage Ve>. Of course, the auxiliary contact of the breaker must have been fed to a binary input of the relay.

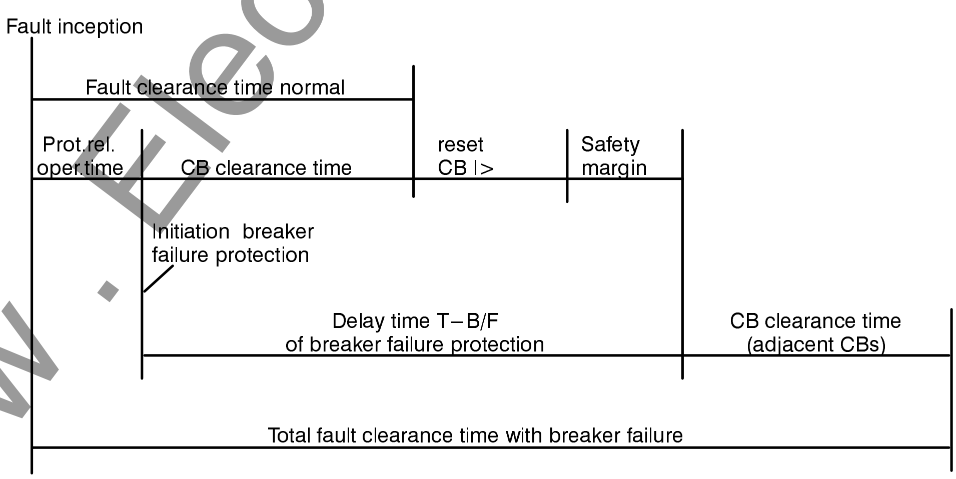


Figure 6.8 Time sequence for normal clearance of a fault, and with circuit breaker failure

```
36T-B/F
2.00  s
```

[3602]
Delay time of breaker failure protection
Setting range: **0.06** s to **60.00** s
and ∞ (no trip)

```
36B/F-AC
OFF
```

[3603]
Switch *OFF* the auxiliary contact criterion

```
+ ON
```

Switch *ON* the auxiliary contact criterion

6.3.9 Settings for unbalanced load / negative sequence protection – address block 24

The relay includes an unbalanced load protection (refer to Section 4.6). 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  UNBAL
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

The unbalanced load protection measures the negative sequence current and is of dual stage design. The high negative sequence current stage I2>> is shortly delayed and the stage I2> is normally assigned with a longer delay time. The preset values are adequate in most cases. If values about the permissible negative sequence current are available (e.g. as stated by the motor manufacturer in case of motor protection), these should be considered.

The percent values relate to the rated current of the CT set.

```
24  I2>
10  %
```

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

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

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

6.3.10 Settings for measured value supervision – address block 29

The sensitivity of the measured value supervision can be changed in block 29, for the device variants 7SJ602*–*****–**A*. The factory settings are experienced values and should be suitable in most cases.

If, during operation, the supervision function reacts sporadically, then sensitivity should be reduced (higher values). Current sum supervision can operate properly only if 4 currents are connected to the relay.

```
29  MEAS.
VAL.SUP.
```

[2900]
Beginning of the block “Current sum supervision”

```
29SUM.Th
0.10  In
```

[2901]
Current threshold above which the sum supervision is effective (see Figure 4.27)
Setting range: **0.05** · I_N to **2.00** · I_N
or ∞ (current sum supervision ineffective)

```
29SUM.Fa
0.10
```

[2902]
Sum factor for the current sum = slope of the sum characteristic (see Figure 4.27)
Setting range: **0.10** to **0.95**

6.3.11 Settings for auto-reclosure – address block 34

Auto-reclose function is effective only if it is incorporated in the relay and has been 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 (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. 7SJ602 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 chart of the system.

The 7SJ602 device 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 force, 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 successful 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 time overcurrent protection.

The lock-out time T–LOC is the time period during which after an unsuccessful auto-reclosure further reclosures by 7SJ602 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).

```
◁ | 3 4   A R | ▷
```

[3400]
Beginning of the block “internal auto-reclosure function”

```
◁ | 3 4   A R |  ▽
  | O N       |
```

[3401]
Switch *ON* of internal auto-reclosure

```
+ | O F F |
```

Switch *OFF* of internal auto-reclosure

34 ARcnt 1	[3472] Number of permissible auto-reclosure shots Setting range: **1** to **9**
34 AR T1 0.10 s	[3465] Dead time for the first auto-reclose cycle Setting range: **0.05** s to **1800.00** s
34 AR T2 0.10 s	[3466] Dead time for the second auto-reclose cycle, if used Setting range: **0.05** s to **1800.00** s
34 AR T3 0.10 s	[3467] Dead time for the third auto-reclose cycle, if used Setting range: **0.05** s to **1800.00** s
34 AR T4 0.10 s	[3468] Dead time for the fourth and any further auto-reclose cycle, if used Setting range: **0.05** s to **1800.00** s
34 T-REC 10.00 s	[3469] Reclaim time after successful auto-reclosure Setting range: **0.05** s to **320.00** s
34 T-LOC 3.00 s	[3470] Lock-out time after unsuccessful AR Setting range: **0.05** s to **320.00** s
34 T-BLM 1.00 s	[3471] Blocking time after manual closing of circuit breaker Setting range: **0.50** s to **320.00** s

6.3.12 Settings for start-up time monitoring – address block 28

The device incorporates a start-up time monitor (refer to Section 4.8), 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 current Istrt and start-up time tStUp of the motor have been already entered with the power system data in Section 6.3.3 (addresses 1119 and 1120).

The start-up criterion is the increased current that the motor takes during start-up. Consequently, the critical current value Ia (address 2803) 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 setting value refers to the rated motor current as set in the power system data under address 1118 (Section 6.3.3). Common setting is half the value of the start-up current: For instance, if the motor start-up current amount to 5 times the rated motor current, Ia is set to 2.5.

The tripping time is proportional to the square of the current magnitude, i.e.

$$T_{trip} = t_{StUp} \cdot \left(\frac{I_{strt}}{I_{rms}} \right)^2$$

Consequently, for half the start-up current, 4 times the start-up time is to be considered.

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 the configuration) should be blocked during start-up of a motor, after 70 ms. This has a meaning in case the pick-up current and the tripping time of the time overcurrent protection would be exceeded during start-up of the motor.

```
28 START
TIME SUP
```

[2800]
Beginning of the block “Start-up time monitoring”

```
28 STRT
ON
```

[2801]
Switching *ON* the start-up time monitoring

```
+ OFF
```

Switching *OFF* the start-up time monitoring

```
28Istrt>
4.0 Im
```

[2803]
Pickup value I_{strt}> of the start-up monitoring function referred to the nominal motor current I_m
Setting range: **0.4** · I_m to **20.0** · I_m

```
28I> blk
NO
```

[2804]
Blocking of the I>/Ip stages during motor start-up

```
+ YES
```

6.3.13 Settings for motor restart inhibit – address block 43

The motor restart inhibit is effective only if it has been configured as *EXIST* (refer to Section 5.4.2).

You can switch the start inhibit *ON* or *OFF* under address 4501 MotPro.

```
43MotPro
```

[4500]
Beginning of the block “Motor restart inhibit”

```
43MotPro
OFF
+
ON
```

[4501]
Switch *ON* the restart inhibit

Switch *OFF* the restart inhibit

The replica of the rotor temperature is decisive for the limit for a permissible restart of the motor. The necessary characteristic quantities, like start-up current, rated motor current, and maximum permissible start-up time have been entered to the relay in the power system data (address block 01, refer to Section 6.3.3).

Furthermore, knowledge of the thermal equalizing time of the rotor is necessary as well as the permissible number of restarts from the cold state (nc) and from the operating temperature (nw) of the motor.

Since the thermal time constant of the rotor is much lower compared with that of the stator, an equalizing time Tequal (address 5402) of 1 minute is practical in most cases.

The number of permissible warm restarts of the motor is set in address 4503 nw, the difference between the permissible warm restarts and cold restarts, nc – nw, is set in address 4504.

The prolongation factor $k\tau$ (address 4505) considers the reduced cooling effect when a self-ventilated motor is at stand-still. Set it as a factor of the operational thermal time constant of the idle state. The motor is assumed to be at stand-still when the current threshold for open breaker is undershot (address 1116 CB I>, see Section 6.3.3). In case of a forced-ventilated motor, set $k\tau$ to 1.

Even the running motor may have different thermal time constants for heating up and cooling down. Setting of the factor $k\tau 2$ (address 4506) considers this phenomenon. Set it as a factor of the thermal time constant of the heating up time constant.

The value for the minimum lockout time TMotBl (time period for which motor restart is locked out) depends of the requirements made by the motor manufacturer, or by the operation conditions. It must in any case be higher than the equalizing time Tequal.

```
43Tequal
1.0min
```

[4502]
Thermal equalizing time of the rotor of the motor
Setting rage: **0.0** min to **60.0** min

```
43nw
2
```

[4503]
Maximim permissible number of warm restarts of the motor
Setting rage: **1** to **4**

```
4 3 n c - n w
1
```

[4504]
Difference between the maximum number of cold starts and the maximum number or warm starts of the motor
Setting rage: **1** to **2**

```
4 3 k τ
5 . 0
```

[4505]
Factor of the thermal cooling-down time at motor standstill (compared with heating-up during operation)
Setting rage: **1.0** to **10.0**

```
4 3 k τ 2
2 . 0
```

[4506]
Factor of the thermal cooling-down time in operation (compared with heating-up during operation)
Setting rage: **1.0** to **10.0**

```
4 3 T M o t B l
6 . 0 m i n
```

[4507]
Minimum lockout time of the restart lockout function
Setting rage: **0.2** min to **120.0** min

6.3.14 Settings for the undercurrent monitoring – address block 40

The undercurrent monitoring is effective only if it has been configured as IL< = *EXIST* (refer to Section 5.4.2).

```
4 0   I L <
M O N
```

[4600]
Beginning of the block "Undercurrent monitoring"

```
4 0   I L <
O F F
```

[4603]
Switch *OFF* the undercurrent monitoring

```
+ O N
```

Switch *ON* the undercurrent monitoring

This function can be used for a variety of protection and supervisory tasks. It can serve, for example, as loss-of-load supervision or to recognize disconnected or interrupted lines. Furthermore, control and regulating tasks are feasible.

For loss-of-load supervision, I< can be set relatively sensitive; for conductor breakage monitoring a reliable differentiation must be made between operational condition and conductor interruption. The delay time depends on the control or alarm functions which should be initiated after the undercurrent condition has been detected. The set current is referred to the rated CT current.

The set time is a pure delay time which does not include the inherent operating time of the monitoring function.

```
4 0   I L <
0 . 2 0 I n
```

[4601]
Pick-up value of the undercurrent monitoring
Setting rage: **0.10** · I_N to **4.00** · I_N

```
4 0   t I L <
0 . 0 s
```

[4602]
Delay time for undercurrent monitoring
Setting rage: **0.0** s to **320.0** s

6.3.15 Settings for the RTD-box – address block 50

An RTD-box 7XV566 can be connected to the serial system interface of the relay in the version 7SJ602*–***8*–****. The RTD-box acquires the temperature values of up to 6 RTDs (resistance temperature detectors) installed in the protected object, and connected to the box via a 2- or 3-wire cable. The RTD-box converts the temperature values of the RTDs into numerical values and transmits them to the serial interface of the relay.

The 1st RTD-value is always decisive for inclusion of the ambient temperature in the overload protection with total memory (refer also to Section 6.3.7.1.) The temperature values of the remaining RTDs can be read out in the 7SJ602 under the measured values. Limit values can be set for all 6 RTD locations.

The RTD-box itself also allows thresholds of each single measuring point to be set. The information is then passed on via an output relay of the box. For further information refer to the instruction manual of the RTD-box.

`50 RTD Box`

[4900]
Beginning of the block "RTD-box"

The following settings are made for each RTD location.

You set the type of RTD for the 1st RTD connected to the RTD-box in address 4910. It may be: *Pt100*, *Ni100* or *Ni120*. This setting allows for correct conversion of the values into temperatures.

The mounting location of the 1st RTD within the protected object is set under address 4911. A choice can be made between *Oil*, *Ambient*, *Winding*, *Bearing*, or *Other* mounting place. This setting serves only for information.

You can determine two limit temperatures for each RTD location. The first threshold is named warning stage, the second alarm stage. Practically, you set the second threshold somewhat higher than the first using it as a trip stage provided you have allocated the output signal of this stage to a trip relay. If you do not need a stage set its pickup value to ∞.

The limit values are set in degrees Celsius or in degrees Fahrenheit. If, during configuration of the protective functions in address 7844 (refer to Section 5.4.2), you have decided to give temperatures in °C, limit values have to be entered in °C under addresses 4912 and 4914 as shown in the examples below. If you have selected °F as temperature unit, set the limit values under addresses 4913 and 4915.

<u>Note:</u> If you change the temperature unit under address 7844 after having made settings for temperature limits, you have to readjust the values here in the changed temperature unit. The values will not be converted automatically.

`50 RTD 1 Ty`
`Pt100`

[4910]
Type of RTD 1
Pt 100

\+ `nonEXIST` — no RTD 1 exists

`Ni120` — *Ni 120*

`Ni100` — *Ni 100*

```
50RTD1Lo
Oil
```

[4911]
Installation location of RTD 1

```
Oil
+ Ambient
Winding
Bearing
Other
```

Oil

Ambient

Winding

Bearing

Other location

```
50 RTD1w
100 °C
```

[4912] (in ˚C) or [4913] (in ˚F)
Pickup value of the 1st (warning) stage of RTD 1
Setting range: **–50** ˚C to **250** ˚C or
–58 ˚F to **482** ˚F
and ∞ (no pickup of the warning stage)

```
50 RTD1a
100 °C
```

[4914] (in ˚C) or [4915] (in ˚F)
Pickup value of the 2nd (alarm/trip) stage of RTD 1
Setting range: **–50** ˚C to **250** ˚C or
–58 ˚F to **482** ˚F
and ∞ (no pickup of the alarm stage)

Corresponding parameter are available for the further RTDs. You set for each RTD the type and mounting location as well as the two limit stages, as shown in the following example for the RTD No. 2.

```
50RTD2Ty
nonEXIST
```

[4920]
Type of RTD 2

```
nonEXIST
+ Pt100
Ni120
Ni100
```

no RTD 2 exists

Pt 100

Ni 120

Ni 100

```
50RTD2Lo
Oil
```

[4621]
Installation location of RTD 2

```
Oil
+ Ambient
Winding
Bearing
Other
```

Oil

Ambient

Winding

Bearing

Other location

```
50  RTD2w
100  °C
```

[4922] (in °C) or [4923] (in °F)
Pickup value of the 1st (warning) stage of RTD 2
Setting range: **–50** °C to **250** °C or **–58** °F to **482** °F
and ∞ (no pickup of the warning stage)

```
50  RTD2a
100  °C
```

[4924] (in °C) or [4925] (in °F)
Pickup value of the 2nd (alarm/trip) stage of RTD 2
Setting range: **–50** °C to **250** °C or **–58** °F to **482** °F
and ∞ (no pickup of the alarm stage)

The same options exist for the other connected RTDs.

6.3.16 Settings for trip circuit supervision – address block 39

The relay includes a trip circuit supervision function (refer to Section 4.12), 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 4.12. Section 5.2.4 contains information about connection and dimensioning hints as to the resistor in case of supervision with one single binary input.

```
39CIRsup
```

[3900]
Beginning of the block “Trip circuit supervision”

```
39CIRsup
ON
```

[3901]
Switch *ON* the trip circuit supervision

```
+ OFF
```

Switch *OFF* the trip circuit supervision

6.3.17 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, output 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 delayed annunciations”

```
38T-Anc1
0.01 s
```

[3801]
Pick-up time delay for the first user definable annunciations
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 annunciations
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 annunciations
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 annunciations
Smallest setting value: **0.00** s
Largest setting value: **10.00** s
and ∞, i.e. no start

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 6.9. 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 auto-reclosure 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, voltage magnitudes, power, values of the thermal overload protection).

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.

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 6.10.

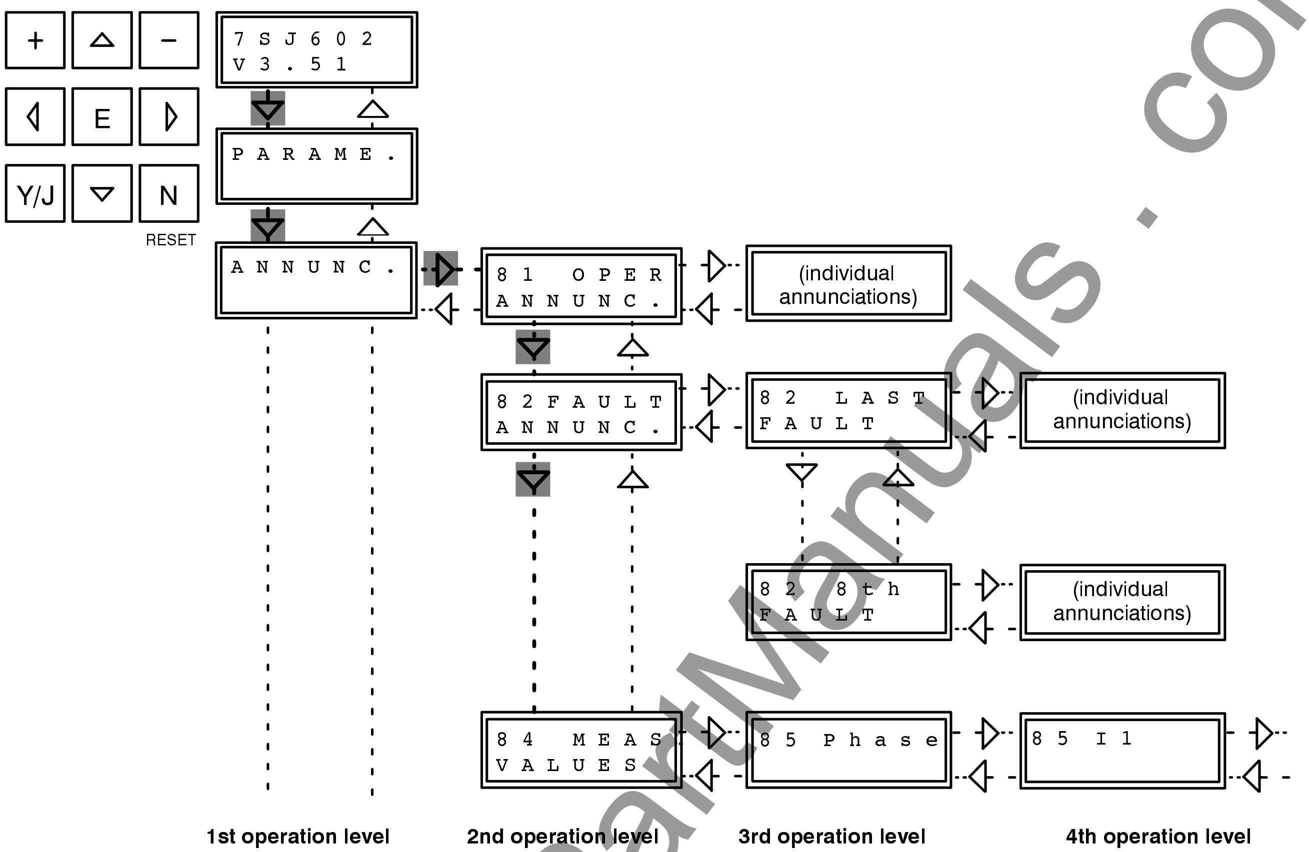


Figure 6.9 Selection of annunciation blocks

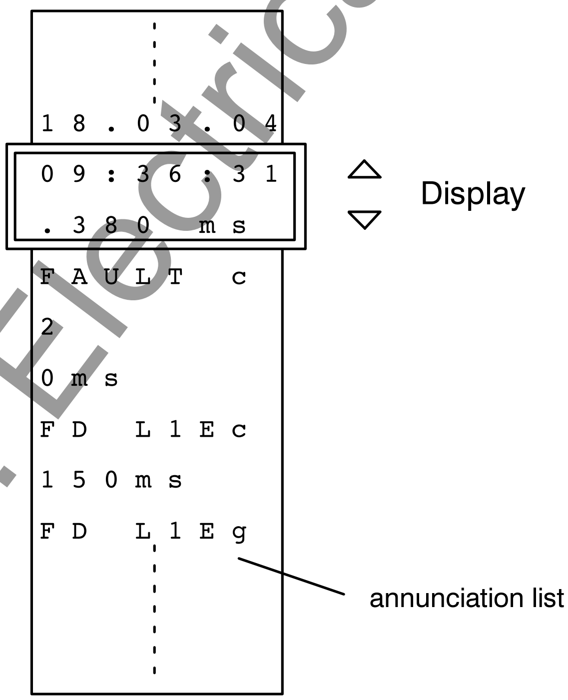


Figure 6.10 Display of an annunciation list − example

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.

```
81  OPER.
ANNUNC.
```

[5100]
Beginning of the block "Operational annunciations"

```
14.05.04
08:42:21
```

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.

```
08:42:21
LED  resc
```

1st line: Time of the event or status change
2nd line: Annunciation text, in the example **c**oming

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)
>SysMMb	Block annunciations and measured values to system interface (c/g)
>mCLOSE	Manual close command (c/g)

>CBclo	Circuit breaker closed (from CB auxiliary contact) (c/g)
>CBPcld	Circuit breaker closed (c/g)
>CBPopd	Circuit breaker opened (c/g)
>revPhR	Reversed phase rotation (c/g)
>RemBlk	Block remote control (c/g)
>I>>>bk	Block instantaneous very high set stage I>>> of the phase overcurrent protection via binary input (c/g)
>I>>blk	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)
>VE bl	Block displacement voltage stage of sensitive earth fault protection (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)
>MSP bl	Block motor restart inhibit (c/g)
>MSP em	Emergency start for motor restart inhibit (c/g)
>MSPRTI	Reset thermal replica of motor restart inhibit (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)
>ResMax	Reset minimum/maximum measured values (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)
>SysMMb	Block annunciations and measured values to system interface (c/g)
Meas.Bl	Annunciations and measured values to system interface are blocked (c/g)
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)
>CBPcld	Circuit breaker closed (c/g)
>CBPopd	Circuit breaker opened (c/g)
>revPhR	Reversed phase rotation (c/g)

Annunciations of monitoring functions:

ANNlost	Annunciations lost (buffer overflow) (c)
PCannLT	Annunciations for operating (PC) interface lost (c)
FailΣI	Failure: Current summation supervision (c/g)
OfClkSy	Clock synchronization failure (c/g)
BatFail	Battery failure (low battery) (c/g)
StATE	Failure ambient temperature measurement (c/g)
OfProfi	Failure at system interface Profibus (c/g)
OfOlmCA	Failure OLM channel A (c/g)
OfOlmCB	Failure OLM channel B (c/g)
FailRTDb	Failure on the RTD-box (c/g)
FailRTD	Failure of any RTD (group annunciation) (c/g)

`FailRTD1`	Failure of RTD No. 1 (c/g)
`FailRTD2`	Failure of RTD No. 2 (c/g)
`FailRTD3`	Failure of RTD No. 3 (c/g)
`FailRTD4`	Failure of RTD No. 4 (c/g)
`FailRTD5`	Failure of RTD No. 5 (c/g)
`FailRTD6`	Failure of RTD No. 6 (c/g)

Operational annunciations of time overcurrent protection:

`O/Cpoff`	Phase overcurrent protection is switched off (c/g)
`O/Cpblk`	Phase overcurrent protection is blocked (c/g)
`O/Cpact`	Phase overcurrent protection is active (c/g)
`>I>>>bk`	Block instantaneous very high set stage I>>> of the phase overcurrent protection via binary input (c/g)
`>I>>blk`	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)
`O/Ceoff`	Earth overcurrent protection is switched off (c/g)
`O/Ceblk`	Earth overcurrent protection is blocked (c/g)
`O/Ceact`	Earth overcurrent protection is active (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)
`FD dyn`	O/C protection: dynamic parameters active (c/g)

Operational annunciations of sensitive earth fault protection:

`O/Ceoff`	Sensitive earth fault protection is switched off (c/g)
`O/Ceblk`	Sensitive earth fault protection is blocked (c/g)
`O/Ceact`	Sensitive earth fault protection is active (c/g)
`>IE>>bk`	Block I_{EE}>> stage of sensitive earth fault protection via binary input (c/g)
`>IE> bk`	Block I_{EE}> stage of sensitive earth fault protection via binary input (c/g)
`>IEp bk`	Block I_{EEp} stage of sensitive earth fault protection via binary input (c/g)
`EFfor`	Earth fault in forward direction (c/g)
`EFrev`	Earth fault in reverse direction (c/g)
`EFundef`	Earth fault with undefined direction (c/g)
`>VE bl`	Block displacement voltage stage of earth fault protection via binary input (c/g)
`FD VE`	Pick-up (fault detection) of displacement voltage stage of earth fault protection (c/g) (c/g)
`Trip VE`	Trip by displacement voltage stage of earth fault protection (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:

I 2 off	Unbalanced load protection is switched off (c/g)
I 2 blk	Unbalanced load protection is blocked (c/g)
I 2 act	Unbalanced load protection is active (c/g)

Operational annunciations of circuit breaker failure protection:

BF off	Circuit breaker failure protection is switched off (c/g)
BF act	Circuit breaker failure protection is active (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)
AR blMC	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)
>ARblCl	Close command of internal auto-reclosure blocked via binary input (statically) (c/g)

Operational annunciations of start-up time monitor for motors:

SRT off	Start-up time monitor is switched off (c/g)
SRT blk	Start-up time monitor is blocked (c/g)
SRT act	Start-up time monitor is active (c/g)
SRT Trp	Start-up time monitor trip (c/g)

Operational annunciations of restart inhibit for motors:

MSP off	Motor restart inhibit is switched off (c/g)
MSP blk	Motor restart inhibit is blocked (c/g)
MSP act	Motor restart inhibit is active (c/g)
ThetaW	Motor restart inhibit thermal warning stage (c/g)
MSP tri	Motor restart inhibit trip (c)
>MSP em	Emergency start for motor restart inhibit (c/g)
MSPRTI	Thermal replica of motor restart inhibit is reset (c/g)

Operational annunciations of undercurrent monitoring for motors:

IL< al	Limit value of undercurrent is undershot (c/g)

Operational annunciations of trip circuit supervision:

>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)
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)

Operational annunciations of the statistical functions:

ResMax	Min/max value reset via binary input (c)
iResMax	Min/max value reset internally (c)

Operational annunciations of the circuit breaker control:

Q0 clo.	Circuit breaker close command (c)
Q0 trp.	Circuit breaker open (trip) command (c)
RemBlk	Remote control is blocked (c)
sw.arm	Switching authorization remote (c/g)

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)

Operational annunciations of the RTD-box connection:

FailRTDb	Failure on the RTD-box (c/g)
FailRTD	Failure of any RTD (group annunciation) (c/g)
FailRTD1	Failure of RTD No. 1 (c/g)
TrpRTD1w	Pickup of RTD No. 1 warning stage (c/g)
TrpRTD1a	Pickup of RTD No. 1 alarm/trip stage (c/g)

`FailRTD2`	Failure of RTD No. 2 (c/g)
`TrpRTD2w`	Pickup of RTD No. 2 warning stage (c/g)
`TrpRTD2a`	Pickup of RTD No. 2 alarm/trip stage (c/g)
`FailRTD3`	Failure of RTD No. 3 (c/g)
`TrpRTD3w`	Pickup of RTD No. 3 warning stage (c/g)
`TrpRTD3a`	Pickup of RTD No. 3 alarm/trip stage (c/g)
`FailRTD4`	Failure of RTD No. 4 (c/g)
`TrpRTD4w`	Pickup of RTD No. 4 warning stage (c/g)
`TrpRTD4a`	Pickup of RTD No. 4 alarm/trip stage (c/g)
`FailRTD5`	Failure of RTD No. 5 (c/g)
`TrpRTD5w`	Pickup of RTD No. 5 warning stage (c/g)
`TrpRTD5a`	Pickup of RTD No. 5 alarm/trip stage (c/g)
`FailRTD6`	Failure of RTD No. 6 (c/g)
`TrpRTD6w`	Pickup of RTD No. 6 warning stage (c/g)
`TrpRTD6a`	Pickup of RTD No. 6 alarm/trip stage (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 6.9. Use the keys ▽ and △ to scroll through the annunciation list (Figure 6.10).

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 lockout 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.

After date and time indication, 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.

`15.03.04` / `22:09:46`

`.810 ms` / `FAULT c`

[5211]
1st line: Date of the last system fault
2nd line: Time of the last system fault (hours, minutes, seconds 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)
IE	Interrupted earth fault current (I_E/I_N)
IEE	Interrupted earth fault current (I_{EE}/I_N)

Fault annunciations of time overcurrent protection:

FD L1	Fault detection overcurrent protection, phase L1
FD L1E	Fault detection overcurrent protection, phase L1 – E
FD L2	Fault detection overcurrent protection, phase L2
FD L2E	Fault detection overcurrent protection, phase L3 – E
FD L12	Fault detection overcurrent protection, phases L1 – L2
FD L12E	Fault detection overcurrent protection, phases L1 – L2 – E
FD L3	Fault detection overcurrent protection, phase L3
FD L3E	Fault detection overcurrent protection, phase L3 – E
FD L13	Fault detection overcurrent protection, phases L1 – L3
FD L13E	Fault detection overcurrent protection, phases L1 – L3 – E
FD L23	Fault detection overcurrent protection, phases L2 – L3
FD L23E	Fault detection overcurrent protection, phases L2 – L3 – E
FD L123	Fault detection overcurrent protection, phases L1 – L2 – L3
FDL123E	Fault detection overcurrent protection, phases L1 – L2 – L3 – E

`FD  E`	Fault detection overcurrent protection, earth fault
`FD  I>>`	Fault detection of the I>> phase current stage
`Trp  I>>`	Trip by overcurrent protection, stage I>> (phases)
`TrpI>>>`	Trip by overcurrent protection, stage I>>> (phases)
`FD  I>`	Fault detection of the I> phase current stage (definite time)
`Trip  I>`	Trip by overcurrent protection, stage I> (phases)
`FD  Ip`	Fault detection of the I_p phase current stage (inverse time)
`Trip  Ip`	Trip by overcurrent protection, stage I_p (phases, inverse time)
`FD  IE>>`	Fault detection of the I_E>> earth current stage
`TrpIE>>`	Trip by overcurrent protection, stage I_E>> (earth)
`FD  IE>`	Fault detection of the I_E> earth current stage (definite time)
`Trp  IE>`	Trip by overcurrent protection, stage I_E> (earth)
`FD  IEp`	Fault detection of the I_{Ep} earth current stage (inverse time)
`Trp  IEp`	Trip by overcurrent protection, stage I_{Ep} (earth, inverse time)

Fault annunciations of highly sensitive earth fault protection:

`FD  E`	Fault detection overcurrent protection, earth fault
`FD  IE>>`	Fault detection of the I_E>> earth current stage
`TrpIE>>`	Trip by overcurrent protection, stage I_E>> (earth)
`FD  IE>`	Fault detection of the I_E> earth current stage (definite time)
`Trp  IE>`	Trip by overcurrent protection, stage I_E> (earth)
`FD  IEp`	Fault detection of the I_{Ep} earth current stage (inverse time)
`Trp  IEp`	Trip by overcurrent protection, stage I_{Ep} (earth, inverse time)
`EF for`	Earth fault in forward direction (c/g)
`EF rev`	Earth fault in reverse direction (c/g)
`EF undef`	Earth fault with undefined direction (c/g)

FD VE	Pick-up (fault detection) of displacement voltage stage of earth fault protection (c/g)
Trip VE	Trip by displacement voltage stage of earth fault protection (c/g)

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 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 annunciation of circuit breaker failure protection:

BF bloc	Breaker failure protection is blocked
BF fltI	Breaker failure protection is initiated from an internal source
BF fltE	Breaker failure protection is initiated from an external source
BF Trip	Breaker failure protection trip

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

Fault annunciation of start-up time monitor for motors:

`SRT Trp`	Trip by start-up time monitor

Fault annunciation of restart inhibit for motors:

`MSP blk`	Motor restart inhibit is blocked
`ThetaW`	Motor restart inhibit thermal warning stage

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 blocks 84 to 89

Operating measured values and calculated values as well as metered values can be read out at any time under the address block 84 and subsequent blocks. 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 6.9. Use the keys ▽ and △ to scroll through the individual measured values (Figure 6.10). Entry of the codeword is not necessary.

The data are displayed in percent of the rated device values and in primary values. Pre-condition for correct display of the values is that the rated values have been set in the power system data according to Section 6.3.3. The values are actualized in intervals of approx. 1 sec.

The scope of displayed values depends on the ordered version and the connection facilities of the relay. Therefore, not all of the values illustrated in the following can be retrieved in every version. In the following examples, some exemplary values have been inserted. In practice, the actual values appear of course.

```
84 MEAS.
VALUES
```

[5700]
Beginning of the block "Operational measured values"

```
85 Phase
```

[5700]
"Measured values of the phases"

Press ▷ to gain the group of the phase values

```
85 IL1
```

```
IL1 =
72 %
```

```
MaxIL1 =
402A
```

```
IL1 =
288A
```

```
MinIL1 =
0A
```

The percentage is referred to rated CT current.
The primary values are calculated on the base of the set rated values (address 1105, see Section 6.3.3).

```
85 IL2
```

```
IL2 =
70 %
```

```
MaxIL2 =
400A
```

```
IL2 =
280A
```

```
MinIL2 =
0A
```

```
8 5   I L 3        I L 3 =        M a x I L 3 =
                   7 2 %          4 1 1 A

                                  I L 3 =
                                  2 8 8 A

                                  M i n I L 3 =
                                  0 A
```

Line-to-earth voltage $V_{L1\text{-}E}$ only for relays with phase voltage input (7SJ602*–*****–**J*) .
The percentage is referred to the voltage at nominal operation, in this case: $V_N/\sqrt{3}$

```
8 5   V L 1 E      V L 1 E =      M a x V L 1 E =
                   1 0 2 %        6 . 0 6 k V

                                  V L 1 E =
                                  5 . 8 9 k V

                                  M i n V L 1 E =
                                  5 . 5 2 k V
```

The primary values are calculated on the base of the set rated value (address 1113, see Section 6.3.3)

Demand values of the currents, example for phase L1.
The interval period has been determined in address 1136 (Section 6.3.3).

```
8 5   I 1 d m d    M a x I 1 d =
                   1 3 5 A

                   I L 1 d m d =
                   2 6 0 A

                   M i n I 1 d =
                   4 0 6 A

8 5   I 2 d m d

8 5   I 3 d m d
```

The same facilities exist for the measured current in phase L2 and, finally, in phase L3

The (residual) earth quantities may vary, dependent on the relay version. Devices with 4 current inputs (7SJ602**1**–... or 7SJ602**5**–...) show the current connected to the earth (residual) current input. Devices with high-sensitivity input (7SJ602**2**–... or 7SJ602**6**–...) display this current connected there. The displacement voltage can only be output if the device has a corresponding voltage input (7SJ602*–*****–****B***), the same applies for the active and reactive component of the earth current.

```
8 6   E a r t h
```

[5700]
"Measured earth values"

Press ▷ to gain the group of the earth values

```
8 6   I E
```

```
I E =
1 %
```

```
I E =
5 A
```

```
8 6   I E E
```

```
I E E =
1 %
```

Magnitude IEE of the earth current at the sensitive input (if available).

```
8 6   I E a
```

```
I e a =
0 %
```

Active and reactive components of the earth current relate to the displacement voltage for directional sensitive earth fault protection.

```
8 6   I E r
```

```
I e r =
1 %
```

Displacement voltage in devices with displacement voltage input.

```
8 6   V E
```

```
V E =
1 %
```

```
M a x V E =
1 0 . 6 k V
```

```
V E =
0 . 1 k V
```

```
M i n V E =
0 . 0 k V
```

Power values can only be calculated and displayed if the relay is provided with a voltage input for the line-to-earth voltage (7SJ602*–*****–**J*). Since only *one* voltage is available the power calculation is based on symmetrical conditions, i.e. a symmetrical voltage star is assumed.

The default definition of the positive sign of the active and reactive power is the direction into the protected object. This can be inverted in address 1115.

```
8 7   P o w e r
```

[5700]
"Calculated power values"
Press ▷ to gain the group of the power components

```
8 7   P =
```

```
P =
6 8 %
```

```
M a x P =
6 . 9 M W
```

```
P =
4 . 6 8 M W
```

```
M i n P =
9 2 0 k W
```

The percentage is referred to the apparent power at nominal conditions, in this case: $\sqrt{3} \cdot V_N \cdot I_N$.
The primary values are calculated on the base of the set rated values (addresses 1105 and 1113, see Section 6.3.3).

```
8 7   Q =
```

```
Q =
2 9 %
```

```
M a x Q =
2 . 2 M V A R
```

```
Q =
1 . 9 9 M V A R
```

```
M i n Q =
3 6 5 k V A R
```

```
8 7   S =
```

```
S =
7 3 %
```

```
M a x S =
6 . 9 5 M V A
```

```
S =
5 . 0 9 M V A
```

```
M i n S =
1 . 0 2 k V A
```

```
MaxPF=
0.98
```

```
87 PF=          PF=
                0.92
```

Power factor cos φ.
The definition of the sign is the same as for the active power.

```
MinPF=
0.74
```

```
MaxPdmd=
6.1MW
```

```
87 Pdmd=        Pdmd=
                5.0MW
```

```
MinPdmd=
1.35MW
```

```
MaxQdmd=
2.1MVAR
```

```
87 Qdmd=        Qdmd=
                2.0MVAR
```

```
MinQdmd=
410kVAR
```

```
MaxSdmd=
6.4MVA
```

```
87 Sdmd=        Sdmd=
                1.4MVAR
```

```
MinSdmd=
410kVAR
```

The metered values of active and reactive energy are only available if the powers can be calculated, i.e. if, besides the currents, the line-to-earth voltage is present. The energy values are integrated separately for the positive and the negative components.

The sign definition of the energy comments is the same as for the powers.

```
88 Energ
```

[5700]
"Metered energy values"

Press ▷ to gain the group of the energy components

```
Wp pos=
247GWh
```

The energy value Wp (active work) and Wq (reactive work) are metered separately for each direction.

```
Wp neg=
12MWh
```

```
Wq pos
98GVARh
```

The same facilities exist for the reactive energy Wq, positive and negative.

```
Wq neg
4.6MVARh
```

Thermal values can be retrieved if the relay provides thermal overload protection. If an RTD-box is connected the associated temperature values are displayed, too.

```
89 THERM
OVERLOAD
```

[5700]
"Thermal values"

Press ▷ to gain the group of the thermal values

```
THETA =
43%
```

The temperature rise for the overload protection with total memory is calculated from the highest of the phase currents and 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 (assuming 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”

```
ThRTD1=
82°
```

Temperature (ambient/cooling medium temperature) at the measuring location of RTD1 provided it is included in the relay from an RTD-box via the serial system interface

The temperature unit is set in address 4901 as ˚C or ˚F

```
ThRTD2=
122°
```

Corresponding values are found for the further connected RTDs

---

Transmission of measured values via the serial system interface requires values without dimension. The temperature degrees have no base values. Therefore, the following base values are defined:

For temperature values stated in degrees Celsius:

0 ˚C	corresponds to	0 %
500 ˚C	corresponds to	100 %

For temperature values stated in degrees Fahrenheit:

0 ˚F	corresponds to	0 %
1000 ˚F	corresponds to	100 %

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. 7SJ602 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 time overcurrent 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 6.3.16 for the appropriate setting addresses.

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 – address block 81

The internal real time clock is secured against auxiliary voltage failure. It can be synchronized by a minute pulse via a binary input or over the serial system interface (as far this is available). You can adjust the clock manually by the following procedure.

From the initial display, press the key ▽ three times until the menu item "ADDITION FUNCTION" ("additional functions") is displayed. Press the key ▷ 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.

Codeword entry is not required for time setting. 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.

Note: If you have changed the system date and/or time of the device you will have to readjust the settings for automatic reset of the minimum/maximum measured values since the device calculates the instant for start and automatic reset from the internal system clock only once after parameterization. Repeat the setting instructions given in Section 6.3.3 under the addresses 1137 to 1139.

```
◁  TIME        ▷
   SETTING
```

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

```
◁  01.12.99    ▽
   01:15:06
```

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

```
◁  DATE
   28.01.04
```

[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
   13:44:00
```

[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 Resetting of stored indications and counters

Annunciations and counters are stored in the relay and saved against auxiliary supply failure by means of a buffer battery. During operation, they can be reset.

This is achieved by operational actions on the front, via binary inputs, or via the serial system interface (if available).

It is not necessary to reset the operational messages, the fault annunciations, or the fault records. The oldest entries are automatically overwritten when the corresponding buffers are full.

Entry of the codeword is necessary to reset stored counters.

You can reset the minimum and maximum measured values manually under the item “ADDITION FUNCTION” (additional functions). The key ▽ is used to reach the item “MAX. – RESET”. You can reset the values going into the next operating level with the ▷ key.

Manual reset is not necessary if, during setting of the power system data, automatic cyclical reset had been parameterized (refer to Section 6.3.3 under addresses 1137 to 1139). But you can reset the values manually even if automatic cyclic resetting had been parameterized. The manual resetting does not influence the parameterized automatic resetting process.

△ ◁ ▽ | MAX. – RESET | ▷

[8300]
Beginning of the block “Reset minima-/maxima counters“

Change with the ▷ key to the manual resetting.

| HAND | **E**

Reset immediately:

After confirmation with the enter key **E** the relay requests for codeword input.

◁ ▽ | HAND EXECUTED |

After correct codeword input, repeat confirmation with the enter key **E**. Reset will be executed and confirmed by the display.

6.5.3 Circuit breaker control

Dependent on the ordered model (7SJ602* – ****1), 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 CONTROL	▷	[7500] Block “Circuit breaker control”

Change with the ▷ key to the individual control commands. Select the desired control operation (open or close) with ▽.

△	CB CLOSE ?	E	[7501] 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 STARTED	E	The device confirms the command. With the ◁ key, the higher operation level can be reached.

△	CB OPEN ?	E	[7502] 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 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 5.2.5).

It is recommended that the actual settings for the relay be used for the testing procedure. If these values are not (yet) available, test the relay with the factory settings. In the following description of the test sequence the preset settings are assumed.

For the functional test a three-phase symmetrical current source with individually adjustable currents should be available. For checking the pick-up values a single-phase current source is sufficient. If the relay provides a voltage input a single-phase voltage source is sufficient. Phase rotation is assumed clockwise. The phase sequence for the unbalanced load protection can be inverted via a binary input.

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 protection stages I>>, I_E>>, and the instantaneous stage I>>>

In order to test the high-set overcurrent protection stages, the related functions must have been 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 for the phase current stages; for the earth current stage, the test current must pass through the earth current input I_E. For relays with sensitive earth current input observe also Section 6.6.5.

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·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·I_N) pick-up annunciation "`FD I>>`" and the 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 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/Cpch and/or O/Cech) 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 the phase current stages; for the earth current stage, the test current must pass through the earth current input I_E.

For test current below 4·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·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 $0.2{\cdot}I_N$) 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 $1{\cdot}I_N$) 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/Cpch and/or O/Cech) 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 the phase current stages; for the earth current stage, the test current must pass through the earth current input I_E. For relays with sensitive earth current input observe also Section 6.6.5.

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 $4{\cdot}I_N$ 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 $0.1{\cdot}I_N$) 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 $1{\cdot}I_N$) 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.

If disk emulation is effective, consider that a test must only performed after the protection has completely reset.

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 3.7 (Section 3.3).

It is suggested that one point of the trip time characteristic is checked with 2·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 sensitive earth fault protection stages

The sensitive earth current stages IEE>>/TIEE>>, IEE>/TIEE> (for definite time) and/or IEEp/TEEp (for inverse time) are tested in the same way as the overcurrent stages for earth current as described in Section 6.6.2 to 6.6.4. But observe the following:

The test current is injected in the current input for sensitive earth fault detection which must be provided in the relay. This input is designed for highly sensitive current measurement and has restricted thermal limits.

Caution!

The thermal limits or the highly sensitive earth current input is 15 A continuously. Test currents larger than 15 A may overload and damage the relay if applied continuously. Higher currents must be applied dynamically (refer to Section 3.1.1 for overload capability). Observe a cooling down period!

If one or more stages are intended to operate directional, the voltage, which is needed for directional determination is applied to the displacement voltage input (open delta voltage).

For directional determination, the current component in the direction which is determined by the setting under addresses 3024 PHICOR and 3025 DIRMOD must also be exceeded. Measurement is, for example, not possible when test current and test voltage are in phase and DIRMOD is set *SIN PHI* and PHICOR is set to 0° as the current vector then lies exactly between the directional characteristics for forward and reverse direction.

Testing of the earth fault protection for non-earthed networks is not completely possible with conventional test sets, since the simulation of an earth fault requires a complete displacement of the voltage triangle. The correct relationship and polarity of the measuring transformer connections, essential for proper earth fault detection, can only be tested when primary load current is available during commissioning (see Section 6.7.9).

6.6.6 Testing the displacement voltage stage

A displacement voltage must be simulated either by bypassing one voltage phase (e.g. L1) of a symmetrical voltage star or by injecting a single-phase voltage.

Trip test can only be performed if the sensitive earth fault protection is parameterized to give trip command (address 3001 XMZ SENSIVE E = *ON*).

The pickup threshold is set under address 3309 Ve>. The pickup delay is set under address 3311 TVeADI, the trip delay under address 3312 TVe>.

When the applied voltage exceeds the set pickup threshold pickup will occur after the inherent operating time (approximately 60 ms) plus the pickup delay. Trip will occur after the additional trip dely time. Check the corresponding messages in the operation annunciations. If annunciations are marshalled to LED indicators and/or output relay(s) these output shall be checked.

6.6.7 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.

6.6.7.1 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 $4 \cdot I_N$, 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 $4 \cdot I_N$ 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 $1 \cdot I_N$) 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 3.10 (Section 3.5.2).

It is suggested that one point of the trip time characteristic is checked with 2 times setting value provided the thermal capability is not exceeded. Trip signal "`O/L Trp`" is given.

6.6.7.2 Overload protection with total memory

The base current for the detection of overload is always the rated current of the CT set.

When applying the rated current (factory settings) tripping must not occur. After an appropriate time (approximately $5 \cdot \tau$) 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 89. For different setting values k, test current should be lower than $k \cdot I_N$ (e.g. 90%).

To check the time constant, the current input is simply subjected to 1.6 times the pick-up value, i. e. $1.6 \cdot k \cdot I_N$. 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 3.8). 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 $5 \cdot k_\tau \cdot \tau$ or by blocking the overload protection via an correspondingly assigned binary input ("`>O/Lblk`").

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 $5 \cdot \tau$.

Inclusion of the ambient temperature via an RTD-box, if applicable, is verified later during primary tests.

6.6.8 Testing the circuit breaker failure protection

The circuit breaker failure protection must have been configured as *EXIST* (address 7835) and switched *ON* (address 3601).

It is necessary that a the binary output has been assigned to the trip command of the breaker failure protection in order to check the response of this function.

The test current must not be interrupted by the trip command of a protection functions of 7SJ602 to allow the time of the breaker failure protection to expire.

After applying the test current for a protection function that will trip due to this current, the test current continues flowing after trip command. The test current must equally be higher than the setting value CB I> (address 1116).

Caution!

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

The trip command starts the breaker failure protection timer. After expiry of T–B/F (address 3602) the breaker failure protection trips the assigned output relay.

If the breaker failure protection is intended also to be started via a binary input, this function should also be tested. A test current higher than the set value CBI> (address 1116) but smaller than any setting value of the time overcurrent protection is injected so that the time overcurrent protection functions will not operate but the breaker failure protection function will do.

Now start the breaker failure protection by energizing the binary input “>BF St” (FNo 1431). After expiry of T–B/F (address 3602) the breaker failure protection trips the assigned output relay.

Switch off test current.

6.6.9 Testing the unbalanced load / negative sequence protection

The unbalanced load protection can 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 nominal device 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.

6.6.10 Testing the internal auto-reclose functions

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.

6.6.11 Testing the startup time monitor for motors

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 (address block 28 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 $4 \cdot I_N$ 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 3.9).

It is suggested that one point of the trip time characteristic is checked. For example, Istrt = $4 \cdot I_N$ and tStUp = 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 it on again after the tests, if it is to be used.

6.6.12 Testing the motor restart inhibit

The motor restart inhibit function must be configured in address block 00 as MotPro = *EXIST* and parameterized as operative (MotPro = *ON*).

Processing of the thermal replica is carried out with the highest of the three stator currents. Therefore, tests can be performed with a single-phase test current.

Caution!

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

The motor restart inhibit presupposes that the thermal limit of the rotor is reached when the motor has been started just for the permissible number of times. With the preset parameters 4503 (nw = 2) and 4504 (nc – nw = 1) the motor may be started three times (nc = 3) successively.

Considering the preset motor data (address 1118 (I_m/I_N = 1), 1119 (Istrt/I_N = 5) and 1120 (tStUp = 10 s), three motor starts must be simulated one after the other, each with 10 s duration and with a test current of 5 times rated motor current. Then the thermal limit value must be nearly reached.

When the test current is switched off, the protection will issue a lockout signal, i.e. annunciation "`MSP tri`". The lockout signal disappears as soon as another restart would be permissible. It can be aborted also by switching of the lockout function or via a binary blocking input (not allocated when delivered).

Note: The motor restart inhibit operates independent on the thermal overload protection and the start-up time monitor. Thus, it is possible that the overload protection and/or the start-up time monitor may trip before the motor restart protection does, dependent on the set parameters. If necessary, the overload protection and the start-up time monitoring may be switched off or blocked before testing the restart inhibit. But do not forget to switch them on again after the tests.

6.6.13 Testing the undercurrent monitoring for motors

The undercurrent monitoring for motors is a pure supervision function which is normally not intended to trip. It should issue an alarm so that suitable measures can be taken like, for example, shut down the motor if it runs in idle state. It must have been configured in address block 00 as *EXIST* and parameterized as operative (IL< = *ON*).

Testing can be performed if the output signal of the undercurrent monitoring "`IL< al`" is allocated to a LED or output relay.

Without test current, the alarm must already be present. It must disappear when all three phase currents have exceeded the set value IL< (address 4201).

6.6.14 Testing the trip circuit supervision

The trip circuit supervision must have been configured *with 2BI* (with 2 binary inputs) or *bypass−R* (with one binary input, the second is by-passed by a resistor) in address block 00. Furthermore, it must be switched *ON* in address block 39 (CIRsup = *ON*), and the associated binary input(s) must have been allocated for this purpose (refer to Section 5.5.2).

6.6.14.1 Trip circuit supervision using two binary inputs

In accordance with the task 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 4.12.1). The alarm is given, if this condition lasts for a time period 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.

6.6.14.2 Trip circuit supervision using one binary input

In accordance with the task of the trip circuit supervision, the trip circuit is assumed to be disturbed when the binary input is not energized. (refer also to Section 4.12.2). 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 circuits. The preparation work according to Section 5.2 must have been completed. For testing with primary values the protected object must be energized. Before all control operations, ensure that switching is allowed under the actual operating conditions of the plant.

⚠ 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 Checking 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. Use this feature also for later verification of logical functions.

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.

```
Y e s / N o ?
```

Y/J

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)

```
B I   S T A T
1   2   -
```

▽

Indication for BI1, BI2, BI3

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. 7SJ602 provides 4 powerful output relays which are designed to trip a circuit breaker. Distinction between command (trip) relay and signal relay is not necessary. The relays are designated CMD1 to CMD4 in the marshalling table (Section 5.5.4) and in the General diagrams (Appendix A). Nevertheless, in the relay test display, the designations are T1 and T2 for the relays CMD1 and CMD2, and S1 and S2 for the relays CMD3 and CMD4.

△

```
R E - S T A T
```

E

[4102]
Block "Status of the output relays"

```
Y e s / N o ?
```

Y/J

Pressing the enter key **E** causes the relay to display 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).

Note:
S1 corresponds to output relay CMD3
S2 corresponds to output relay CMD4
T1 corresponds to output relay CMD1
T2 corresponds to output relay CMD2

```
R E - S T A T
S 1 -   T - 2
```

▽

Indication for relay CMD3 and CMD4

Indication for relay CMD1 and CMD2

Each energized output is marked by its number, outputs which are not energized are marked with a –

The illustrated example shows that the output relay S1 (CMD3) is energized, output relay S2 (CMD4) is not energized, output relay T1 (CMD1) is not energized, output relay T2 (CMD2) is energized.

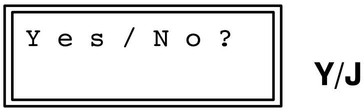
Press the key ▽ to change to the conditions of the LED indicators:

△

```
L E D
S T A T U S
```

E

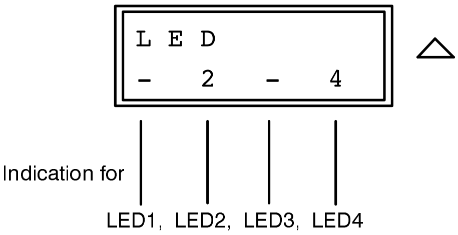
[4103]
Block "Status of LED indicators"



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



The illustrated example shows that the LED 1 is energized, LED 2 is not energized, LED 3 is not energized, LED 4 is energized.

6.7.2 Verifying the connections of the RTD-box

The RTD-box for inclusion of the ambient temperature of the protected object is available in the relay version 7SJ602*–***8*–****. It is connected to the relay by means of a serial data cable via the serial system interface. Verify that the termination resistors are effective at both ends of the connection cable.

For notes concerning the 7XV566 see for the instruction manual attached to the device. Put the RTD-box into operation, first.

The ambient temperatures acquired by the RTD-box can be retrieved in the operational measured values of the device.

When you compare the values displayed by 7SJ602 with those determined by the RTD-box, consider that the RTD-box is designed for the resistance values of a Pt100 detector. With other detectors, the box establishes higher values which are corrected in 7SJ602 provided the correct type of detector is set.

6.7.3 Checking 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.

Consider that user definable logic functions may cause control operations in the plant. In these cases ensure that switching is allowed under the actual operating conditions of the plant. If necessary, isolate the circuit breaker at both sides.

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 Checking the reverse interlock scheme

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.

6.7.5 Checking 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 6.5.3.

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 5.5.4).

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 Checking the circuit breaker failure protection

The protection function itself has already been tested according to Section 6.6.8.

Verify that the auxiliary contact(s) of the breaker are correctly connected to the device (if used, e.g. according to Section 6.7.1).

The most important consideration during checks with the installation is that the distribution of the trip commands for the adjacent circuit breakers is checked for correctness.

The adjacent circuit breakers are all those which must be tripped in case of failure of the considered feeder breaker, so that the short-circuit current will be interrupted. These are the circuit breakers of all feeders which feed the bus-bar section to which the considered faulty feeder is connected.

A general and detailed description of the checking procedure is not possible since the definition of the adjacent circuit breakers is widely dependent of the configuration of the installation.

Particularly in case of multi-section bus-bars it is of utmost importance that the distribution logic for the adjacent circuit breakers is checked. For this, it must be checked for each bus-bar section that, in case of failure of the circuit breaker of the considered feeder, all those circuits breakers are tripped, which could feed the same bus-bar section but that no other breaker is tripped.

6.7.7 Checking the measured value circuits

Connections to current and voltage transformers are checked with primary values. For this purpose the protected object must be energized A load current of at least 10 % of the rated relay 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!

If the unbalanced load protection is used the direction of the phase rotation is important. Check that the unbalanced load protection does **not** pick up. The test current must be clearly above the pick-up value of this protection I2> (address 1502).

If you carry out a counter-check by swapping two phases observe strictly the DANGER-note about shortening the CT connections above. Reconnect the CT connections after the test regarding the same cautionary measures.

DANGER!

Secondary connections of the current transformers must be short-circuited before any current leads to the relay are interrupted!

If you have altered the pick-up value for the unbalanced load protection for checking the phase rotation, do not forget to readjust the correct value after phase rotation check.

If a line-to-earth voltage is connected to the relay read out the measured voltage value and compare it with the real value to check this voltage input.

If the displacement voltage is connected to the relay it must be near 0. The polarity is checked in conjunction with the earth fault check.

6.7.8 Direction check with load current

The direction check with load current is necessary if the relay is equipped with the voltage input V_{L1-E} (version 7SJ602*–*****–**J*). The correct polarity is a pre-condition for correct indication of power values and metered energy values.

The protected object must be energized and must carry a load current of at least 10 % of the rated relay current; this shall be resistive or resistive-inductive. The direction of the load current must be known. In cases of doubt, interconnected or ring networks must be isolated.

The correct direction can be verified by the power measurement of the relay. The indicated power components allow to determine the position of the power vector in the complex P-Q-diagram.

The relationship as illustrated in Figure 6.11 result when active-inductive power is flowing into the protected object. This presumes the preset sign definition in address 1115 (Section 6.3.3). If the sign is inverted, i.e. setting PQinv is *ON*, the the power from the protected object is assumed to be positive. The example in Figure 6.11 is the valid when active-inductive power is drawn from the protected object.

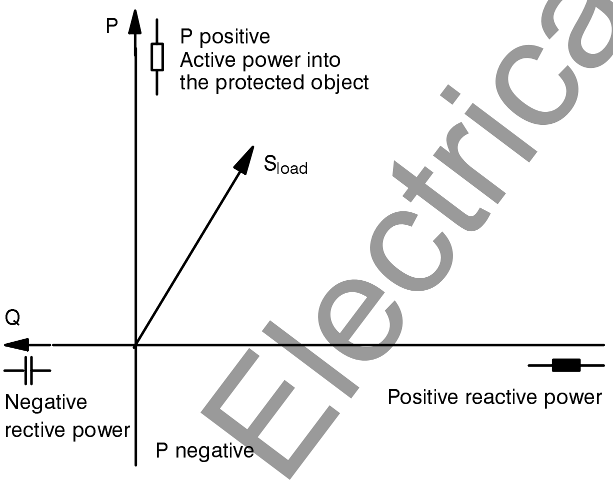


Figure 6.11 Apparent power with load

Power calculation assumes symmetrical measured values as they are true during directional check. It is presumed that the voltage V_{L1}-E is connected to the relay. If the results show angle deviations in multiples of 60°, recheck the voltage connection and correct it if necessary.

6.7.9 Direction check for sensitive earth fault protection

6.7.9.1 Earth fault checks for non-earthed systems

The primary current test allows determination of the correct polarity of transformer connections for the earth fault direction determination.

DANGER!

Operations in primary area must only be performed with plant sections voltage-free and earthed!

The most reliable test is to apply a primary earth fault. The procedure is as follows:

– If the earth fault protection is intended to trip the breaker in an non-earthed system, the trip circuit should be interrupted so that there will be enough time to read out the earth current values.

– Disconnect the line and earth at both ends; the line must remain disconnected at the remote end throughout the whole test.

– Apply a bolted single phase earth bridge to the line. On overhead lines, this can be done at any convenient point, but in any case behind the current transformers (looked at from the direction of the bus-bar of the circuit under test). For cables, the earth should be applied at the remote end (termination).

– Open the line earthing switches.

– Close the circuit breaker at the line end to be tested.

– In the operating annunciations, the earth fault direction will be indicated, i.e. “`EFfor`”. Active and reactive current are equally indicated: for isolated networks the reactive current component, for resonant earthed networks the active current component is critical. If the display indicates “`EFrev`” then there is a crossed connection in the earth circuit of voltage or current transformers. If the display shows “`EFundef`” or no earth fault message at all, the earth fault current is probably too small.

– Disconnect the line and earth it; remove the bolted earth connection.

– The test is thus completed.

If a test with a real primary earth fault is not possible, at least a fault should be simulated on the secondary side with the line energized.

DANGER!

All precautionary measures must be observed when working on the instrument transformers! Secondary connections of the current transformers must be short-circuited before any current leads to the relay are interrupted!

If the residual current is derived from a window type summation c.t., the displacement voltage will be derived by bypassing a voltage transformer phase (e.g. L1, see Figure 6.12).

From this interrupted phase a test current is fed into the window type summation c.t. via a series connected impedance Z, which limits the current. Here, direction and connection of the current flow through the window type summation c.t. must be correct as shown. If the current is too small to operate the directional detection, its effect can be increased by making additional turns of the conductor through the window of the summation c.t. In resonantly earthed networks, the value of Z should be an ohmic resistance (60 Ω/100 W to 600 Ω/10 W), in isolated networks, a capacitor (5 μF to 100 μF; ≥ 250 V) connected in series with a resistance of approximately 30 to 60 Ω (≥ 10 W) to limit the closing current.

The connection illustrated in Figure 6.12 will simulate an earth fault in the line direction. In the operational annunciations, the display should indicate the line direction, i.e. "`EFfor`" Active and reactive current components are equally indicated; for isolated networks the reactive current component, for compensated systems the active current component is critical.

If the directional indication is wrong, it may be due to a crossed connection of the voltage connections in the open delta winding of the voltage transformers or in the earth current path. If the indication "`EFundef`" appears, the earth current is probably too small, it can be increased by winding the conductor repeatedly through the window of the summation c.t. or by reduction of Z (smaller R or larger C).

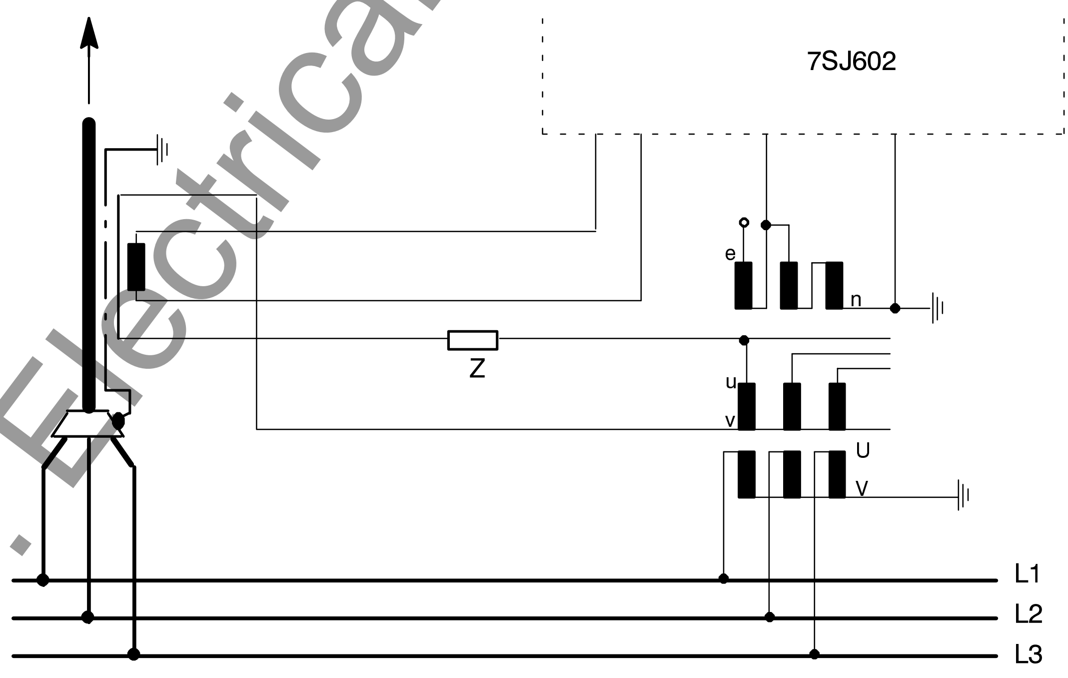


Figure 6.12 Earth fault direction test with window-type summation current transformer

If the Holmgreen connection is used for the current transformers, the displacement voltage will be derived by bypassing a voltage transformer phase (e.g. L1, see Figure 6.13). In the current circuit, only the current from the current transformer corresponding to the phase in which the voltage is missing, will be used. If the line is carrying real power, practically the same relationships apply for the relay as with an earth fault in the line direction in a resonantly earthed (compensated) network. With cos φ measurement, the earth fault direction "EFfor" must be indicated. In an isolated network it must be noted that a load with inductive component flowing in the line direction appears to the relay as an earth fault in the reverse direction. Check the directional indication.

In the operating annunciations, the earth fault direction will be indicated, i.e. "EFfor" if the earth fault is simulated in line direction. Active and reactive component of the "earth current" are equally indicated: for isolated networks the reactive and for resonantly earthed networks the active current is critical.

If the display indicates the wrong direction then a crossed connection is present in either the current or voltage transformer connections. If the display shows "EFundef" the measured components of the earth fault current are probably too low or the phase relationship of the test circuit is not correct.

Finally, **properly reconnect all the transformer connections** and correct parameters which may have be changed during the test. If you had interrupted the trip circuit for this test, reconnect it now.

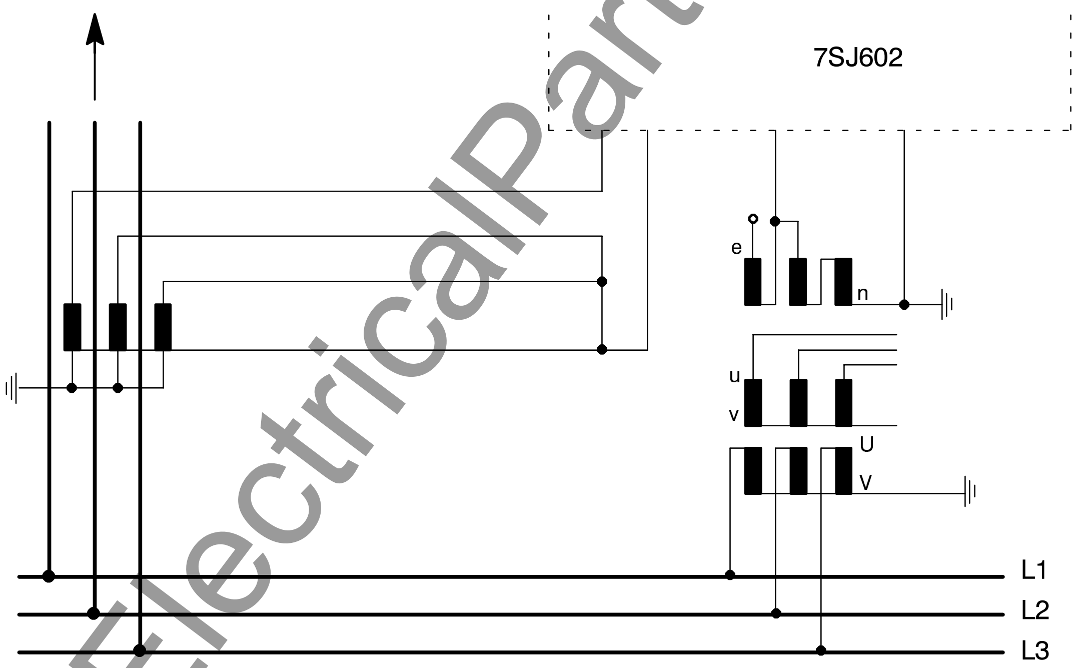


Figure 6.13 Earth fault direction test with Holmgreen connection

6.7.9.2 Direction check for earthed systems

The primary current test allows determination of the correct polarity of transformer connections for the earth fault direction protection.

The trip circuits should be made inoperative as the relay will issue a trip command during this test.

DANGER!

All precautionary measures must be observed when working on the instrument transformers! Secondary connections of the current transformers must be short-circuited before any current leads to the relay are interrupted!

The displacement voltage will be derived by bypassing a voltage transformer phase (e.g. L1, see Figure 6.13). In the current circuit, only the current from the current transformer corresponding to the phase in which the voltage is missing, will be used. If the line is carrying active and inductive power in line direction, practically the same relationships apply for the relay as with an earth fault in the line direction.

Check the directional indication. In the fault event report on the display panel (see also Section 6.4.3) at least the following fault annunciations must be indicated: "EFfor", and trip annunciation. If the directional indication is wrong "EFrev", it may be due to a crossed connection of the voltage connections in the open-delta winding of the voltage transformers or in the earth current path. If the indication "EFundef" appears, the earth current is probably too small. If no pick-up annunciation occurs the current is probably too low or the phase relationship of the test circuit is not correct. If there is no indication whatsoever, it is possible that the threshold value of the displacement voltage (Address 3309 Ve>, see Section 6.3.6.2) has not been reached.

Finally, **properly reconnect all the transformer connections**.

6.7.10 Tripping test including circuit breaker

Time overcurrent protection 7SJ602 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.

6.7.10.1 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, 7SJ602 only gives the tripping command, the procedure shall be followed as described in Section 6.7.10.2.

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:

A B O R T E D	– circuit breaker test is aborted
U N S U C C .	– circuit breaker test has been unsuccessful; breaker has not opened
E X E C U T E D	– circuit breaker test executed
C B n . o p n	– breaker is not open (before reclosing)

6.7.10.2 Live tripping of the circuit breaker

To check the tripping circuits, the circuit breaker can be tripped by 7SJ602 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.

△ C B – T E S T T R I P ▷	[4400] Block "Test of circuit breaker – Trip test"
△ C B – T E S T T R I P ? **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, refer to Section 5.4) and all desired protection functions have been switched *ON* (Section 6.3).

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 time overcurrent 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 system 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 6.7.10.

7.2 Maintenance

7.2.1 Replacing the buffer battery

The battery is used to retain the annunciation memories in the event of an interruption of the power supply. The battery also maintains the internal system clock with calendar after a loss of the power supply.

The back-up battery should be replaced when the operational annunciation “`BatFail`” has appeared, at the latest after 10 years of operation. If the relay is UL-listed use only a battery with UL-listing in order to meet the listing conditions.

Recommended battery:
Lithium battery 3 V/1 Ah, Type CR 1/2 AA, e.g.
– VARTA Order Number 6127 101 501

The battery is located near the upper left edge of the printed circuit board.

The procedure when replacing the battery is described below.

– For safety reasons, short-circuit the current transformers at the transformer terminals.

– Save all annunciations and fault records. These are the data under the annunciation sub-menu (all items in this sub-menu). The records and data will be lost when the battery is removed. The simplest and fastest method is to use the save feature in DIGSI® when the program is on-line.

  Note: All of the protective and control settings, including the input/output configuration and fault annunciations, are not affected by a power supply interruption. The settings are stored independently of the battery. The settings are not lost when the battery is removed, nor are the settings affected if the device operates without a battery.

– Have the replacement battery ready.

Caution!

Do not short the battery! Do not reverse the polarity of the battery! Do not lay the battery on the ground map used to protect components from electrostatic discharges! Do not recharge the battery!

– Isolate the power supply by opening the protective switches for both terminals.

– Prepare area of work. Provide a grounded mat for protecting components subject to damage from electrostatic discharges (ESD).

– 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 the screws.

– If the device provides a serial interface at the bottom side, this must be removed after unscrewing the six fixing screws.

Warning

Hazardous voltages may exist in the device, even after the power supply is disconnected and the boards are withdrawn from the case! Capacitors can still be charged!

– Pull out the module by taking it at the front cover and place it on the grounded mat to protect it from ESD damage.

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 the old battery from the snap-on connector using the plastic battery grip (Figure 7.1).

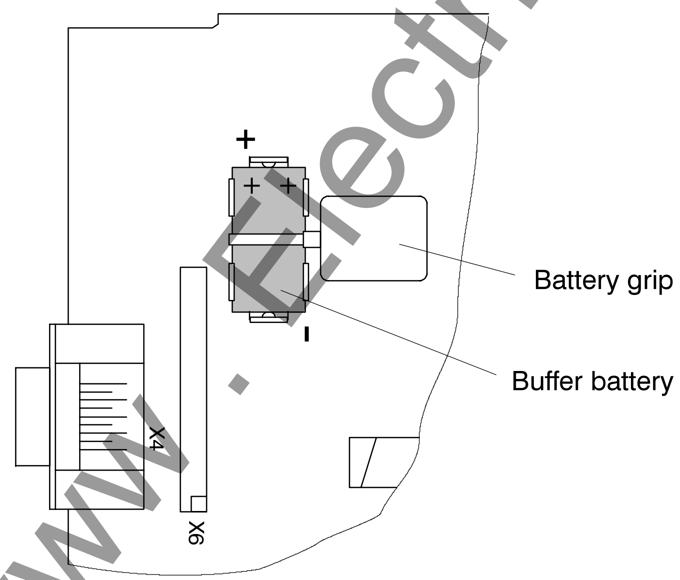


Figure 7.1 Position of the buffer battery

– Remove the battery grip from the old battery, and place the grip on the new battery.

Warning

The used battery contains Lithium. Do not throw the battery into the trash! It must be disposed off in line with the applicable regulations!

Do not reverse the polarity! Do not completely discharge! Do not throw the battery into a fire! Explosion hazard!

– Insert firmly the new battery into the snap-on connector.
Observe the polarity!

– Insert module into the housing.

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

– If the relay provides the serial interface at the bottom of the housing this must be re-inserted and fixed with the 6 screws. Be aware that <u>all</u> screws must be <u>slightly</u> tightened before they are finally fixed.

– Re-insert the covers.

– Switch the auxiliary voltage on. After restarting the device the annunciations and all saved values can be reloaded.

  If the internal system clock is not automatically synchronized via a serial interface, then the clock must be readjusted at this point. Refer to Section 6.5.1 if assistance is needed to set the clock. Consider also that the parameters for automatic reset of the minimum and maximum measured values must be readjusted after date and/or time have been changed. Repeat the setting procedure for addresses 1137 to 1139 as descibed in Section 6.3.3.

– Remove the short-circuit links at the current transformer terminals.

7.3 Fault tracing

If the protective device indicates a defect, the following procedure is suggested:

If none of the LEDs on the front plate of the module is on, then check:

– Has the module been properly pushed in and locked?

– Is the 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 7.3.1.

If the red fault indicator “Blocked” on the front is on and the green ready LED remains dark, the device has recognized an internal fault. Re-initialization of the protection system could be tried by switching the d.c. auxiliary voltage off and on again. Note that the last parameters are not stored if a parameterizing process has not yet been completed.

7.3.1 Replacing the mini-fuse

– For safety reasons, short-circuit the current transformers at the transformer terminals.

– Select a replacement fuse 5 × 20 mm. Ensure that the rated value, time lag (slow) and code letters are correct (T2H250V).

– Prepare area of work. Provide a grounded mat for protecting components subject to damage from electrostatic discharges (ESD).

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

– If the device has a serial system interface at the bottom side, this must be removed after unscrewing the six fixing 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 the grounded mat to protect them from ESD damage.

⚠ 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 7.2).

– Fit new fuse into the holder.

– Insert module into the housing.

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

– If the relay provides the serial interface at the bottom of the housing this must be re-inserted and fixed with the 6 screws. Be aware that <u>all</u> screws must be <u>slightly</u> tightened before they are finally fixed.

– Reinsert the covers.

– Remove the short-circuit links at the current transformer terminals.

Switch on the device again. If a power supply failure is still signalled, a fault or short-circuit is present in the internal power supply. The device should be returned to the factory (see Chapter 8).

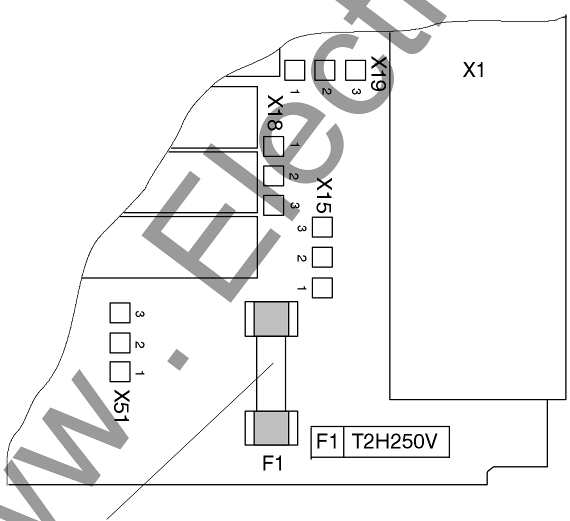


Figure 7.2 Position of the mini-fuse

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 to 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 Instrument transformer circuits

C Operation structure, Tables

A General diagrams

Ordering code: position 7 = 1 or 5

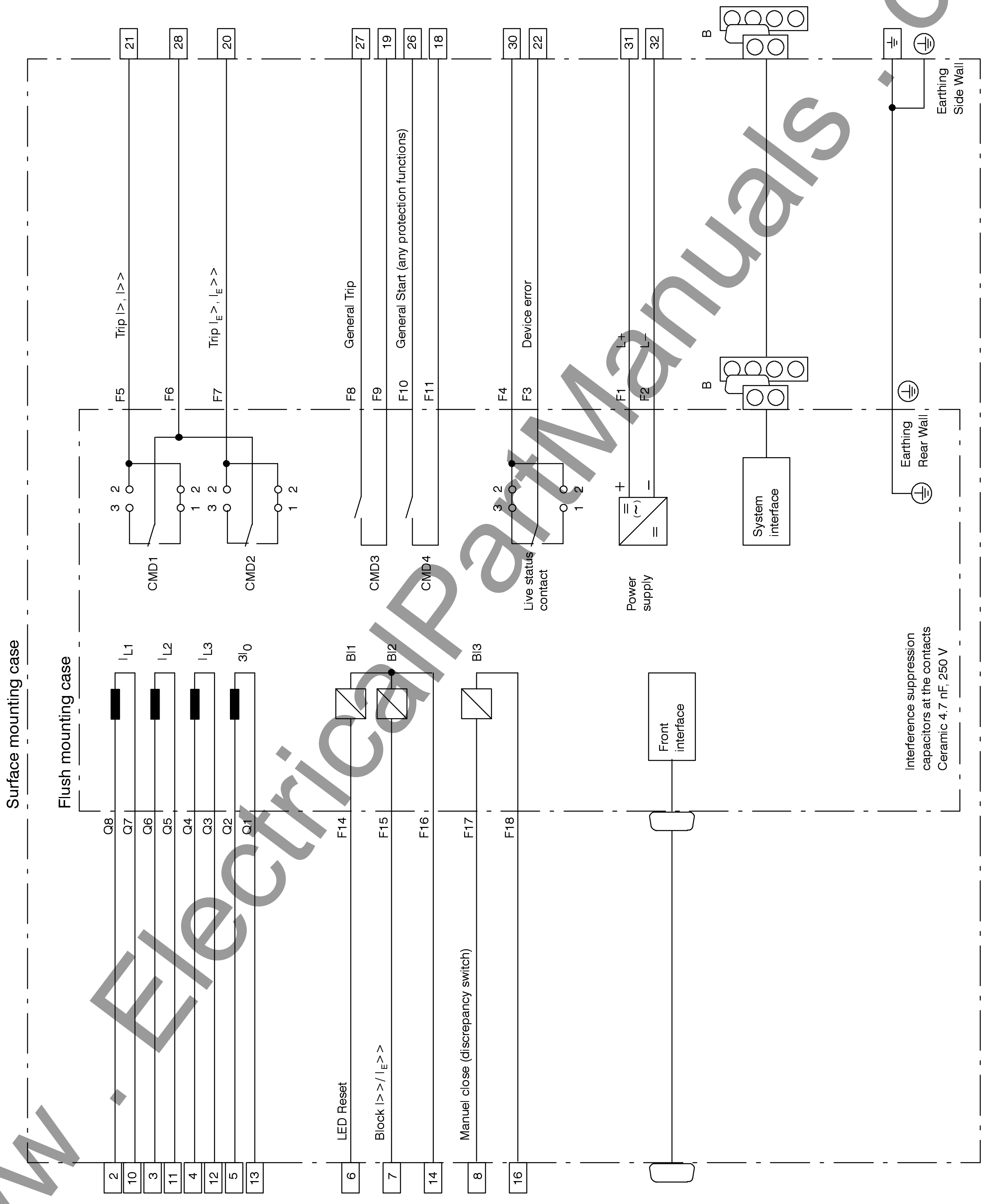


Figure A.1 General diagram of multi-function overcurrent and motor protection relay 7SJ602 (4 current inputs)

Ordering code: position 7 = 2 or 6

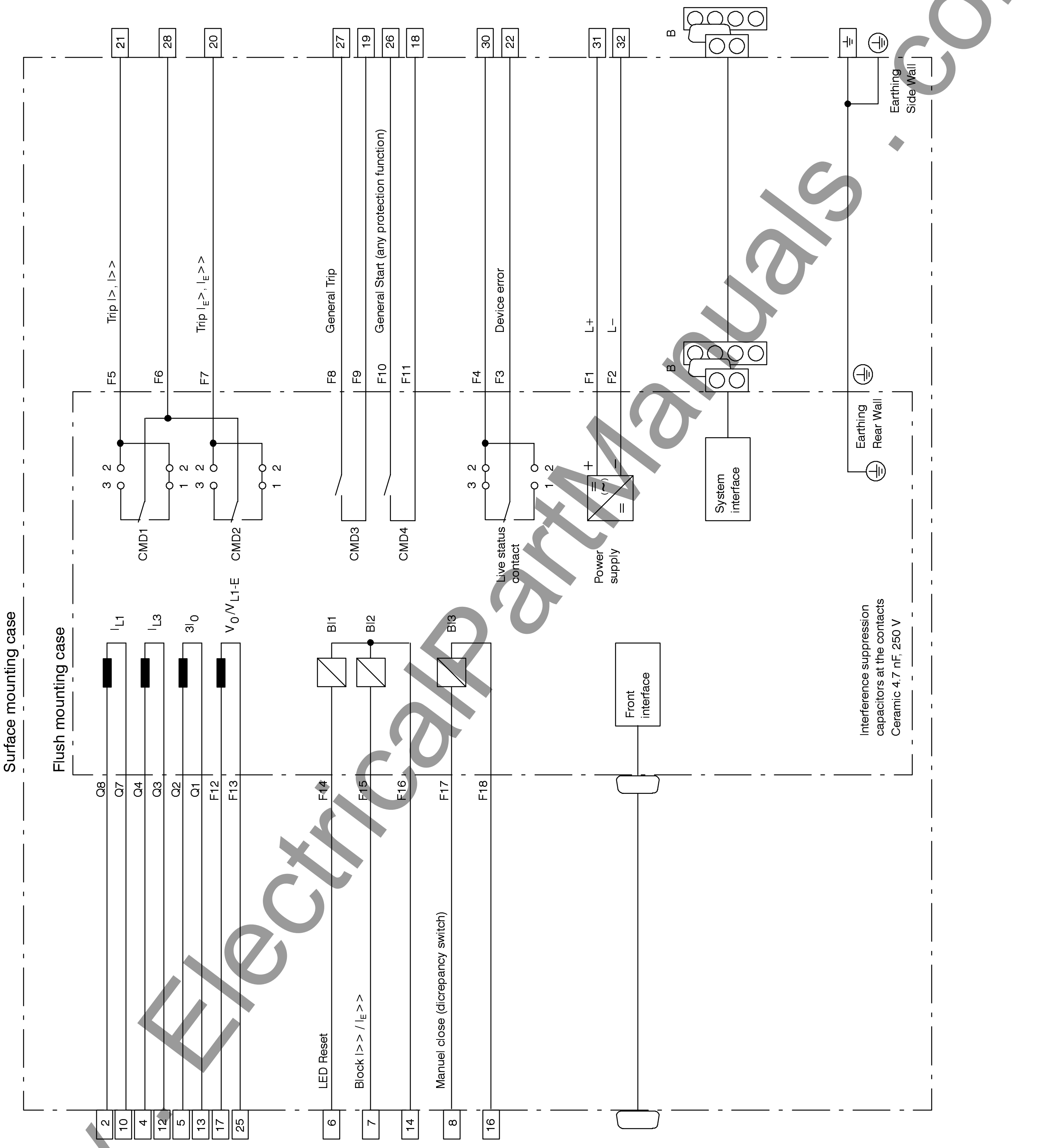


Figure A.2 General diagram of multi-function overcurrent and motor protection relay 7SJ602 (3 current inputs and 1 voltage input)

B Instrument transformer circuits

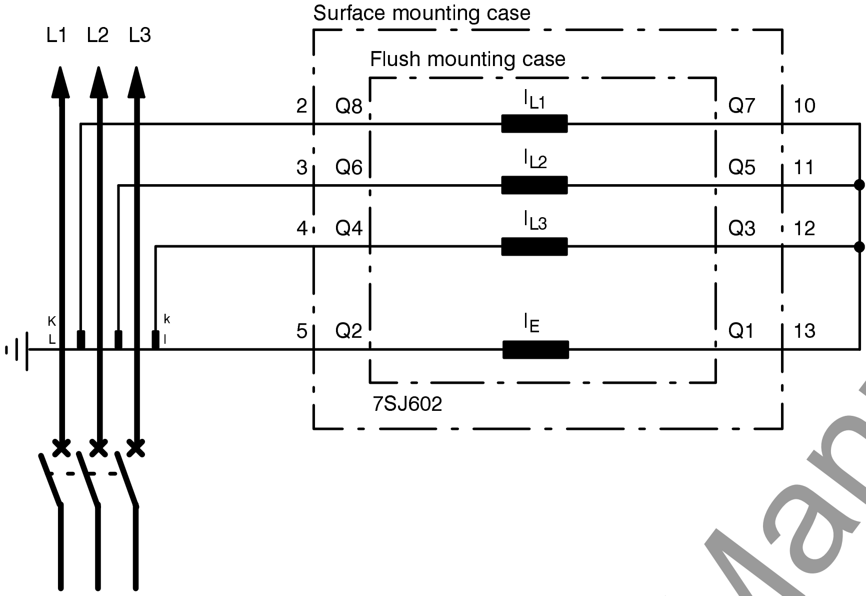


Figure B.1 3 c.t. connection for all systems (normal connection with 4 current inputs)

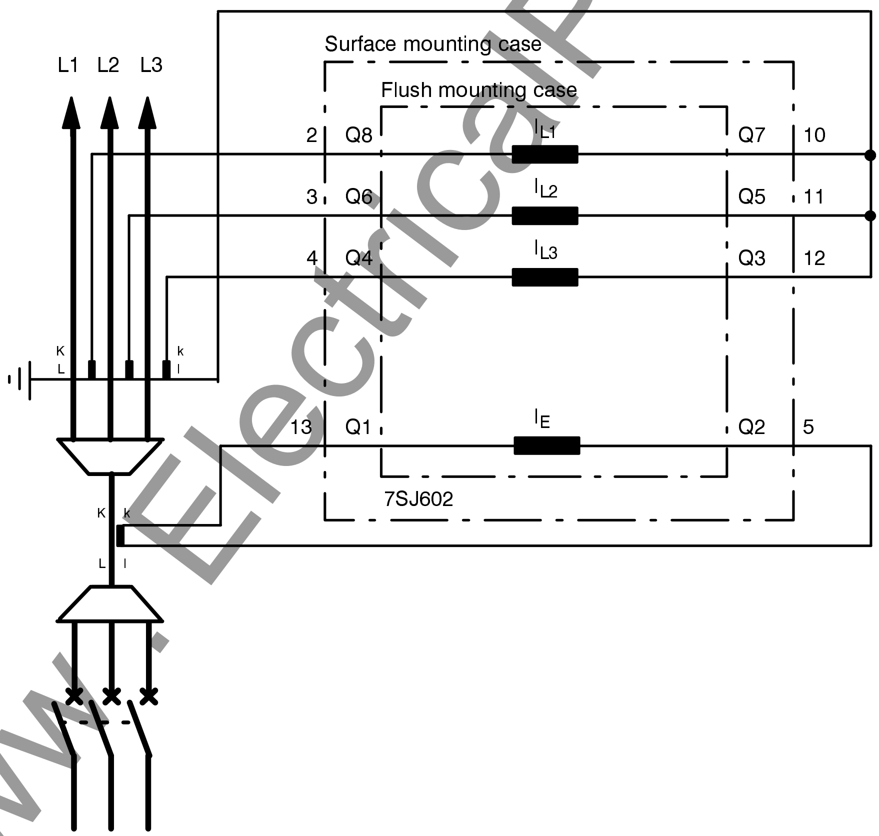


Figure B.2 3 c.t. connection with earth current from a separate summation transformer

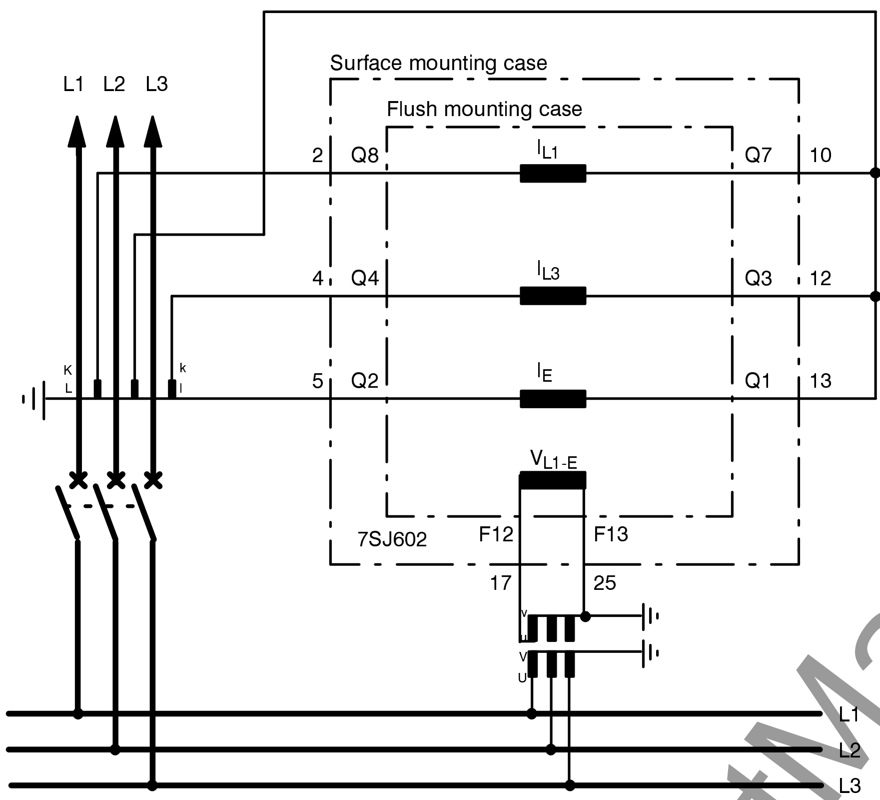


Figure B.3 Connection with 3 current inputs $I_{L1}-I_{L3}-I_E$ and voltage input V_{L1-E} for all systems

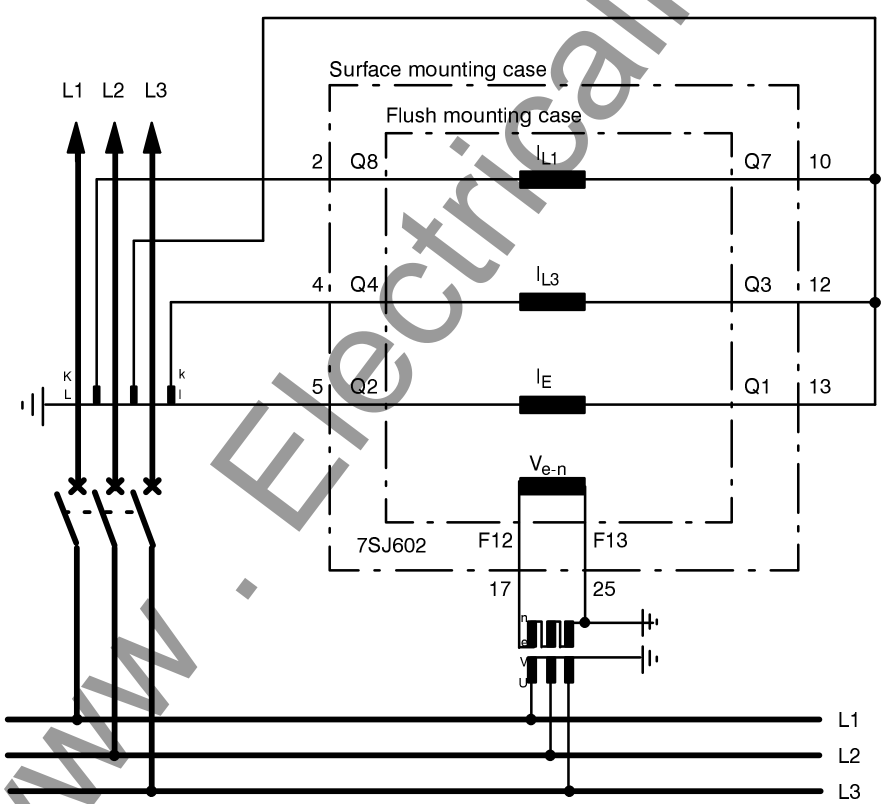


Figure B.4 Connection with 3 current inputs $I_{L1}-I_{L3}-I_E$ and displacement voltage input V_{e-n}

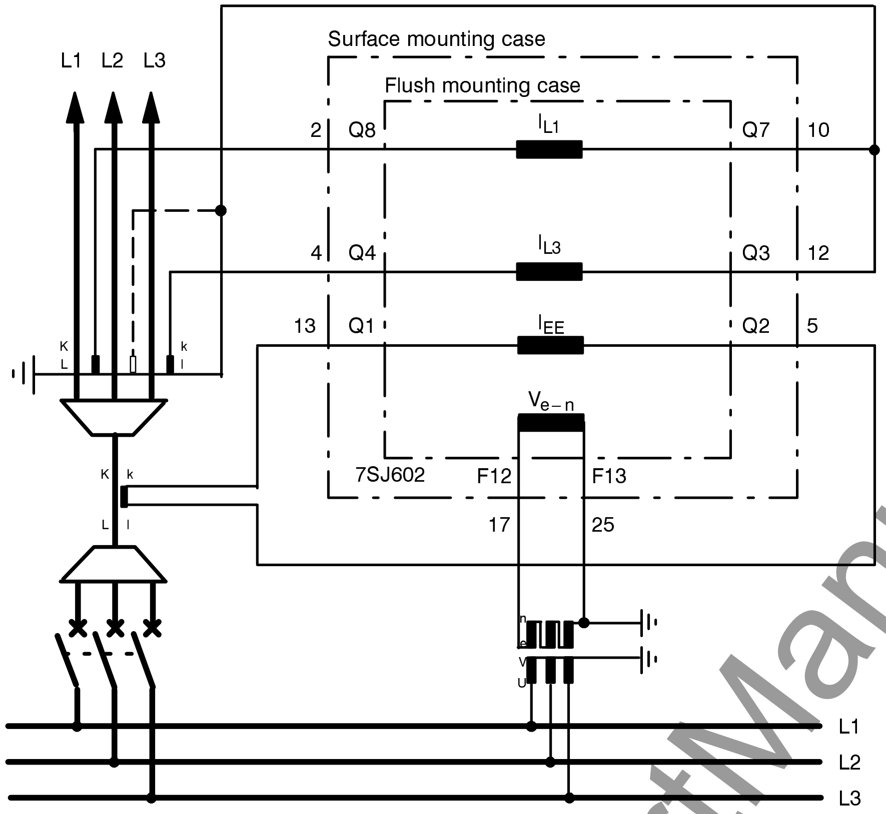


Figure B.5 Connection with 3 current inputs $I_{L1}-I_{L3}-I_{EE}$ with separate summation transformer for high-sensitivity earth fault protection and displacement voltage input V_{e-n}

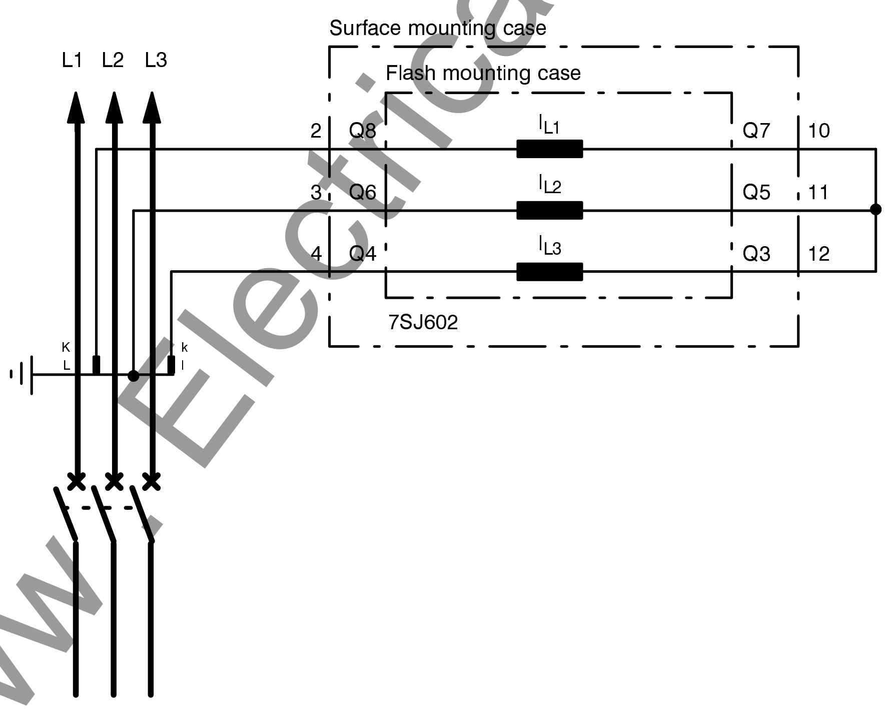


Figure B.6 2 c.t. connection only for isolated or compensated systems

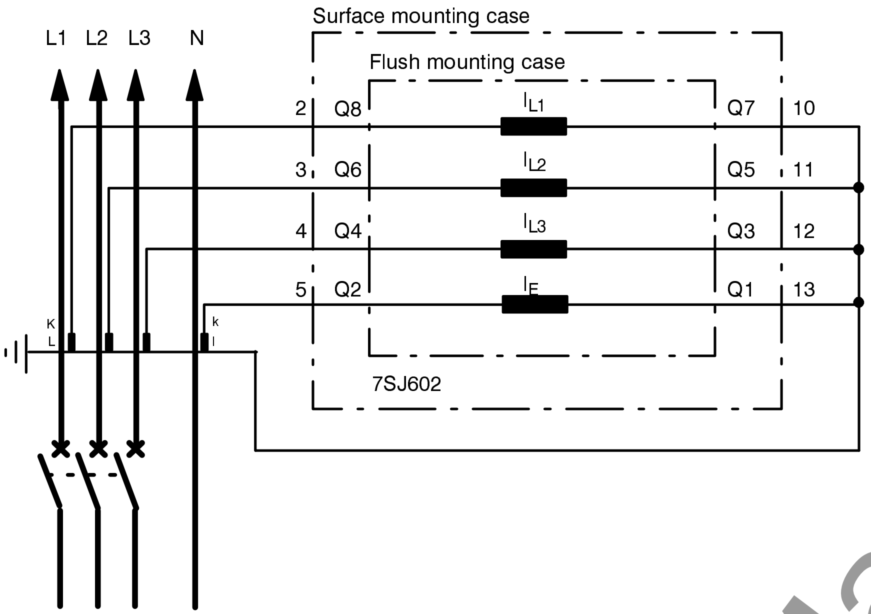


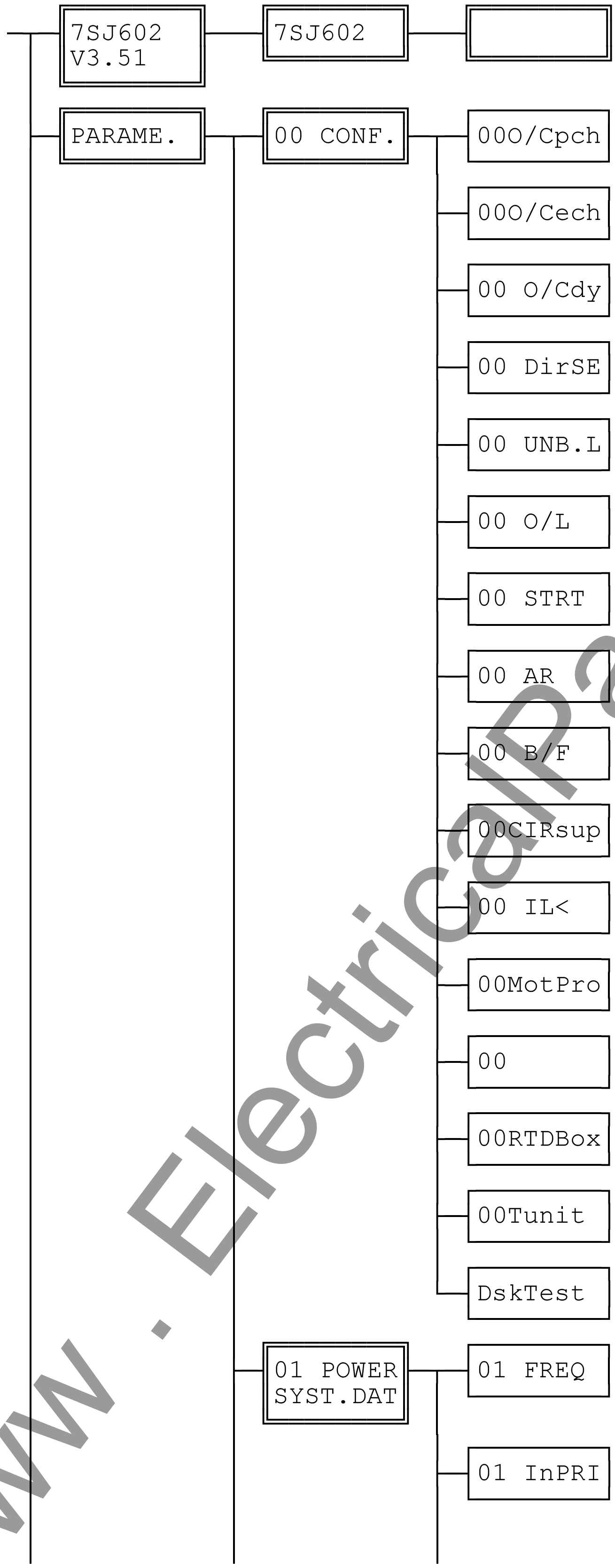
Figure B.7 4 c.t. connection on a 4-wire system (with neutral conductor)

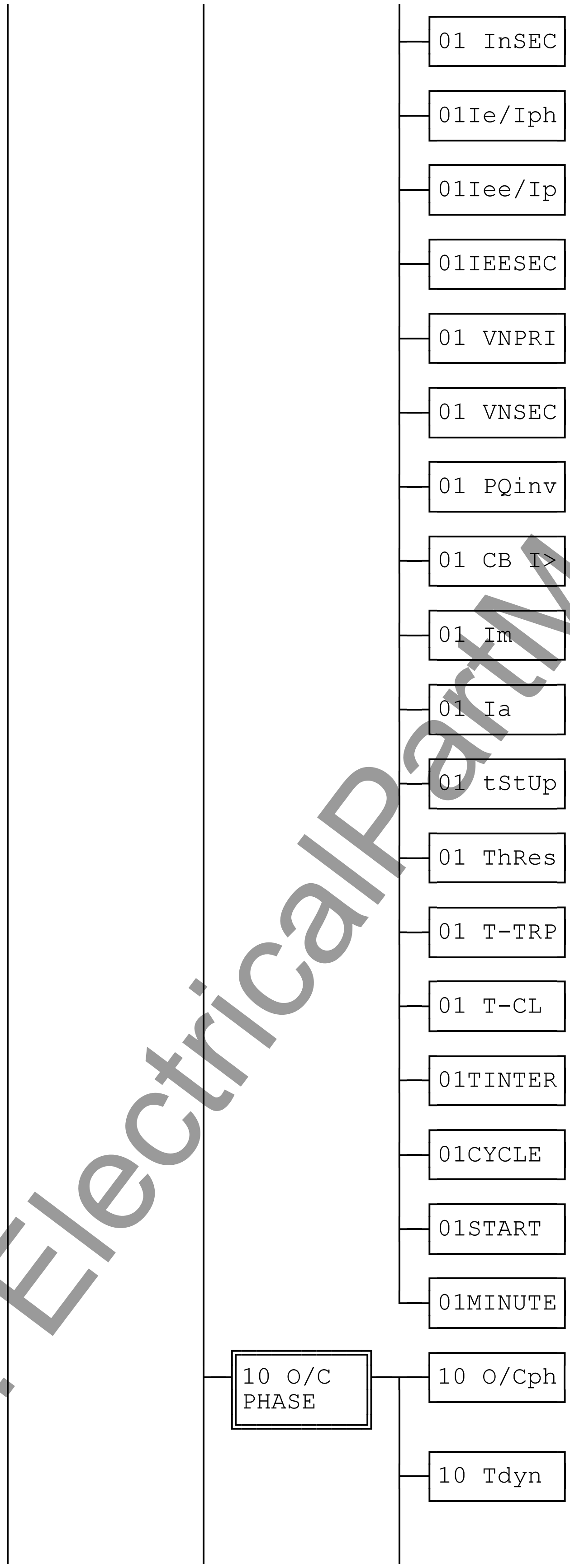
C Operation structure, Tables

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

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

Menu Structure of 7SJ602

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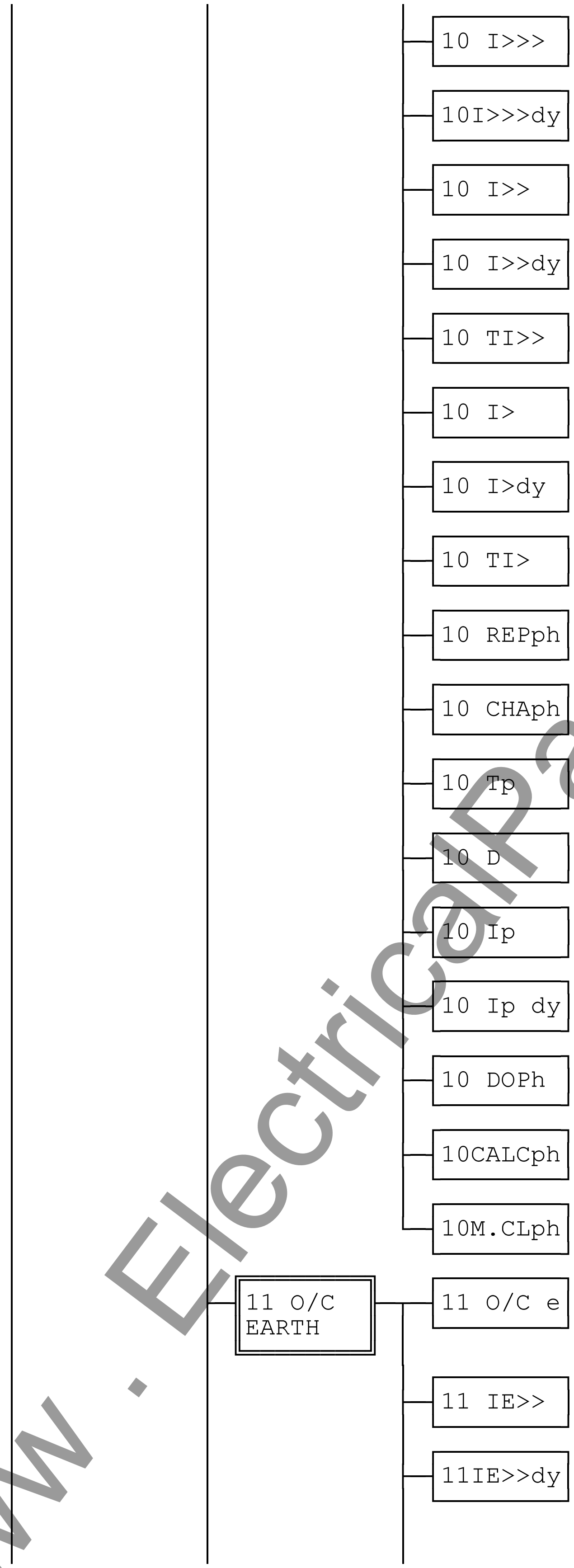
01Iee/Ip
01IEESEC
01 VNPRI
01 VNSEC
01 PQinv
01 CB I>
01 Im
01 Ia
01 tStUp
01 ThRes
01 T-TRP
01 T-CL
01TINTER
01CYCLE
01START
01MINUTE
10 O/C PHASE
10 O/Cph
10 Tdyn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10 I>>
10 I>>dy
10 TI>>
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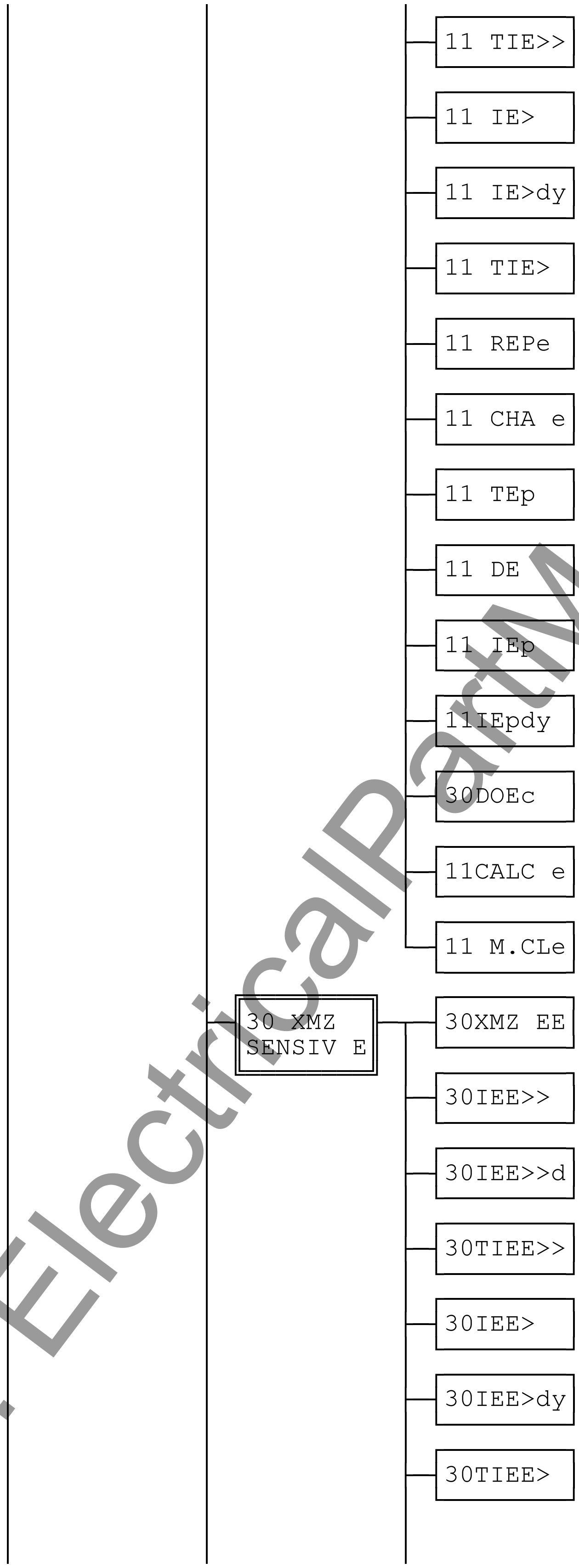
10 I>dy
10 TI>
10 REPph
10 CHAph
10 Tp
10 D
10 Ip
10 Ip dy
10 DOPh
10CALCph
10M.CLph
11 O/C EARTH
11 O/C e
11 IE>>
11IE>>dy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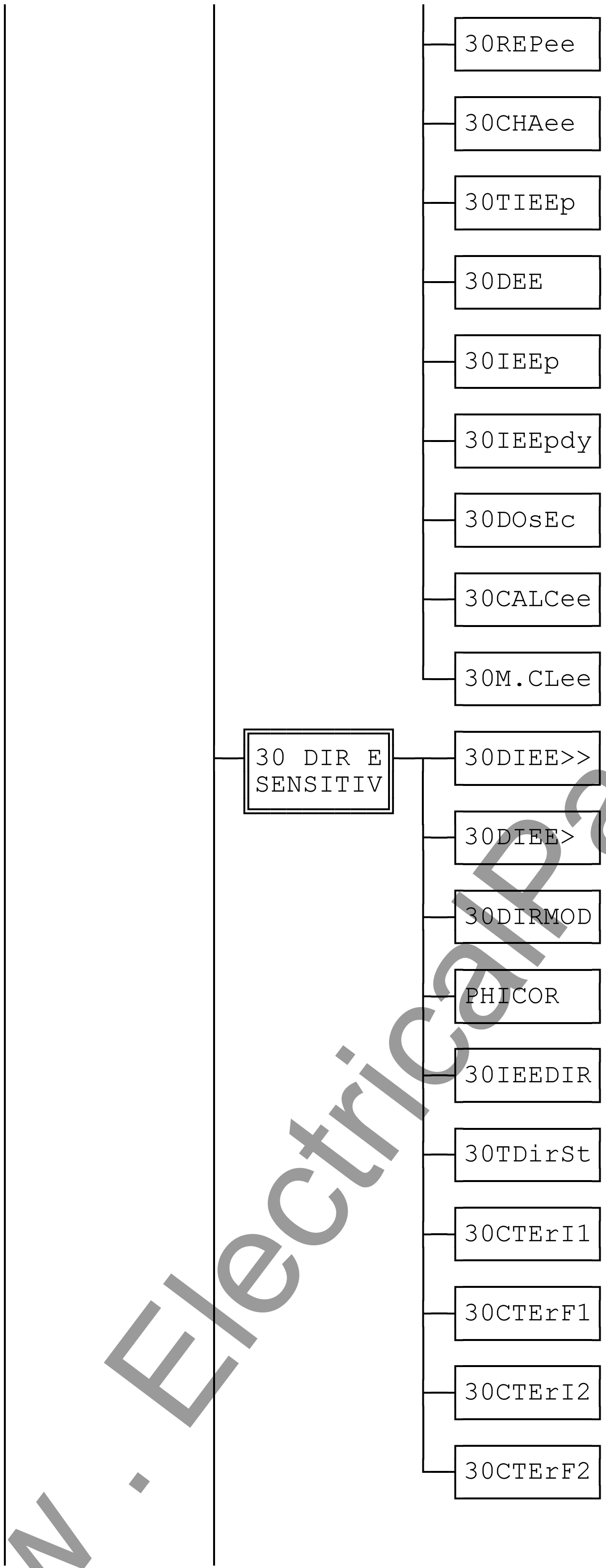
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PHICOR
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30TDirSt
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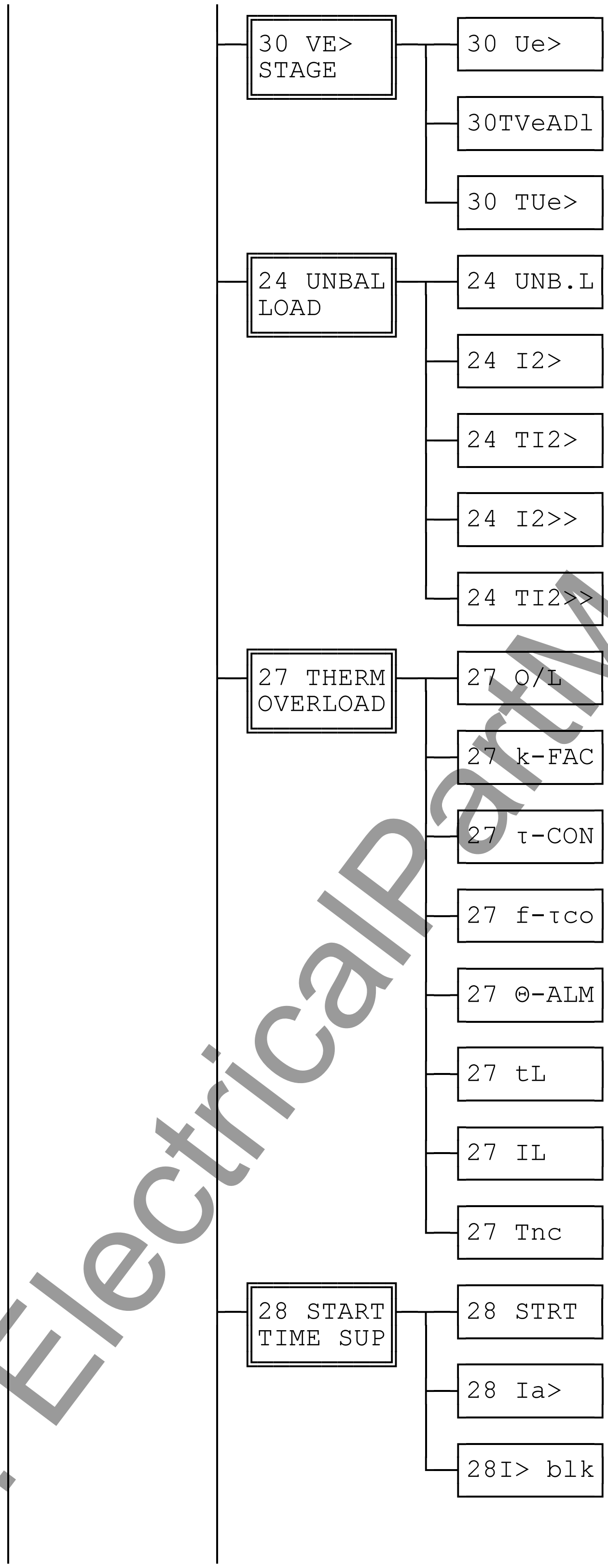
30CTErF1
30CTErI2
30CTErF2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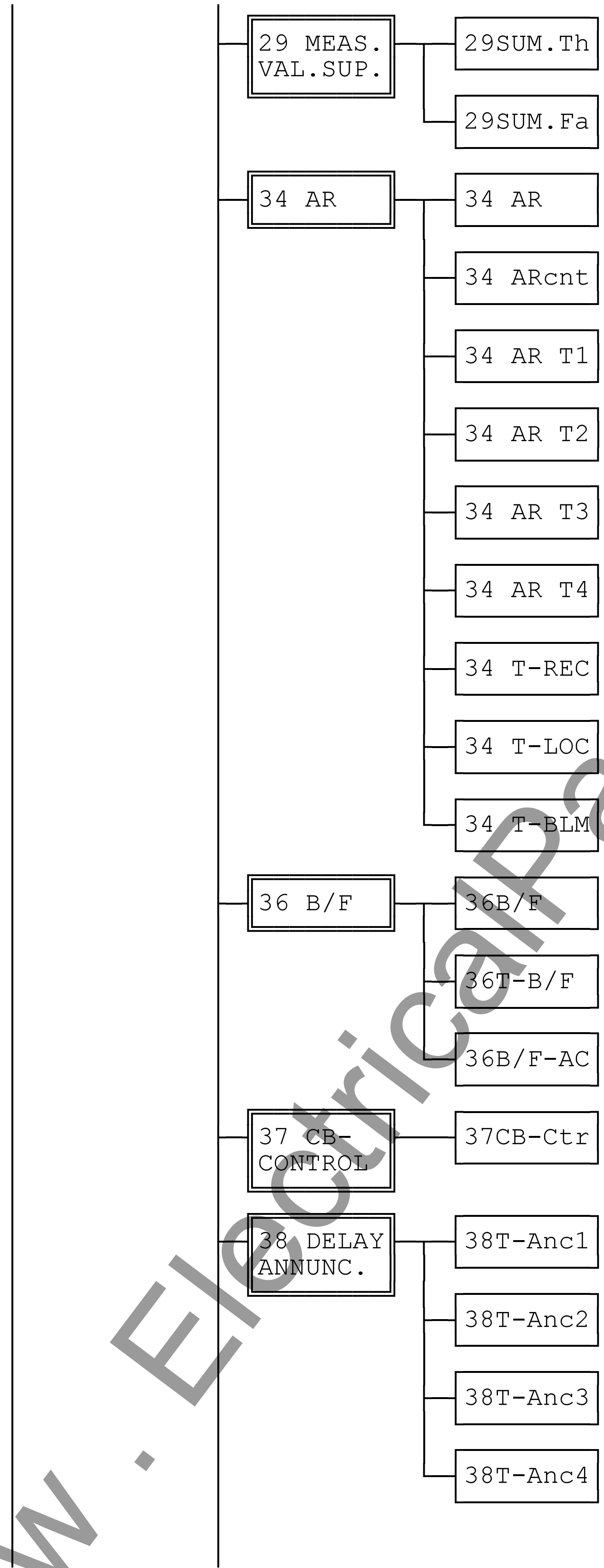
30 Ue>
30TVeADl
30 TUe>
24 UNBAL LOAD
24 UNB.L
24 I2>
24 TI2>
24 I2>>
24 TI2>>
27 THERM OVERLOAD
27 O/L
27 k-FAC
27 τ-CON
27 f-τco
27 Θ-ALM
27 tL
27 IL
27 Tnc
28 START TIME SUP
28 STRT
28 Ia>
28I> blk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VAL.SUP.
29SUM.Th
29SUM.Fa
34 AR
34 AR
34 ARcnt
34 AR T1
34 AR T2
34 AR T3
34 AR T4
34 T-REC
34 T-LOC
34 T-BLM
36 B/F
36B/F
36T-B/F
36B/F-AC
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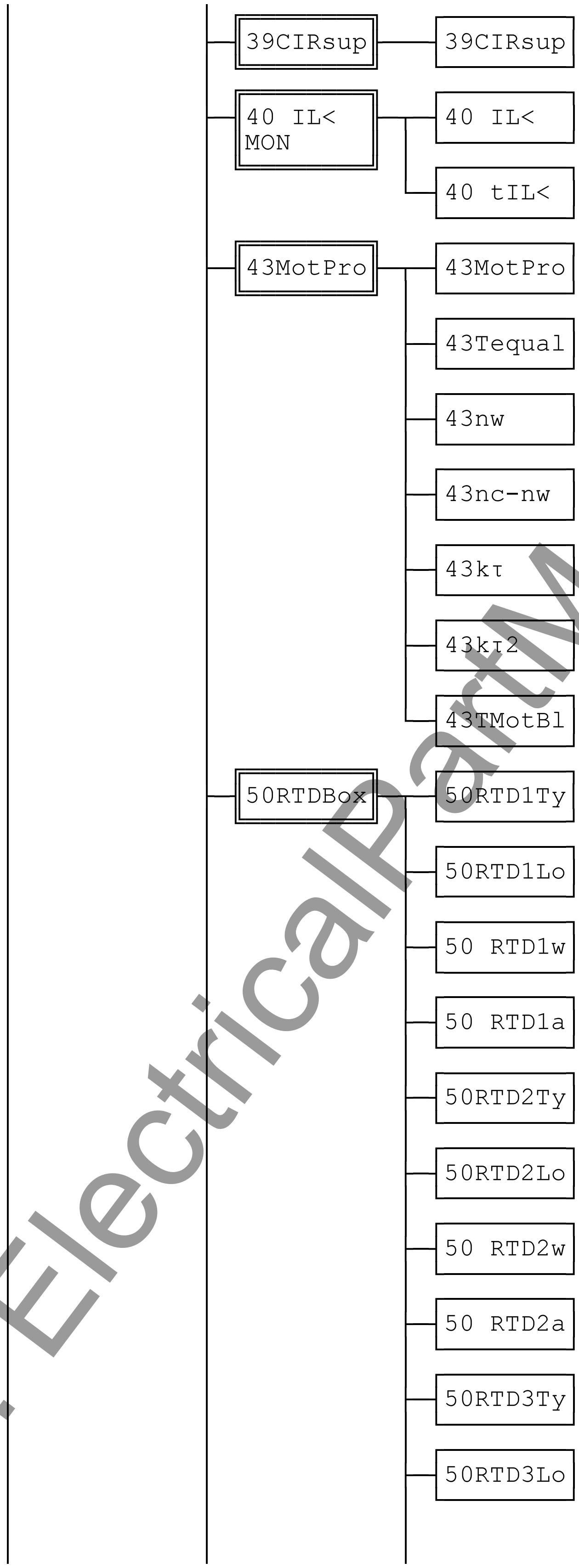
38T-Anc3
38T-Anc4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43TMotBl
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50 RTD1a
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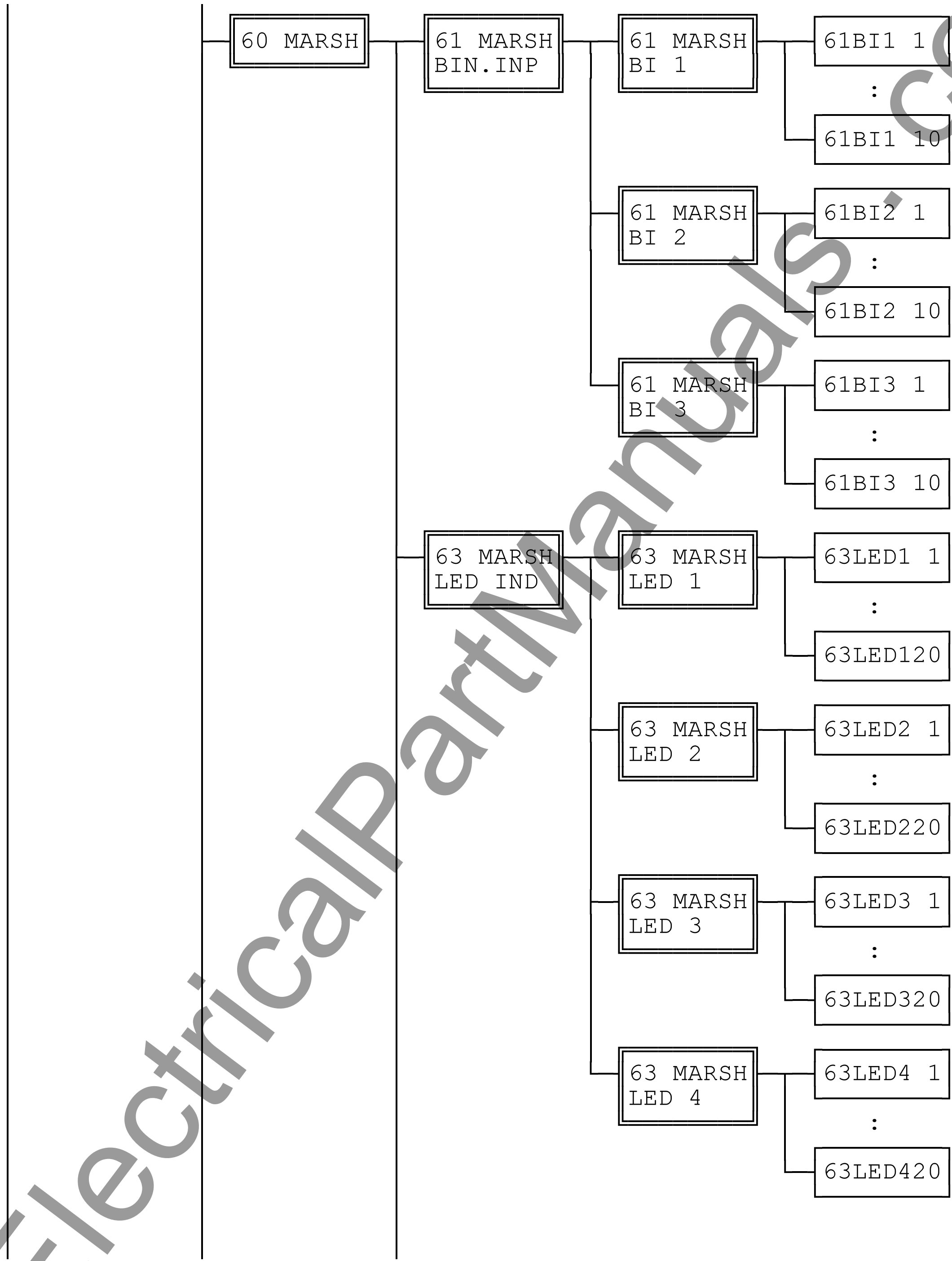
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:
61BI3 10
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63 MARSH LED 1
63LED1 1
:
63LED120
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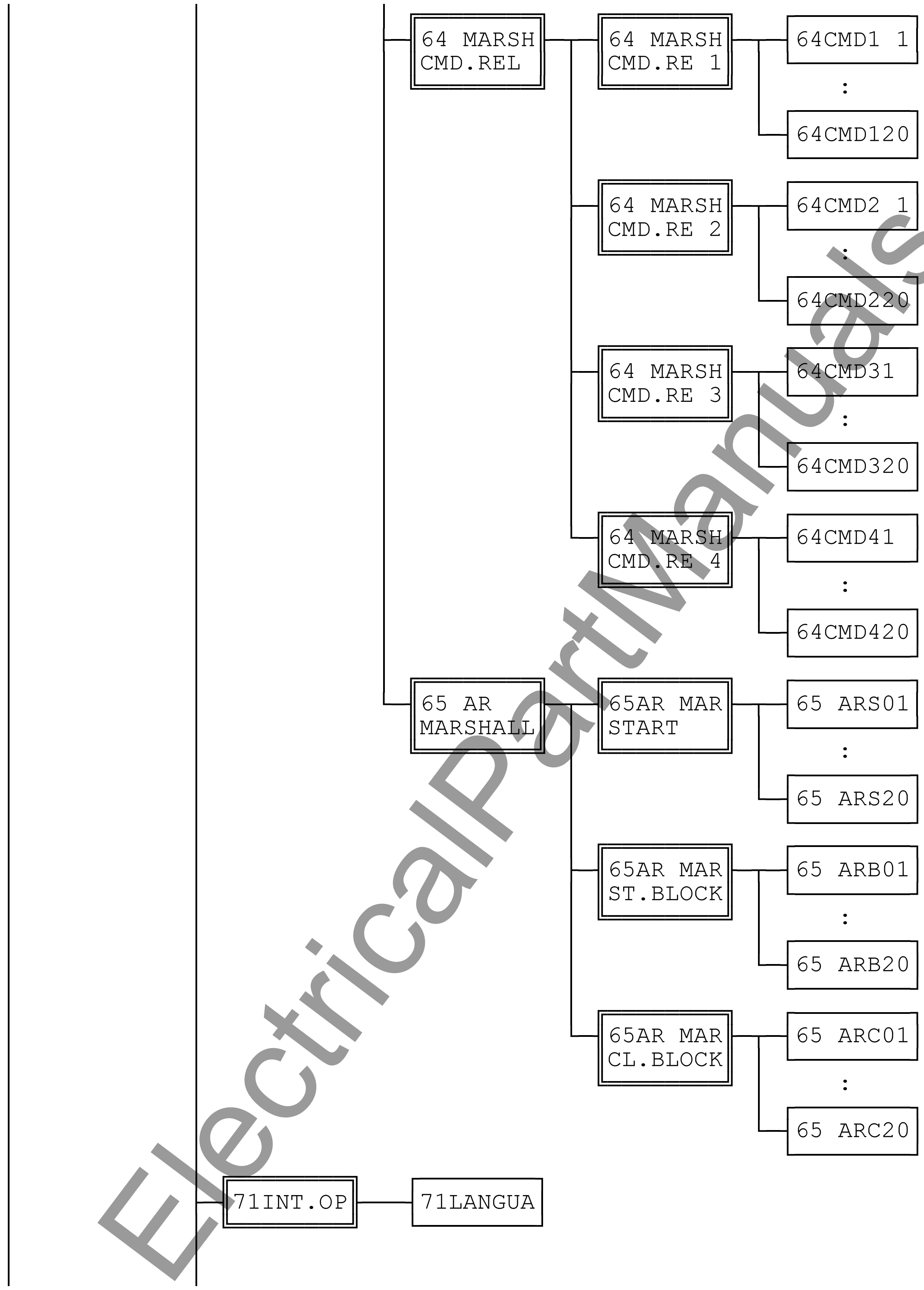
:
63LED420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64 MARSH CMD.RE 4
64CMD41
:
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65AR MAR START
65 ARS01
:
65 ARS20
65AR MAR ST.BLOCK
65 ARB01
:
65 ARB20
65AR MAR CL.BLOCK
65 ARC01
:
65 ARC20
71INT.OP
71LANGUA

- 72 INTERFACE
  - 72DEVICE
  - 72FEEDER
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  - 72F-TYPE
  - 72PC-INT
  - 72 GAPS
  - 72PCBAUD
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  - 72S-GAPS
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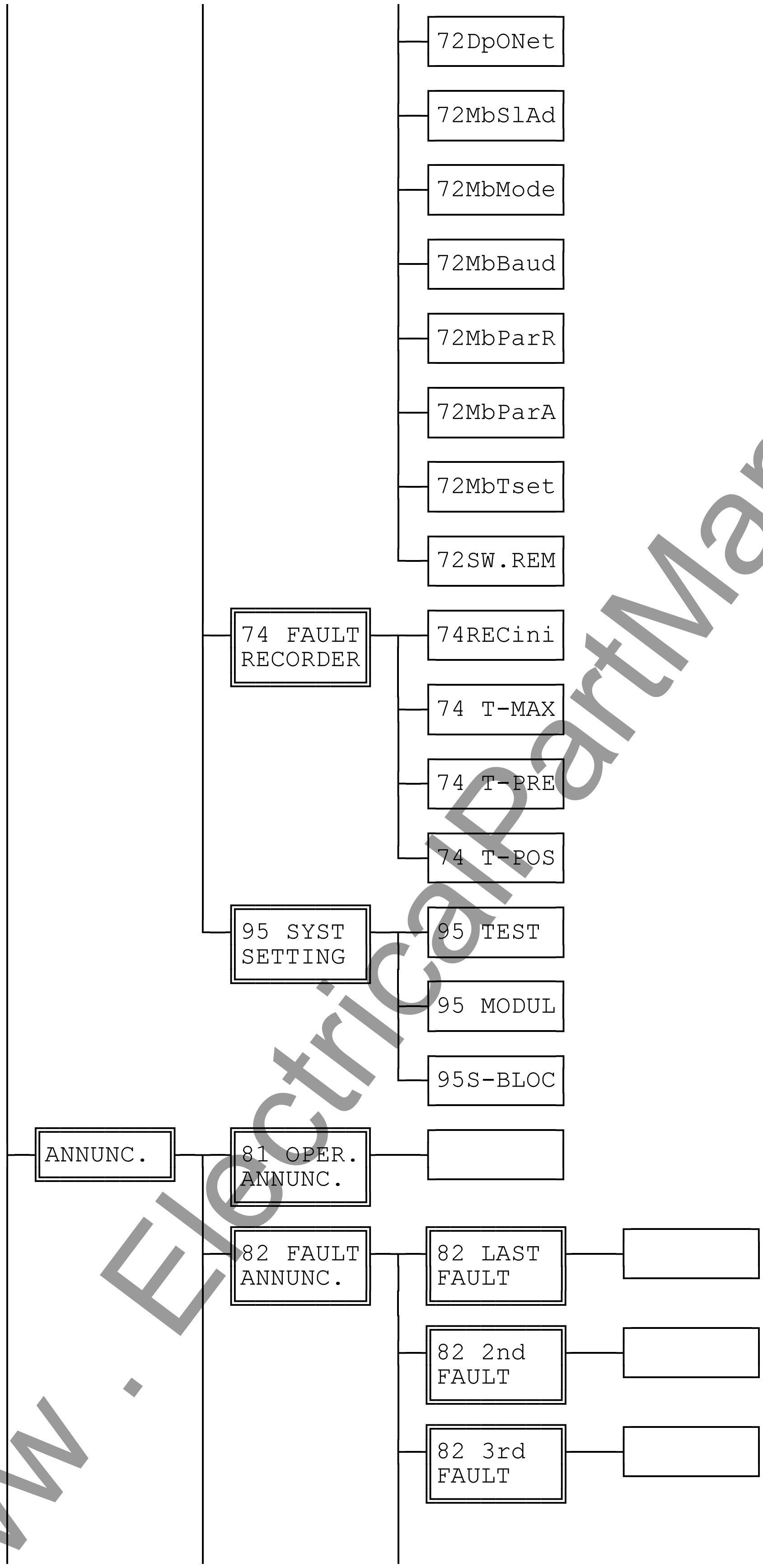
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74 T-PRE
74 T-POS
95 SYST SETTING
95 TEST
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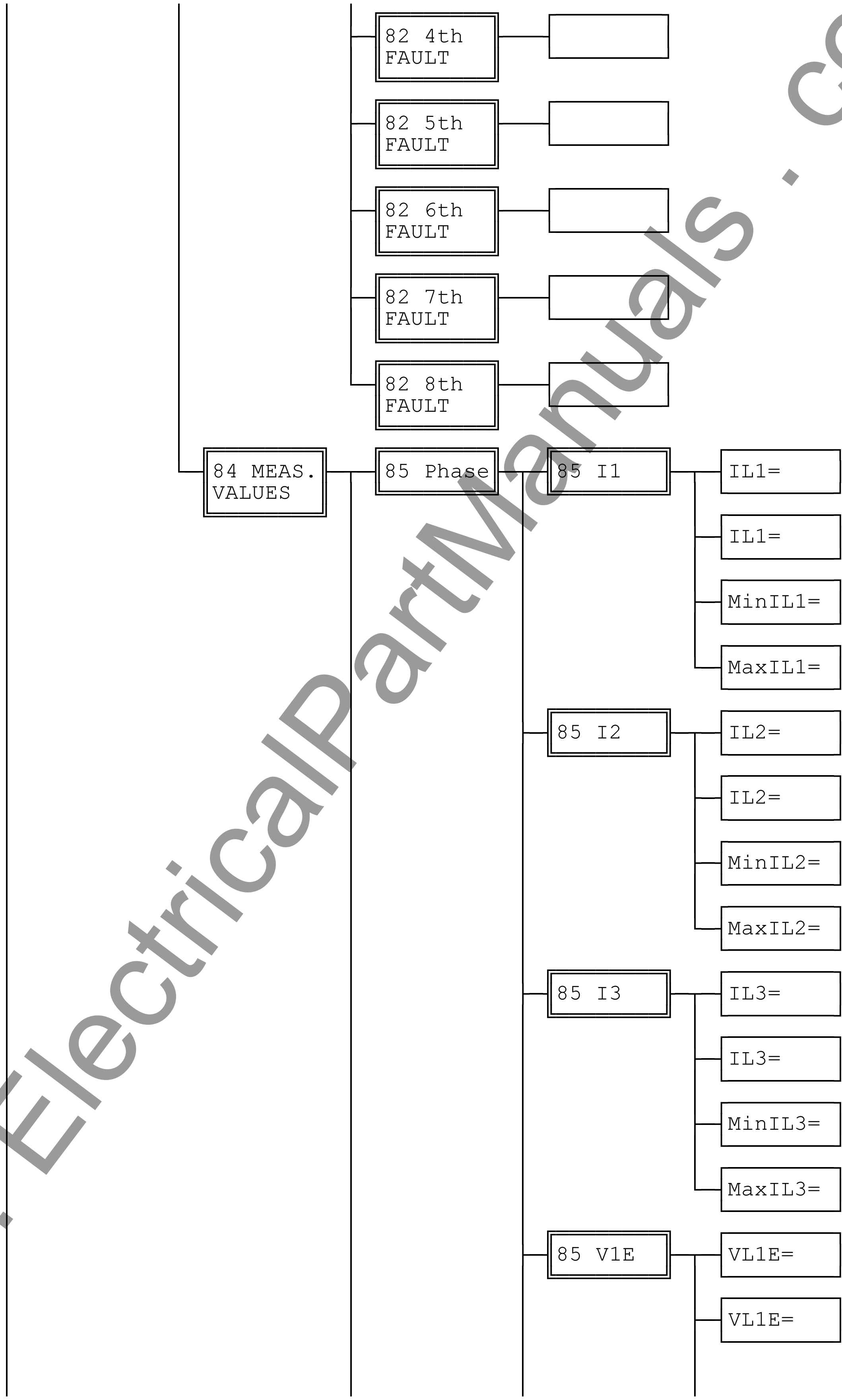
82 LAST FAULT
82 2nd FAULT
82 3rd FAULT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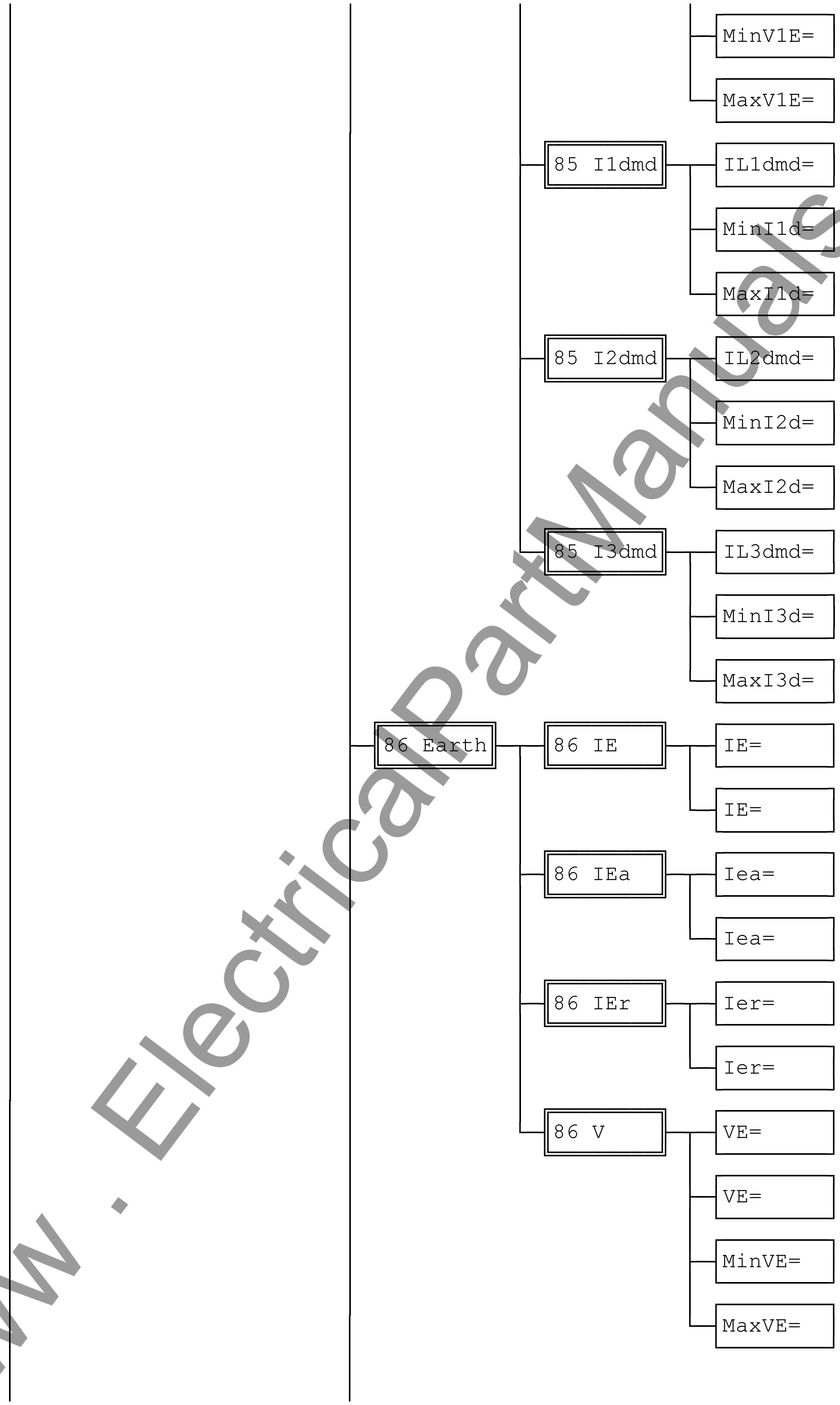
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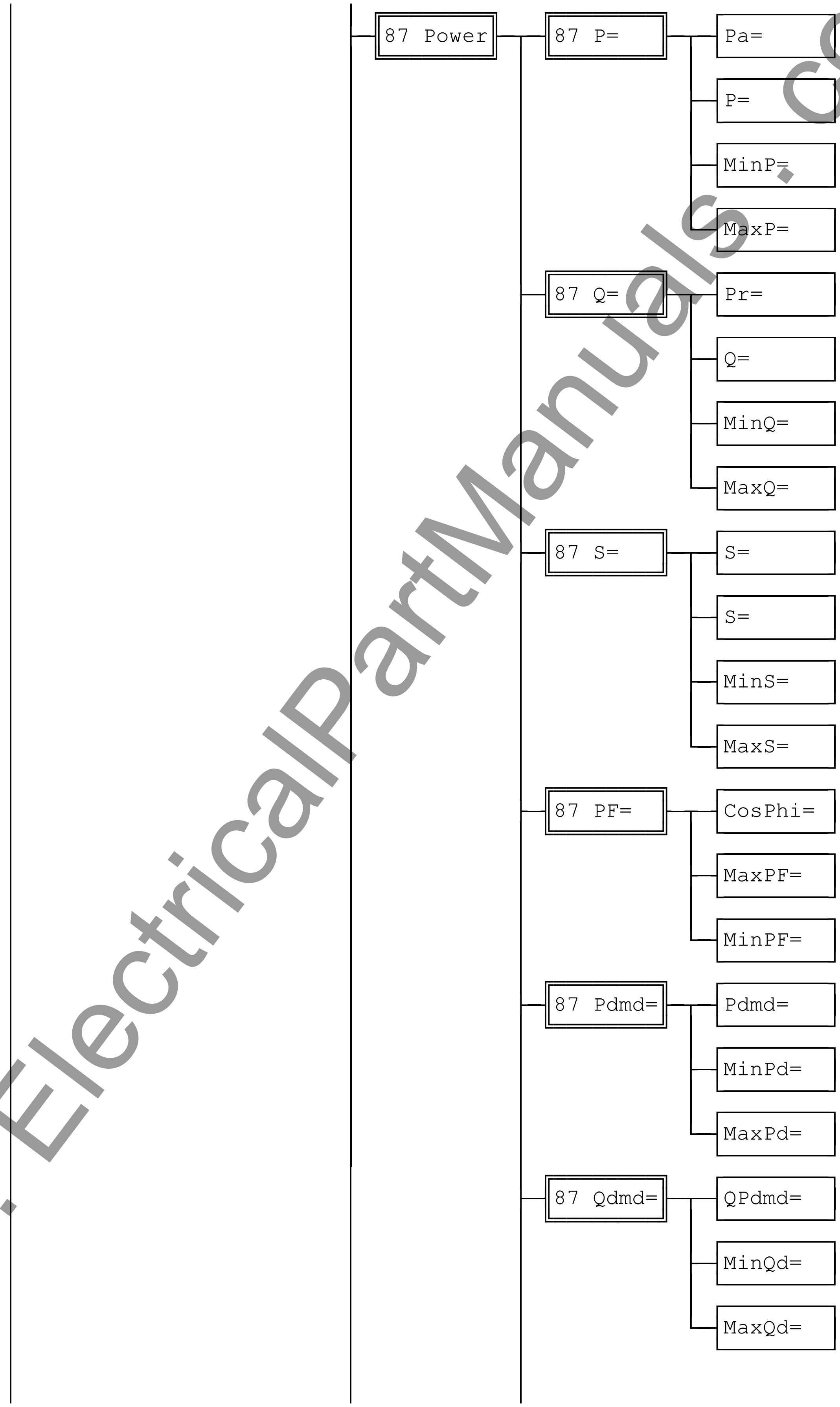
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MaxS=
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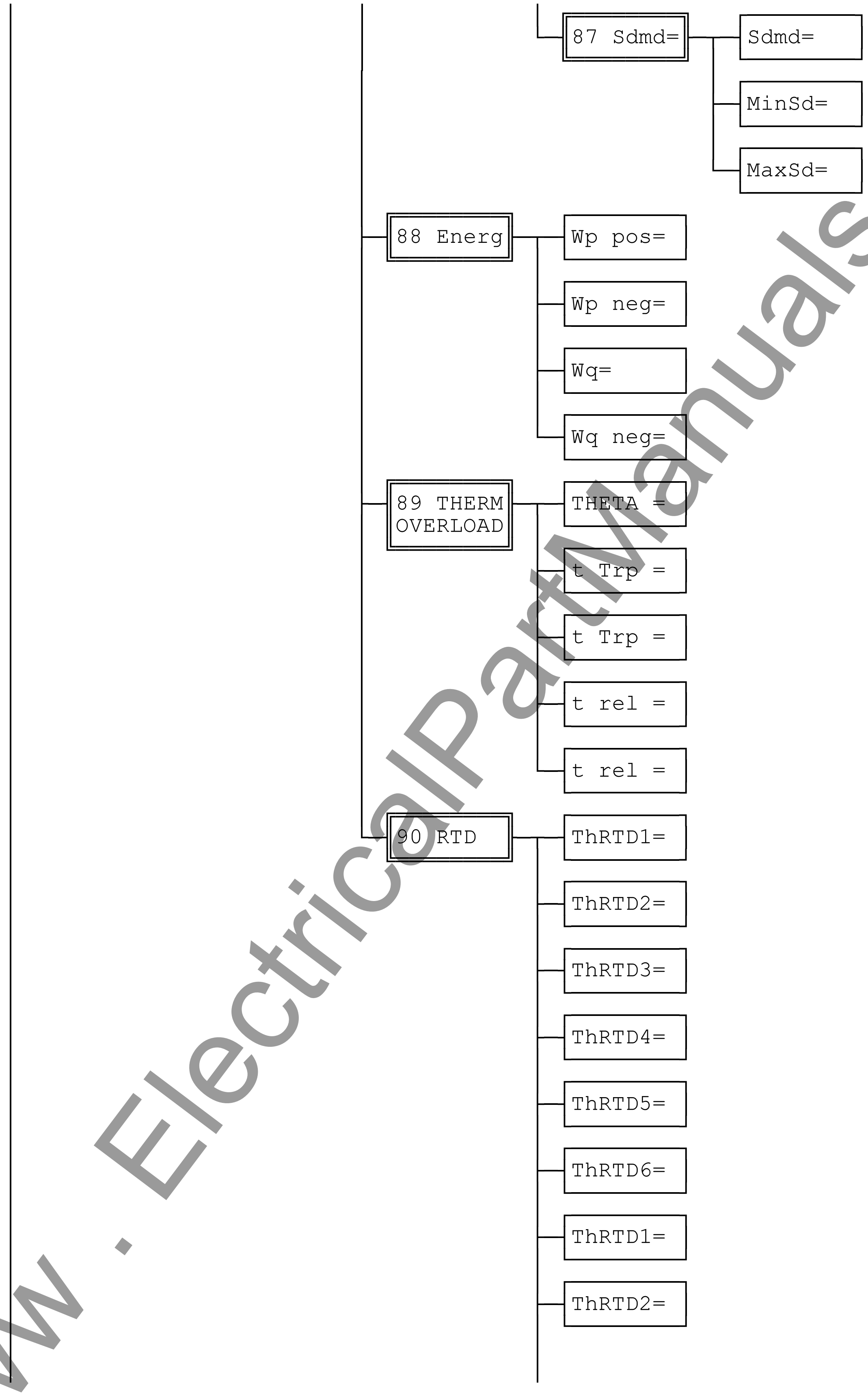
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t Trp =
t Trp =
t rel =
t rel =
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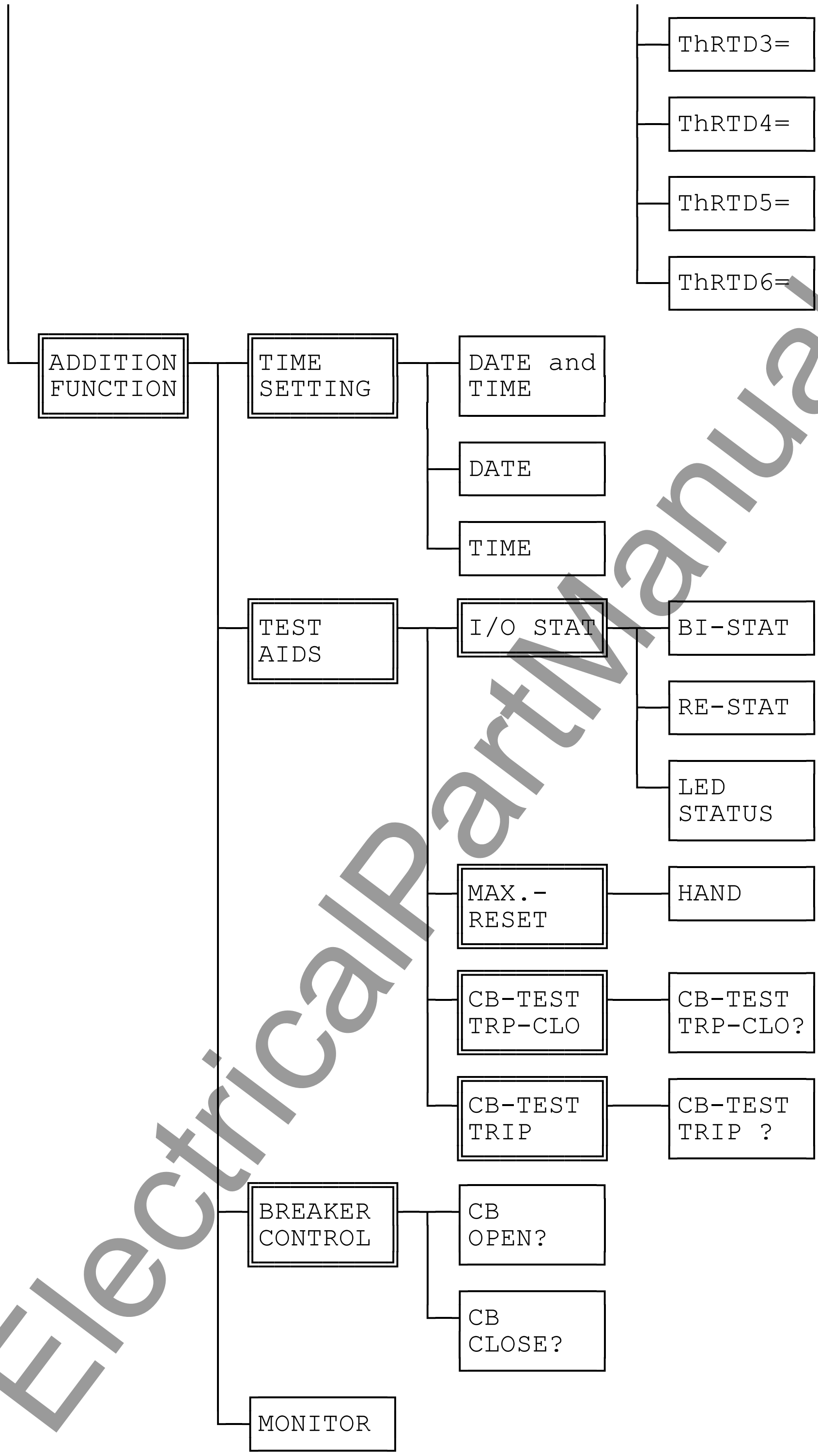
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ThRTD5=
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DATE and TIME
DATE
TIME
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I/O STAT
BI-STAT
RE-STAT
LED STATUS
MAX.- RESET
HAND
CB-TEST TRP-CLO
CB-TEST TRP-CLO?
CB-TEST TRIP
CB-TEST TRIP ?
BREAKER CONTROL
CB OPEN?
CB CLOSE?
MONITOR

Annunciations 7SJ602 V3.5 for LSA (according to IEC 60870-5-103)

FNo. - Function number for IEC interface
Op/Ft - Operation/Fault annunciation
C/CG: Coming/Coming and Going annunciation
MV : Measurand

According to IEC 60870-5-103:
CA - Compatible annunciation
GI - Annunciation for General Interrogation
BT - Binary Trace for fault recordings
Type - Function type
(p: according to the configured "Function Type")
Inf - Information number

Operation and Fault Annunciations:

FNo.	Text	Meaning	Ctrl dir.	Annun Op	Ft	IEC 60870-5-103 CA	GI	BT	Type	Inf
3	>Ti.syn	>Time synchronization	yes						135	48
5	>LED r.	>Reset LED indicators							135	50
11	>Annu.1	>User defined annunciation 1		CG		CA	GI	BT	p	27
12	>Annu.2	>User defined annunciation 2		CG		CA	GI	BT	p	28
13	>Annu.3	>User defined annunciation 3		CG		CA	GI	BT	p	29
14	>Annu.4	>User defined annunciation 4		CG		CA	GI	BT	p	30
16	>SysMMb	>Block. of monitoring dir. via sys.-int		CG					135	54
52	operat.	Any protection operative		CG		CA	GI		p	18
53	Res.FCB	Reset frame count bit				CA			p	2
54	ResetKE	Reset communication unit				CA			p	3
56	Init.st	Initial start of processor system				CA			p	5
57	GI-end	End of general interrogation				CA			255	0
58	Time sy	Time synchronization				CA			255	0
60	LED res	LED Reset		C		CA			0	19
61	Meas.Bl	Logging and measuring functions blocked		CG		CA			0	20
63	PCviaSy	PC operation via system interface				CA			135	83
80	SigStör	For internal use only							135	110
81	SigBef.	For internal use only							135	111
83	SigTest	For internal use only							135	113
110	ANNlost	Annunciations lost (buffer overflow)		C					135	130
111	PCannLT	Annunciations for PC lost		C					135	129
112	LSAanLT	Annunciations for LSA lost							135	131
113	TAGlost	Fault tag lost						BT	135	136
115	ANNovfl	Fault annunciation buffer overflow			C				135	132
129	IECstIN	IEC state invalid							135	149
159	LSAdist	LSA (system interface) disrupted							135	44
162	Fail∑I	Failure: Current summation supervision		CG			GI		135	182
177	BatFail	Failure: Battery		CG					135	193
203	REC del	Fault recording data deleted		C					135	203
235	RemBlk	Remote is blocked		CG					135	159
284	IL< al	IL< alarm		CG					135	244
356	>mCLOSE	>Manual close		CG					150	6
415	>ResMax	Reset min/max of measured data	yes	CG					150	84
416	iResMax	Int. reset min/max of measured data		C					150	85
417	ResMax	Min/max of measured data has been reset		C					150	86
501	FT det	General fault detection of device			CG	CA	GI	BT	p	84
511	DEV.Trp	General trip of device			C	CA		BT	p	68
521	IL1	Interrupted current: Phase L1 (I/In)			C				150	171
522	IL2	Interrupted current: Phase L2 (I/In)			C				150	172
523	IL3	Interrupted current: Phase L3 (I/In)			C				150	173
537	IE=	Interrupted current: IE (I/In)			C				150	182

Note: Function number 16 is announced only "Coming" to LSA

FNo.	Text	Meaning	Ctrl dir.	Annun Op	Ft	IEC 60870-5-103 CA	GI	BT	Type	Inf
538	IEE=	Interrupted current: IEE (I/In)			C				150	183
563	CBA sup	CB alarm suppressed							150	199
1157	>CBclo	>Circuit breaker closed		CG			GI		151	57
1174	CBtest	Circuit breaker test in progress		CG			GI		151	74
1185	CBtpTST	Circuit breaker test: Trip 3pole		CG			GI		151	85
1188	CBTwAR	Circuit breaker test: Trip w. reclosure		CG			GI		151	89
1201	>UE bl	>Block UE stage of sensitive E/F prot.	yes	CG					151	101
1215	FD UE	Earth flt. det. by displacement voltage		CG	CG		GI		151	115
1217	Trip UE	Trip by displacement voltage stage		C	C				151	117
1276	EFfor	Earth fault (isol./comp.) forward dir.		CG	C	CA			p	51
1277	EFrev	Earth fault (isol./comp.) reverse dir.		CG	C	CA			p	52
1278	EFundef	Earth fault (isol./comp.) undefined dir		CG	C				151	178
1403	>BF blo	>Block breaker failure protection	yes	CG					166	103
1431	>BF St	>ext. start breaker failure protection	yes		CG				166	104
1451	BF off	Breaker fail protection is switched off		CG					166	151
1452	BF bloc	Breaker failure protection is blocked			CG				166	152
1453	BF act	Breaker failure protection is active		CG					166	153
1456	BF fltI	Breaker failure (int): fault detection			CG				166	156
1457	BF fltE	Breaker failure (ext): fault detection			CG				166	157
1471	BF Trip	Trip by breaker failure protection			C	CA			p	85
1501	>O/L on	>Switch on thermal overload protection	yes				GI		167	1
1502	>O/Loff	>Switch off thermal overload protection	yes				GI		167	2
1503	>O/Lblk	>Block thermal overload protection	yes				GI		167	3
1511	O/L off	Thermal overload prot. is switched off		CG			GI		167	11
1512	O/L blk	Thermal overload protection is blocked		CG			GI		167	12
1513	O/L act	Thermal overload protection is active		CG			GI		167	13
1516	O/L wrn	Thermal overload prot.: Thermal warning		CG	CG		GI		167	16
1518	O/L p/u	Thermal overload prot.: Pick-up		CG	CG		GI		167	18
1521	O/L Trp	Thermal overload protection trip			C			BT	167	21
1530	THETA =	Operating temperature =		MV					167	30
1531	t Trp =	O/L: estimated time to trip in sec		MV					167	31
1532	t Trp =	O/L: estimated time to trip in min		MV					167	32
1533	t rel =	O/L: estimated time to release closing		MV					167	33
1534	t rel =	O/L: estimated time to release closing		MV					167	34
1701	>O/Cpon	>Switch on O/C protection phases	yes						60	12
1702	>O/Cpof	>Switch off O/C protection phases	yes						60	13
1704	>O/Cpbk	>Block overcurrent protection phases	yes						60	14
1711	>O/Ceon	>Switch on overcurrent protection earth	yes						60	15
1712	>O/Ceof	>Switch off overcurrent protec. earth	yes						60	19
1714	>O/Cebk	>Block overcurrent protection earth	yes						60	20
1721	>I>>blk	>Overcurrent protection:block stage I>>	yes	CG					60	1
1722	>I> blk	>Overcurrent protection:block stage I>	yes	CG					60	2
1723	>Ip blk	>Overcurrent protection:block stage Ip	yes	CG					60	3
1724	>IE>>bk	>Overcurrent protec.: block stage IE>>	yes	CG					60	4
1725	>IE> bk	>Overcurrent protection:block stage IE>	yes	CG					60	5
1726	>IEp bk	>Overcurrent protection:block stage IEp	yes	CG					60	6
1727	>C/O	>C/O of overcurrent fault detec. level	yes						60	73
1751	O/Cpoff	Overcurrent prot. phase is switched off		CG			GI		60	21
1752	O/Cpblk	Overcurrent prot. phase is blocked		CG			GI		60	22
1753	O/Cpact	Overcurrent prot. phase is active		CG			GI		60	23
1756	O/Ceoff	O/C protection earth is switched off		CG			GI		60	26
1757	O/Ceblk	O/C protection earth is blocked		CG			GI		60	27
1758	O/Ceact	O/C protection earth is active		CG			GI		60	28
1762	O/C L1	O/C fault detection phase L1				CA	GI	BT	p	64
1763	O/C L2	O/C fault detection phase L2				CA	GI	BT	p	65
1764	O/C L3	O/C fault detection phase L3				CA	GI	BT	p	66
1765	O/C E	O/C fault detection earth				CA	GI	BT	p	67
1771	FD L1	O/C fault detection L1 only			C				60	31
1772	FD L1E	O/C fault detection L1-E			C				60	32
1773	FD L2	O/C fault detection L2 only			C				60	33
1774	FD L2E	O/C fault detection L2-E			C				60	34

FNo.	Text	Meaning	Ctrl dir.	Annun Op	Annun Ft	IEC 60870-5-103 CA	GI	BT	Type	Inf
1775	FD L12	O/C fault detection L1-L2			C				60	35
1776	FD L12E	O/C fault detection L1-L2-E			C				60	36
1777	FD L3	O/C fault detection L3 only			C				60	37
1778	FD L3E	O/C fault detection L3-E			C				60	38
1779	FD L13	O/C fault detection L1-L3			C				60	39
1780	FD L13E	O/C fault detection L1-L3-E			C				60	40
1781	FD L23	O/C fault detection L2-L3			C				60	41
1782	FD L23E	O/C fault detection L2-L3-E			C				60	42
1783	FD L123	O/C fault detection L1-L2-L3			C				60	43
1784	FDL123E	O/C fault detection L1-L2-L3-E			C				60	44
1785	FD E	O/C fault detection E only			C		GI		60	45
1800	FD I>>	O/C fault detection stage I>>			CG		GI		60	75
1805	Trp I>>	O/C protection I>> phase trip			C	CA		BT	p	91
1810	FD I>	O/C fault detection stage I>			CG		GI		60	76
1815	Trip I>	O/C protection I> phase trip			C	CA		BT	p	90
1820	FD Ip	O/C fault detection stage Ip			CG		GI		60	77
1825	Trip Ip	O/C protection Ip phase trip			C			BT	60	58
1831	FD IE>>	O/C fault detection IE>> earth			CG		GI		60	59
1833	TrpIE>>	O/C protection IE>> earth trip			C	CA		BT	p	93
1834	FD IE>	O/C fault detection IE> earth			CG		GI		60	62
1836	Trp IE>	O/C protection IE> earth trip			C	CA		BT	p	92
1837	FD IEp	O/C fault detection IEp earth			CG		GI		60	64
1839	Trp IEp	O/C protection IEp earth trip			C			BT	60	66
1850	FD dyn	O/C prot.: dynamic parameters active		CG					60	74
2701	>AR on	>AR: Switch on auto-reclose function	yes						40	1
2702	>AR off	>AR: Switch off auto-reclose function	yes						40	2
2732	>AR St.	>AR: Start external	yes	CG	CG				40	23
2733	>ARblSt	>AR: External Blocking of Start	yes	CG	CG				40	24
2734	>ARblCl	>AR: External Blocking of reclosure	yes	CG	CG				40	25
2736	AR act.	AR: Auto reclosure is active		CG			GI		40	26
2781	AR off	AR: Auto-reclose is switched off		CG			GI		40	81
2801	AR i pg	AR: Auto-reclose in progress			CG		GI		40	101
2851	AR ClCm	AR: Close command from auto-reclose			CG	CA	GI		p	128
2863	AR dTrp	AR: Definitive trip			CG		GI		40	163
2872	AR Strt	AR: Start			CG		GI		40	50
2873	AR blSt	AR: blocked			CG		GI		40	51
2874	AR blCl	AR: Reclosure blocked			CG		GI		40	52
2875	AR blMC	AR: Blocked by manual close		CG			GI		40	53
2876	AR DT	AR: Dead time		C	C				40	182
4632	>SWblo.	>Switching authorization: blocked					GI		101	32
4640	Q0 Clo.	Control-Close-Command CB-Q0	yes						101	121
4641	Q0 Trp.	Control-Trip-Command CB-Q0	yes						101	120
4642	Q0 Ctr.	Control-Command CB-Q0		C					101	35
4822	>MSP bl	>Block motor start protection	yes	CG					168	56
4823	>MSP em	>Motor start protection emergency start	yes	CG					168	51
4824	MSP off	Motor start protection is switched off		CG					168	52
4825	MSP blk	Motor start protection is blocked		CG	CG				168	53
4826	MSP act	Motor start protection is active		CG					168	54
4827	MSP tri	Trip by motor start protection		C					168	55
4828	>MSPRTI	Reset Thermal Image	yes	CG					168	57
4829	MSP RTI	Thermal Image is reset		CG					168	50
5143	>I2 blk	>Block unbalanced load protection	yes						70	126
5144	>revPhR	>Reversed phase rotation	yes	CG			GI		70	125
5151	I2 off	Unbalanced load prot. is switched off		CG			GI		70	131
5152	I2 blk	Unbalanced load protection is blocked		CG			GI		70	132
5153	I2 act	Unbalanced load protection is active		CG			GI		70	133
5159	FD I2>>	Fault detection neg. seq. I (I2>)			CG		GI		70	138
5165	FD I2>	Fault detection neg. seq. I (I2>)			CG		GI		70	150
5170	Trp I2	neg. seq. I. (I2) prot.: Trip			C			BT	70	149

FNo.	Text	Meaning	Ctrl dir.	Annun Op	Annun Ft	IEC 60870-5-103 CA	GI	BT	Type	Inf
6757	TrpI>>>	O/C protection I>>> phases trip			CG		GI	BT	231	69
6758	>I>>>bk	>inst. high set prot.: block stage I>>>	yes	CG			GI		231	70
6801	>SRT bk	>Block starting time monitoring	yes						169	57
6811	SRT off	Starting time monitoring is off		CG			GI		169	51
6812	SRT blk	Starting time monitoring is blocked		CG			GI		169	52
6813	SRT act	Starting time monitoring is active		CG			GI		169	53
6821	SRT Trp	Trip by monitoring of starting time		CG	C			BT	169	54
6851	>SUP bk	>Block trip circuit supervision	yes						170	57
6852	>TrpRel	>Trip circuit supervision: Trip relay	yes	CG			GI		170	51
6853	>CBaux	>Trip circuit supervision: CB aux.	yes	CG			GI		170	52
6861	SUP off	Trip circuit supervision off		CG			GI		170	53
6862	SUP blk	Trip circuit supervision blocked		CG			GI		153	16
6863	SUP act	Trip circuit supervision active		CG			GI		153	17
6864	SUPnoBI	TC superv. blocked: BI not marshalled		CG			GI		170	54
6865	CIR int	Trip circuit interrupted		CG			GI		170	55

Measured Values:

Compatible Mode

Type	Inf	FNo.	Meaning	Position in Telegram
p	144	602	Current in phase IL2 [%] =	1

Extended Mode

Type	Inf	FNo.	Meaning	Position in Telegram
134	125	601	Current in phase IL1 [%] =	1
		602	Current in phase IL2 [%] =	2
		603	Current in phase IL3 [%] =	3
		604	IE [%] =	4
		621	UL1E [%] =	5
		627	UE [%] =	6
		641	Active power Pa [%] =	7
		642	Reactive power Pr [%] =	8
		645	Apparent power S [%] =	9
		713	Iea =	10
		714	Ier =	11
		830	Sensitive earth current =	12
		901	Maximum power factor cos phi =	13

Annunciations 7SJ602 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	>Ti.syn	>Time synchronization	C		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
16	>SysMMb	>Block. of monitoring dir. via sys.-int	CG		I	O
52	operat.	Any protection operative	CG			O
53	Res.FCB	Reset frame count bit				
54	ResetKE	Reset communication unit				
56	Init.st	Initial start of processor system				
57	GI-end	End of general interrogation				
58	Time sy	Time synchronization				
60	LED res	LED Reset	C			
61	Meas.Bl	Logging and measuring functions blocked	CG			O
63	PCviaSy	PC operation via system interface				
75		For internal use only				
76		For internal use only				
77		For internal use only				
80	SigStör	For internal use only				
81	SigBef.	For internal use only				
83	SigTest	For internal use only				
110	ANNlost	Annunciations lost (buffer overflow)	C			
111	PCannLT	Annunciations for PC lost	C			
112	LSAanLT	Annunciations for LSA lost				
113	TAGlost	Fault tag lost				
115	ANNovfl	Fault annunciation buffer overflow		C		
129	IECstIN	IEC state invalid				
159	LSAdist	LSA (system interface) disrupted				
162	Fail∑I	Failure: Current summation supervision	CG			O
177	BatFail	Failure: Battery	CG			O
203	REC del	Fault recording data deleted	C			
235	RemBlk	Remote is blocked	CG			O
236	OfProfi	Operational fault of Port PROFIBUS	CG			O
237	OfOlmCA	Operational fault of OLM Channel A	CG			O
238	OfOlmCB	Operational fault of OLM Channel B	CG			O
239	OfClkSy	Operational fault of clock syncr.	CG		I	O
244		Diff. time of clock synchronism				
264	FaiRTDb	Failure Thermo Box	CG			O
284	IL< al	IL< alarm	CG			O
301	Sys.Flt	Fault in the power system	C	C		O
302	FAULT	Flt. event w. consecutive no.	C	C		O
356	>mCLOSE	>Manual close	CG		I	O
415	>ResMax	Reset min/max of measured data	CG		I	O
416	iResMax	Int. reset min/max of measured data	C			O
417	ResMax	Min/max of measured data has been reset	C			O
418	>RemBlk	Block remote	CG		I	O
501	FT det	General fault detection of device		CG		O
511	DEV.Trp	General trip of device		C		O

FNo.	Text	Meaning	Op	Ft	I	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		
537	IE=	Switched off current IE I/In		C		
538	IEE=	Switched off current IEE I/In		C		
563	CBA sup	CB alarm suppressed				O
601	IL1=	Current in phase IL1 [%] =	M			
602	IL2=	Current in phase IL2 [%] =	M			
603	IL3=	Current in phase IL3 [%] =	M			
604	IE=	IE[%]=	M			
621	VL1E=	UL1E [%]=	M			
627	VE=	UE[%]=	M			
641	Pa=	Active power Pa [%] =	M			
642	Pr=	Reactive power Pr [%] =	M			
645	S=	Apparent power S[%]=	M			
651	IL1=	Current in phase IL1 =	M			
652	IL2=	Current in phase IL2 =	M			
653	IL3=	Current in phase IL3 =	M			
654	IE=	Operational measurement: IEa=	M			
671	VL1E=	Voltage UL1E =	M			
677	VE=	Voltage UE=	M			
691	P=	Active power Pa =	M			
692	Q=	Reactive power Pr =	M			
695	S=	Apparent power S=	M			
711	Iea=	Iea =	M			
712	Ier=	Ier =	M			
713	Iea=	IEEw[%]LSA	M			
714	Ier=	IEEb[%]LSA	M			
830	IEE=	Sensitive earth current	M			
834	Pdmd=	Interval mean value of active power	M			
835	QPdmd=	Interval mean value of reactive power	M			
836	Sdmd=	Interval mean value of apparent power	M			
837	MinI1d=	Min interval mean value of I1	M			
838	MaxI1d=	Max interval mean value of I1	M			
839	MinI2d=	Min interval mean value of I2	M			
840	MaxI2d=	Max interval mean value of I2	M			
841	MinI3d=	Min interval mean value of I3	M			
842	MaxI3d=	Max interval mean value of I3	M			
845	MinPd=	Min interval mean value of active power	M			
846	MaxPd=	Max interval mean value of active power	M			
847	MinQd=	Min interval mean value of react. power	M			
848	MaxQd=	Max interval mean value of react. power	M			
849	MinSd=	Min interval mean value of app. power	M			
850	MaxSd=	Max interval mean value of app. power	M			
851	MinIL1=	Minimum current phase L1	M			
852	MaxIL1=	Maximum current phase L1	M			
853	MinIL2=	Minimum current phase L2	M			
854	MaxIL2=	Maximum current phase L2	M			
855	MinIL3=	Minimum current phase L3	M			
856	MaxIL3=	Maximum current phase L3	M			
859	MinV1E=	Minimum voltage V1E	M			
860	MaxV1E=	Maximum voltage V1E	M			
872	MinVE=	Minimum displacement voltage	M			
873	MaxVE=	Maximum displacement voltage	M			
876	MinP=	Minimum active power P	M			
877	MaxP=	Maximum active power P	M			
878	MinQ=	Minimum reactive power Q	M			
879	MaxQ=	Maximum reactive power Q	M			
880	MinS=	Minimum apparent power S	M			
881	MaxS=	Maximum apparent power S	M			
884	MaxPF=	Maximum power factor cos phi	M			

FNo.	Text	Meaning	Op	Ft	I	O
885	MinPF=	Minimum power factor cos phi	M			
891	Wp pos=	Actual positive active power	M			
892	Wp neg=	Actual negative active power	M			
901	CosPhi=	Power factor cos phi	M			
921	Wq=	Reactive energy Wq	M			
927	Wq neg=	Reactive Energy Wq negative =	M			
951	TmpAmb=	Operat. meas. ambient temperature				
963	IL1dmd=	long-term average of current L1	M			
964	IL2dmd=	long-term average of current L2	M			
965	IL3dmd=	long-term average of current L3	M			
1080	ThRTD1=	RTD sensor 1 temperature	M			
1081	ThRTD2=	RTD sensor 2 temperature	M			
1082	ThRTD3=	RTD sensor 3 temperature	M			
1083	ThRTD4=	RTD sensor 4 temperature	M			
1084	ThRTD5=	RTD sensor 5 temperature	M			
1085	ThRTD6=	RTD sensor 6 temperature	M			
1086	ThRTD1=	RTD sensor 1 temperature	M			
1087	ThRTD2=	RTD sensor 2 temperature	M			
1088	ThRTD3=	RTD sensor 3 temperature	M			
1089	ThRTD4=	RTD sensor 4 temperature	M			
1090	ThRTD5=	RTD sensor 5 temperature	M			
1091	ThRTD6=	RTD sensor 6 temperature	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
1201	>UE bl	>Block UE stage of sensitive E/F prot.	CG		I	O
1215	FD UE	Earth flt. det. by displacement voltage	CG	CG		O
1217	Trip UE	Trip by displacement voltage stage	C	C		O
1276	EFfor	Earth fault (isol./comp.) forward dir.	CG	C		O
1277	EFrev	Earth fault (isol./comp.) reverse dir.	CG	C		O
1278	EFundef	Earth fault (isol./comp.) undef. dir.	CG	C		O
1403	>BF blo	>Block breaker fail protection	CG		I	O
1431	>BF St	>ext. start breaker failure protection	CG		I	O
1451	BF off	Breaker fail protection is switched off	CG			
1452	BF bloc	Breaker failure protection is blocked	CG			
1453	BF act	Breaker failure protection is active	CG			
1456	BF fltI	Breaker fail(int): fault detection	CG	CG		O
1457	BF fltE	Breaker(ext): fault detection	CG	CG		O
1471	BF Trip	Trip by breaker failure protection		CG		O
1501	>O/L on	>Switch on thermal overload protection	CG		I	O
1502	>O/Loff	>Switch off thermal overload protection	CG		I	O
1503	>O/Lblk	>Block thermal overload protection	CG		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
1514	StATE	Failure temperature input	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 in sec	M			
1532	t Trp =	O/L: estimated time to trip in min	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	CG		I	O
1702	>O/Cpof	>Switch off O/C protection phase	CG		I	O
1704	>O/Cpbk	>Block overcurrent protection phases	CG		I	O
1711	>O/Ceon	>Switch on overcurrent protection earth	CG		I	O
1712	>O/Ceof	>Switch off overcurrent protec. earth	CG		I	O
1714	>O/Cebk	>Block overcurrent protection earth	CG		I	O

FNo.	Text	Meaning	Op	Ft	I	O
1721	>I>>blk	>Overcurrent protection:block stage I>>	CG		I	O
1722	>I> blk	>Overcurrent protection:block stage I>	CG		I	O
1723	>Ip blk	>Overcurrent protection:block stage Ip	CG		I	O
1724	>IE>>bk	>Overcurrent protec.: block stage IE>>	CG		I	O
1725	>IE> bk	>Overcurrent protection:block stage IE>	CG		I	O
1726	>IEp bk	>Overcurrent protection:block stage IEp	CG		I	O
1727	>C/O	>C/O of overcurrent fault detec. level	CG		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		CG		O
1763	O/C L2	O/C fault detection phase L2		CG		O
1764	O/C L3	O/C fault detection phase L3		CG		O
1765	O/C E	O/C fault detection earth		CG		O
1771	FD L1	O/C fault detection L1 only		C		
1772	FD L1E	O/C fault detection L1-E		C		
1773	FD L2	O/C fault detection L2 only		C		
1774	FD L2E	O/C fault detection L2-E		C		
1775	FD L12	O/C fault detection L1-L2		C		
1776	FD L12E	O/C fault detection L1-L2-E		C		
1777	FD L3	O/C fault detection L3 only		C		
1778	FD L3E	O/C fault detection L3-E		C		
1779	FD L13	O/C fault detection L1-L3		C		
1780	FD L13E	O/C fault detection L1-L3-E		C		
1781	FD L23	O/C fault detection L2-L3		C		
1782	FD L23E	O/C fault detection L2-L3-E		C		
1783	FD L123	O/C fault detection L1-L2-L3		C		
1784	FDL123E	O/C fault detection L1-L2-L3-E		C		
1785	FD E	O/C fault detection E only	C	C		
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 active	CG			O
1923	DskTest	Test of DiskEM	CG		I	O
2701	>AR on	>AR: Switch on auto-reclose function	CG		I	O
2702	>AR off	>AR: Switch off auto-reclose function	CG		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

FNo.	Text	Meaning	Op	Ft	I	O
4601	>CBPcld		CG		I	O
4602	>CBPopd		CG		I	O
4632	>SWblo.	>Switching authorization: blocked	CG		I	O
4640	Q0 Clo.	Control-Close-Command CB-Q0	C			O
4641	Q0 Trp.	Control-Trip-Command CB-Q0	C			O
4642	Q0 Ctr.	Control-Command CB-Q0				
4684	sw.a.rm	Switching authorization:remote	CG			O
4822	>MSP bl	>Block motor start protection	CG		I	O
4823	>MSP em	>Motor start protection emergency start	CG		I	O
4824	MSP off	Motor start protection is switched off	CG			O
4825	MSP blk	Motor start protection is blocked	CG	CG		O
4826	MSP act	Motor start protection is active	CG			O
4827	MSP tri	Trip by motor start protection	CG			O
4828	>MSPRTI	Reset Thermal Image	CG		I	O
4829	MSP RTI	Thermal Image resetted	CG			O
4830	ThetaW	Warn Theta			I	O
5143	>I2 blk	>Block unbalanced load protection	CG		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	>Block starting time monitoring	CG		I	O
6811	SRT off	Starting time monitoring off	CG			O
6812	SRT blk	Starting time monitoring blocked	CG			O
6813	SRT act	Starting time monitoring active	CG			O
6821	SRT Trp	Trip by monitoring of starting time	CG	C		O
6851	>SUP bk	>Blocking trip circuit supervision	CG		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
8001	FailRTD	RTD sensor collective declaration	CG			O
8005	FaiRTD1	RTD sensor 1 failure	CG			O
8006	TpRTD1w	RTD sensor 1 trip temperature level 1	CG			O
8007	TpRTD1a	RTD sensor 1 trip temperature level 2	CG			O
8010	FaiRTD2	RTD sensor 2 failure	CG			O
8011	TpRTD2w	RTD sensor 2 trip temperature level 1	CG			O
8012	TpRTD2a	RTD sensor 2 trip temperature level 2	CG			O
8015	FaiRTD3	RTD sensor 3 failure	CG			O
8016	TpRTD3w	RTD sensor 3 trip temperature level 1	CG			O
8017	TpRTD3a	RTD sensor 3 trip temperature level 2	CG			O
8020	FaiRTD4	RTD sensor 4 failure	CG			O
8021	TpRTD4w	RTD sensor 4 trip temperature level 1	CG			O
8022	TpRTD4a	RTD sensor 4 trip temperature level 2	CG			O
8025	FaiRTD5	RTD sensor 5 failure	CG			O
8026	TpRTD5w	RTD sensor 5 trip temperature level 1	CG			O
8027	TpRTD5a	RTD sensor 5 trip temperature level 2	CG			O
8030	FaiRTD6	RTD sensor 6 failure	CG			O
8031	TpRTD6w	RTD sensor 6 trip temperature level 1	CG			O
8032	TpRTD6a	RTD sensor 6 trip temperature level 2	CG			O

Reference Table for Functional Parameters 7SJ602

```
PARAME. - PARAMETER SETTINGS

   00 CONF. - SCOPE OF FUNCTIONS

      00O/Cpch                 Characteristic of O/C protection
         def TIME          [ ] Definite time
         IEC inv.          [ ] Inverse time
         ANSI inv          [ ] ANSI inv
         IEC O/C           [ ] IEC O/C
         ANSI O/C          [ ] ANSI O/C
         nonEXIST          [ ] Non-existent

      00O/Cech                 Characteristics for O/C earth
         def TIME          [ ] Definite time
         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 DirSE                 Direction determination for sensitive earth
         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                  Monitoring of starting time
         nonEXIST          [ ] Non-existent
         EXIST             [ ] Existent

      00 AR                    Internal auto-reclose function
         nonEXIST          [ ] Non-existent
         EXIST             [ ] Existent

      00 B/F                   Breaker fail protection
         nonEXIST          [ ] Non-existent
         EXIST             [ ] Existent

      00CIRsup                 Trip circuit supervision
         nonEXIST          [ ] Non-existent
         with 2BI          [ ] No resist., 2 BI
         bypass-R          [ ] bypass resistor,1 BI

      00 IL<                   Undercurrent monitoring
         nonEXIST          [ ] Non-existent
         EXIST             [ ] Existent
```

```
00MotPro             Motor start protection
   nonEXIST      [ ] Non-existent
   EXIST         [ ] Existent

00 BUS               Modbus or Profibus?
   MODBUS        [ ] Modbus
   PROFIBUS      [ ] Profibus

00RTDBox             Thermo Box
   nonEXIST      [ ] Non-existent
   EXIST         [ ] Existent

00Tunit              Temperature Unit
   °C            [ ] °C
   °F            [ ] °F
```

```
01 POWER SYST.DAT - POWER SYSTEM DATA

01 FREQ              Rated system frequency
   50 Hz         [ ] fN 50 Hz
   60 Hz         [ ] fN 60 Hz

01 InPRI             Primary rated current
   min. 10           A
   max. 50000   ____

01 InSEC             Secondary rated current
   1A            [ ] 1A
   5A            [ ] 5A

01Ie/Iph             Matching factor Ie/Iph for earth current
   min. 0.010
   max. 5.000   ____

01Iee/Ip             Matching factor Iee/Iph for earth current
   min. 0.003
   max. 1.500   ____

01IEESEC             CT nom. current IEEp, sec
   1A            [ ] 1A
   5A            [ ] 5A

01 VNPRI             Nominal VT voltage, primary
   min. 0.10         kV
   max. 400.00  ____

01 VNSEC             Nominal VT voltage, secondary
   min. 100          V
   max. 125     ____
```

```
01 PQinv                  Reverse power direction
   OFF               [ ] off
   ON                [ ] on

01 CB I>                  Threshold circuit breaker closed
   min. 0.04              I/In
   max. 1.00      _____

01 Im                     Nominal current of motor in relation to Tr.C.
   min. 0.2
   max. 1.2       _____

01 Ia                     Startup current in relation to nominal current
   min. 0.4
   max. 20.0      _____

01 tStUp                  Maximum startup time
   min. 1.0               s
   max. 360.0     _____

01 ThRes                  Reset thermal image on startup
   YES               [ ] yes
   NO                [ ] no

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     _____

01TINTER                  Intervalltime for average measurements
   15min             [ ] 15 MIN
   30min             [ ] 30 MIN
   60min             [ ] 60 MIN

01CYCLE                   Cycle for automatic drag indicator reset
   min. 1                 D
   max. 365/∞     _____

01START                   Start of automatic drag indicator reset
   min. 0                 D
   max. 365       _____

01MINUTE                  Minute of day for autom. drag indicator reset
   min. 0                 min
   max. 1439      _____
```

---

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 inst. stage I>>>
   min. 0.3                 I/In
   max. 12.5/∞      ____

10I>>>dy                    Pick-up val. of high ins. stage I>>> (dyn)
   min. 0.3                 I/In
   max. 12.5/∞      ____

10 I>>                      Pick-up value of high-set stage I>>
   min. 0.1                 I/In
   max. 25.0/∞      ____

10 I>>dy                    Pick-up value of high-set stage I>> (dyn)
   min. 0.1                 I/In
   max. 25.0/∞      ____

10 TI>>                     Trip time delay of high-set stage I>>
   min. 0.00                s
   max. 60.00       ____

10 I>                       Pick-up value of overcurrent stage I>
   min. 0.1                 I/In
   max. 25.0/∞      ____

10 I>dy                     Pick-up value of O/C stage I> (dyn)
   min. 0.1                 I/In
   max. 25.0/∞      ____

10 TI>                      Trip time delay of 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
   RI               [ ]     RI
   never            [ ]     Never

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 Tp                       Trip time delay inverse time O/C stage Ip
   min. 0.05                s
   max. 3.20        ____

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          _____

   10 DOPh                   Drop-out for phase
      Immediat          [ ]  Immediately
      DskEm             [ ]  Disk Emulation

   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 REPe                   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
   RI               [ ]  RI
   RD               [ ]  RD
   never            [ ]  Never

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 TEp                   Trip time delay inverse time O/C stage IEp
   min. 0.05             s
   max. 3.20       ____

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 t. E/F stage IEp (dyn)
   min. 0.05             I/In
   max. 4.00       ____

30DOEc                   Drop-out for earth current
   Immediat         [ ]  Immediately
   DskEm            [ ]  Disk Emulation

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
```

---

30 XMZ SENSIV E - EARTH FAULT IN COMPENSATED/ISOLATED NETWORKS

```
30XMZ EE                 High-sensitivity earth fault protection
   ON               [ ]  on
   OFF              [ ]  off
   ALRMonly         [ ]  Alarm only

30IEE>>                  IEE>> stage of high-sensitivity E/F prot.
   min. 0.003            I/In
   max. 1.500/∞    ____
```

```
30IEE>>d               Pick-up value of high-set stage IEE>> (dy)
   min. 0.003          I/In
   max. 1.500/∞  _____

30TIEE>>               Delay time T-IEE>> of the IEE>> stage
   min. 0.00           s
   max. 60.00    _____

30IEE>                 IEE> stage of high-sensitivity E/F prot.
   min. 0.003          I/In
   max. 1.500/∞  _____

30IEE>dy               Pick-up value of O/C stage IEE> (dyn)
   min. 0.003          I/In
   max. 1.500/∞  _____

30TIEE>                Delay time T-IEE> of the IEE> stage
   min. 0.00           s
   max. 60.00    _____

30REPee                Measurement repetition for E/F pickup
   NO            [ ] no
   YES           [ ] yes

30CHAee                Characteristic of the O/C stage IEEp (ANSI)
   inverse       [ ] Normal inverse
   short in      [ ] Very inverse
   extr.inv      [ ] Extremely inverse
   long inv      [ ] long inverse
   RI            [ ] RI
   RD            [ ] RD
   never         [ ] Never

30TIEEp                Trip time delay inverse time O/C stage IEEp
   min. 0.05           s
   max. 3.20     _____

30KNL.EE               Characteristic of the O/C stage IEEp
   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

30DEE                  Delayfactor of inverse earth-current protec.
   min. 0.5            s
   max. 15.0     _____

30IEEp                 Pick-up value inverse time O/C stage IEEp
   min. 0.003          I/In
   max. 1.400    _____

30IEEpdy               Pick-up value inverse time O/C stage IEEp dyn.
   min. 0.003          I/In
   max. 1.400    _____
```

```
30DOsEc                    Drop-out for sensitive earth current
   Immediat         [ ] Immediately
   DskEm            [ ] Disk Emulation

30CALCee                   RMS format for inverse time O/C protection
   noHARMON         [ ] Without harmonics
   HARMONIC         [ ] With harmonics

30M.CLee                   Manual close
   IE>>unde         [ ] IE>> undelayed
   IE>undel         [ ] Ie> undelayed
   IEp unde         [ ] IEp undelayed
   INEFFECT         [ ] Ineffective
```

```
30 DIR E SENSITIV - DIRECTION OF SENSITIVE EARTH

   30DIEE>>                Dir. IEE>> stage of high-sensit. E/F prot.
      forwds.       [ ] Forwards
      reverse       [ ] Reverse
      non-dir.      [ ] Non-directional

   30DIEE>                 Dir. IEE> stage of high-sensit. E/F prot.
      forwds.       [ ] Forwards
      reverse       [ ] Reverse
      non-dir.      [ ] Non-directional

   30DIRMOD                Measurement mode for direc. determination
      COS PHI       [ ] Cos phi
      SIN PHI       [ ] Sin phi

   PHICOR                  Correction angle for direc. determination
      min. -45.0           deg
      max. 45.0     ____

   30IEEDIR                Operating direction of the IEE>/IEEp stage
      min. 0.003           I/In
      max. 1.200    ____

   30TDirSt                Drop-off delay for dir. stabilization
      min. 1               s
      max. 60       ____

   30CTErI1                Second. current I1 for max error angle of CT
      min. 0.003           I/In
      max. 1.600    ____

   30CTErF1                Error angle of C.T. at I1
      min. 0.0             deg
      max. 5.0      ____

   30CTErI2                Second. current I2 for max error angle of CT
      min. 0.003           I/In
      max. 1.600    ____

   30CTErF2                Error angle of C.T. at I2
      min. 0.0             deg
      max. 5.0      ____
```

30 VE> STAGE - DISPLACEMENT VOLTAGE PROTECTION VE>

30 Ue> — Displacement voltage level Ue>
min. 0.02 — Un
max. 1.05 ______

30TVeADl — Delay time for annunciation of VE>
min. 0.04 — s
max. 320.00/∞ ______

30 TUe> — Delay time T-UE of the UE> stage
min. 0.10 — s
max. 40000.00/∞ ______

---

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 stage I2>
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         ____

   27 Tnc                      Temperature at nominal current (˚C)
      min. 40                  ˚C
      max. 200         ____

   27 Tnc                      Temperature at nominal current (˚F)
      min. 104                 ˚F
      max. 392         ____
```

```
28 START TIME SUP - STARTING-TIME SUPERVISION

   28 STRT                     Supervision of starting time
      ON                   [ ] on
      OFF                  [ ] off

   28 Ia>                      Base value Istrt of permiss. start-up curr.
      min. 0.4                 I/In
      max. 20.0        ____

   28I> blk                    Block of the I>/Ip stages during start-up
      NO                   [ ] no
      YES                  [ ] yes
```

```
29 MEAS. VAL.SUP. - MEASURED VALUE SUPERVISION

   29SUM.Th                    Summation threshold for current supervision
      min. 0.05                I/In
      max. 2.00/∞      ____

   29SUM.Fa                    Factor for current summation supervision
      min. 0.10
      max. 0.95        ____
```

```
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   ____
```

```
36 B/F - BREAKER-FAILURE PROTECTION

   36B/F                  Circuit breaker failure protection
      OFF             [ ] off
      ON              [ ] on

   36T-B/F                Delay time T-B/F
      min. 0.06           s
      max. 60.00/∞  ____

   36B/F-AC               Analysis of auxiliary contacts for B/F
      OFF             [ ] off
      ON              [ ] on
```

```
37 CBCONTROL - CIRCUIT BREAKER CONTROLLING

   37CB-Ctr               Circuit breaker controlling
      ON              [ ] on
      OFF             [ ] off
```

```
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

---

40 IL< MON - UNDERCURRENT MONITORING

40 IL< — Undercurrent monitoring
OFF [ ] off
ON [ ] on

40 IL< — Limit for undercurrent monitoring
min. 0.10 — I/In
max. 4.00 ______

40 tIL< — Delay time for undercurrent monitoring
min. 0.0 — s
max. 320.0 ______

43MotPro - MOTOR START PROTECTION

43MotPro — Motor start protection
OFF [ ] off
ON [ ] on

43Tequal — Temperature equalization time
min. 0.0 — min
max. 60.0 ______

43nw — Maximum permissible number of warm-starts
min. 1
max. 4 ______

43nc-nw — Difference betw. no. of cold and warm-starts
min. 1
max. 2 ______

43kτ — Factor for tau during standstill
min. 1.0
max. 10.0 ______

43kτ2 — Factor for tau during operation
min. 1.0
max. 10.0 ______

```
   43TMotBl                  Minimum blocking time for motor protection
      min. 0.2               min
      max. 120.0      _____
```

```
50RTDBox - RTD Box

   50RTD1Ty                  Thermobox probe 1 type
      Pt100            [ ]   Pt100
      nonEXIST         [ ]   Non-existent
      Ni120            [ ]   Ni120
      Ni100            [ ]   Ni100

   50RTD1Lo                  Location of thermobox probe 1
      Oil              [ ]   Oil
      Ambient          [ ]   Ambient
      Winding          [ ]   Winding
      Bearing          [ ]   Bearing
      Other            [ ]   Other

   50 RTD1w                  Warning level of thermobox probe 1 (˚C)
      min. -50               ˚C
      max. 250/∞      _____

   50 RTD1w                  Warning level of thermobox probe 1 (˚F)
      min. -58               ˚F
      max. 482/∞      _____

   50 RTD1a                  Alarm level of thermobox probe 1 (˚C)
      min. -50               ˚C
      max. 250/∞      _____

   50 RTD1a                  Alarm level of thermobox probe 1 (˚F)
      min. -58               ˚F
      max. 482/∞      _____

   50RTD2Ty                  Thermobox probe 2 type
      nonEXIST         [ ]   Non-existent
      Pt100            [ ]   Pt100
      Ni120            [ ]   Ni120
      Ni100            [ ]   Ni100

   50RTD2Lo                  Location of thermobox probe 2
      Oil              [ ]   Oil
      Ambient          [ ]   Ambient
      Winding          [ ]   Winding
      Bearing          [ ]   Bearing
      Other            [ ]   Other

   50 RTD2w                  Warning level of thermobox probe 2 (˚C)
      min. -50               ˚C
      max. 250/∞      _____

   50 RTD2w                  Warning level of thermobox probe 2 (˚F)
      min. -58               ˚F
      max. 482/∞      _____

   50 RTD2a                  Alarm level of thermobox probe 2 (˚C)
      min. -50               ˚C
      max. 250/∞      _____
```

50 RTD2a — Alarm level of thermobox probe 2 (˚F)
min. -58 — ˚F
max. 482/∞ ______

50RTD3Ty — Thermobox probe 3 type
nonEXIST [ ] Non-existent
Pt100 [ ] Pt100
Ni120 [ ] Ni120
Ni100 [ ] Ni100

50RTD3Lo — Location of thermobox probe 3
Oil [ ] Oil
Ambient [ ] Ambient
Winding [ ] Winding
Bearing [ ] Bearing
Other [ ] Other

50 RTD3w — Warning level of thermobox probe 3 (˚C)
min. -50 — ˚C
max. 250/∞ ______

50 RTD3w — Warning level of thermobox probe 3 (˚F)
min. -58 — ˚F
max. 482/∞ ______

50 RTD3a — Alarm level of thermobox probe 3 (˚C)
min. -50 — ˚C
max. 250/∞ ______

50 RTD3a — Alarm level of thermobox probe 3 (˚F)
min. -58 — ˚F
max. 482/∞ ______

50RTD4Ty — Thermobox probe 4 type
nonEXIST [ ] Non-existent
Pt100 [ ] Pt100
Ni120 [ ] Ni120
Ni100 [ ] Ni100

50RTD4Lo — Location of thermobox probe 4
Oil [ ] Oil
Ambient [ ] Ambient
Winding [ ] Winding
Bearing [ ] Bearing
Other [ ] Other

50 RTD4w — Warning level of thermobox probe 4 (˚C)
min. -50 — ˚C
max. 250/∞ ______

50 RTD4w — Warning level of thermobox probe 4 (˚F)
min. -58 — ˚F
max. 482/∞ ______

50 RTD4a — Alarm level of thermobox probe 4 (˚C)
min. -50 — ˚C
max. 250/∞ ______

50 RTD4a — Alarm level of thermobox probe 4 (˚F)
min. -58 — ˚F
max. 482/∞ ______

```
50RTD5Ty                    Thermobox probe 5 type
   nonEXIST           [ ] Non-existent
   Pt100              [ ] Pt100
   Ni120              [ ] Ni120
   Ni100              [ ] Ni100

50RTD5Lo                    Location of thermobox probe 5
   Oil                [ ] Oil
   Ambient            [ ] Ambient
   Winding            [ ] Winding
   Bearing            [ ] Bearing
   Other              [ ] Other

50 RTD5w                    Warning level of thermobox probe 5 (˚C)
   min. -50                 ˚C
   max. 250/∞       ____

50 RTD5w                    Warning level of thermobox probe 5 (˚F)
   min. -58                 ˚F
   max. 482/∞       ____

50 RTD5a                    Alarm level of thermobox probe 5 (˚C)
   min. -50                 ˚C
   max. 250/∞       ____

50 RTD5a                    Alarm level of thermobox probe 5 (˚F)
   min. -58                 ˚F
   max. 482/∞       ____

50RTD6Ty                    Thermobox probe 6 type
   nonEXIST           [ ] Non-existent
   Pt100              [ ] Pt100
   Ni120              [ ] Ni120
   Ni100              [ ] Ni100

50RTD6Lo                    Location of thermobox probe 6
   Oil                [ ] Oil
   Ambient            [ ] Ambient
   Winding            [ ] Winding
   Bearing            [ ] Bearing
   Other              [ ] Other

50 RTD6w                    Warning level of thermobox probe 6 (˚C)
   min. -50                 ˚C
   max. 250/∞       ____

50 RTD6w                    Warning level of thermobox probe 6 (˚F)
   min. -58                 ˚F
   max. 482/∞       ____

50 RTD6a                    Alarm level of thermobox probe 6 (˚C)
   min. -50                 ˚C
   max. 250/∞       ____

50 RTD6a                    Alarm level of thermobox probe 6 (˚F)
   min. -58                 ˚F
   max. 482/∞       ____
```

Reference Table for Configuration Parameters 7SJ602

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 2	BINARY INPUT 1 2nd FUNCTION
61BI1 3	BINARY INPUT 1 3rd FUNCTION
61BI1 4	BINARY INPUT 1 4th FUNCTION
61BI1 5	BINARY INPUT 1 5th FUNCTION
61BI1 6	BINARY INPUT 1 6th FUNCTION
61BI1 7	BINARY INPUT 1 7th FUNCTION
61BI1 8	BINARY INPUT 1 8th FUNCTION
61BI1 9	BINARY INPUT 1 9th 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 2	BINARY INPUT 2 2nd FUNCTION

61BI2 3 BINARY INPUT 2 3rd FUNCTION

61BI2 4 BINARY INPUT 2 4th FUNCTION

61BI2 5 BINARY INPUT 2 5th FUNCTION

61BI2 6 BINARY INPUT 2 6th FUNCTION

61BI2 7 BINARY INPUT 2 7th FUNCTION

61BI2 8 BINARY INPUT 2 8th FUNCTION

61BI2 9 BINARY INPUT 2 9th 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 2 BINARY INPUT 3 2nd FUNCTION

61BI3 3 BINARY INPUT 3 3rd FUNCTION

61BI3 4 BINARY INPUT 3 4th FUNCTION

61BI3 5 BINARY INPUT 3 5th FUNCTION

61BI3 6 BINARY INPUT 3 6th FUNCTION

61BI3 7 BINARY INPUT 3 7th FUNCTION

61BI3 8 BINARY INPUT 3 8th FUNCTION

61BI3 9 BINARY INPUT 3 9th FUNCTION

61BI3 10 BINARY INPUT 3 10th FUNCTION

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63 MARSH LED IND - MARSHALLING LED INDICATORS

63 MARSH LED 1 - MARSHALLING OF LED INDICATOR 1

63LED1 1 LED 1 1st CONDITION

63LED1 2 LED 1 2nd CONDITION

63LED1 3 LED 1 3rd CONDITION

63LED1 4 LED 1 4th CONDITION

63LED1 5 LED 1 5th CONDITION

63LED1 6 LED 1 6th CONDITION

63LED1 7 LED 1 7th CONDITION

63LED1 8 LED 1 8th CONDITION

63LED1 9 LED 1 9th CONDITION

63LED110 LED 1 10th CONDITION

63LED111	LED 1 11th CONDITION
63LED112	LED 1 12th CONDITION
63LED113	LED 1 13th CONDITION
63LED114	LED 1 14th CONDITION
63LED115	LED 1 15th CONDITION
63LED116	LED 1 16th CONDITION
63LED117	LED 1 17th CONDITION
63LED118	LED 1 18th CONDITION
63LED119	LED 1 19th CONDITION
63LED120	LED 1 20th CONDITION

63 MARSH LED 2 - MARSHALLING OF LED INDICATOR 2

63LED2 1	LED 2 1st CONDITION
63LED2 2	LED 2 2nd CONDITION
63LED2 3	LED 2 3rd CONDITION
63LED2 4	LED 2 4th CONDITION

63LED2 5	LED 2 5th CONDITION
63LED2 6	LED 2 6th CONDITION
63LED2 7	LED 2 7th CONDITION
63LED2 8	LED 2 8th CONDITION
63LED2 9	LED 2 9th CONDITION
63LED210	LED 2 10th CONDITION
63LED211	LED 2 11th CONDITION
63LED212	LED 2 12th CONDITION
63LED213	LED 2 13th CONDITION
63LED214	LED 2 14th CONDITION
63LED215	LED 2 15th CONDITION
63LED216	LED 2 16th CONDITION
63LED217	LED 2 17th CONDITION
63LED218	LED 2 18th CONDITION
63LED219	LED 2 19th CONDITION

63LED220	LED 2 20th CONDITION

63 MARSH LED 3 - MARSHALLING OF LED INDICATOR 3

63LED3 1	LED 3 1st CONDITION
63LED3 2	LED 3 2nd CONDITION
63LED3 3	LED 3 3rd CONDITION
63LED3 4	LED 3 4th CONDITION
63LED3 5	LED 3 5th CONDITION
63LED3 6	LED 3 6th CONDITION
63LED3 7	LED 3 7th CONDITION
63LED3 8	LED 3 8th CONDITION
63LED3 9	LED 3 9th CONDITION
63LED310	LED 3 10th CONDITION
63LED311	LED 3 11th CONDITION
63LED312	LED 3 12th CONDITION
63LED313	LED 3 13th CONDITION

63LED314	LED 3 14th CONDITION
63LED315	LED 3 15th CONDITION
63LED316	LED 3 16th CONDITION
63LED317	LED 3 17th CONDITION
63LED318	LED 3 18th CONDITION
63LED319	LED 3 19th CONDITION
63LED320	LED 3 20th CONDITION

63 MARSH LED 4 - MARSHALLING OF LED INDICATOR 4

63LED4 1	LED 4 1st CONDITION
63LED4 2	LED 4 2nd CONDITION
63LED4 3	LED 4 3rd CONDITION
63LED4 4	LED 4 4th CONDITION
63LED4 5	LED 4 5th CONDITION
63LED4 6	LED 4 6th CONDITION
63LED4 7	LED 4 7th CONDITION

63LED4 8 LED 4 8th CONDITION

63LED4 9 LED 4 9th CONDITION

63LED410 LED 4 10th CONDITION

63LED411 LED 4 11th CONDITION

63LED412 LED 4 12th CONDITION

63LED413 LED 4 13th CONDITION

63LED414 LED 4 14th CONDITION

63LED415 LED 4 15th CONDITION

63LED416 LED 4 16th CONDITION

63LED417 LED 4 17th CONDITION

63LED418 LED 4 18th CONDITION

63LED419 LED 4 19th 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

64CMD1 2	COMMAND RELAY 1 2nd CONDITION
64CMD1 3	COMMAND RELAY 1 3rd CONDITION
64CMD1 4	COMMAND RELAY 1 4th CONDITION
64CMD1 5	COMMAND RELAY 1 5th CONDITION
64CMD1 6	COMMAND RELAY 1 6th CONDITION
64CMD1 7	COMMAND RELAY 1 7th CONDITION
64CMD1 8	COMMAND RELAY 1 8th CONDITION
64CMD1 9	COMMAND RELAY 1 9th CONDITION
64CMD110	COMMAND RELAY 1 10th CONDITION
64CMD111	COMMAND RELAY 1 11th CONDITION
64CMD112	COMMAND RELAY 1 12th CONDITION
64CMD113	COMMAND RELAY 1 13th CONDITION
64CMD114	COMMAND RELAY 1 14th CONDITION
64CMD115	COMMAND RELAY 1 15th CONDITION
64CMD116	COMMAND RELAY 1 16th CONDITION

64CMD117 COMMAND RELAY 1 17th CONDITION

64CMD118 COMMAND RELAY 1 18th CONDITION

64CMD119 COMMAND RELAY 1 19th CONDITION

64CMD120 COMMAND RELAY 1 20th CONDITION

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64 MARSH CMD.RE 2 - MARSHALLING OF COMMAND RELAY 2

64CMD2 1 COMMAND RELAY 2 1st CONDITION

64CMD2 2 COMMAND RELAY 2 2nd CONDITION

64CMD2 3 COMMAND RELAY 2 3rd CONDITION

64CMD2 4 COMMAND RELAY 2 4th CONDITION

64CMD2 5 COMMAND RELAY 2 5th CONDITION

64CMD2 6 COMMAND RELAY 2 6th CONDITION

64CMD2 7 COMMAND RELAY 2 7th CONDITION

64CMD2 8 COMMAND RELAY 2 8th CONDITION

64CMD2 9 COMMAND RELAY 2 9th CONDITION

64CMD210 COMMAND RELAY 2 10th CONDITION

64CMD211	COMMAND RELAY 2 11th CONDITION
64CMD212	COMMAND RELAY 2 12th CONDITION
64CMD213	COMMAND RELAY 2 13th CONDITION
64CMD214	COMMAND RELAY 2 14th CONDITION
64CMD215	COMMAND RELAY 2 15th CONDITION
64CMD216	COMMAND RELAY 2 16th CONDITION
64CMD217	COMMAND RELAY 2 17th CONDITION
64CMD218	COMMAND RELAY 2 18th CONDITION
64CMD219	COMMAND RELAY 2 19th CONDITION
64CMD220	COMMAND RELAY 2 20th CONDITION

64 MARSH CMD.RE 3 - MARSHALLING OF COMMAND RELAY 3

64CMD31	COMMAND RELAY 3 1st CONDITION
64CMD32	COMMAND RELAY 3 2nd CONDITION
64CMD33	COMMAND RELAY 3 3rd CONDITION
64CMD34	COMMAND RELAY 3 4th CONDITION

64CMD35	COMMAND RELAY 3 5th CONDITION
64CMD36	COMMAND RELAY 3 6th CONDITION
64CMD37	COMMAND RELAY 3 7th CONDITION
64CMD38	COMMAND RELAY 3 8th CONDITION
64CMD39	COMMAND RELAY 3 9th CONDITION
64CMD310	COMMAND RELAY 3 10th CONDITION
64CMD311	COMMAND RELAY 3 11th CONDITION
64CMD312	COMMAND RELAY 3 12th CONDITION
64CMD313	COMMAND RELAY 3 13th CONDITION
64CMD314	COMMAND RELAY 3 14th CONDITION
64CMD315	COMMAND RELAY 3 15th CONDITION
64CMD316	COMMAND RELAY 3 16th CONDITION
64CMD317	COMMAND RELAY 3 17th CONDITION
64CMD318	COMMAND RELAY 3 18th CONDITION
64CMD319	COMMAND RELAY 3 19th CONDITION

64CMD320 COMMAND RELAY 3 20th CONDITION

______ ______

64 MARSH CMD.RE 4 - MARSHALLING OF COMMAND RELAY 4

64CMD41 COMMAND RELAY 4 1st CONDITION

______ ______

64CMD42 COMMAND RELAY 4 2nd CONDITION

______ ______

64CMD43 COMMAND RELAY 4 3rd CONDITION

______ ______

64CMD44 COMMAND RELAY 4 4th CONDITION

______ ______

64CMD45 COMMAND RELAY 4 5th CONDITION

______ ______

64CMD46 COMMAND RELAY 4 6th CONDITION

______ ______

64CMD47 COMMAND RELAY 4 7th CONDITION

______ ______

64CMD48 COMMAND RELAY 4 8th CONDITION

______ ______

64CMD49 COMMAND RELAY 4 9th CONDITION

______ ______

64CMD410 COMMAND RELAY 4 10th CONDITION

______ ______

64CMD411 COMMAND RELAY 4 11th CONDITION

______ ______

64CMD412 COMMAND RELAY 4 12th CONDITION

______ ______

64CMD413 COMMAND RELAY 4 13th CONDITION

______ ______

64CMD414 ________	COMMAND RELAY 4 14th CONDITION ________
64CMD415 ________	COMMAND RELAY 4 15th CONDITION ________
64CMD416 ________	COMMAND RELAY 4 16th CONDITION ________
64CMD417 ________	COMMAND RELAY 4 17th CONDITION ________
64CMD418 ________	COMMAND RELAY 4 18th CONDITION ________
64CMD419 ________	COMMAND RELAY 4 19th CONDITION ________
64CMD420 ________	COMMAND RELAY 4 20th CONDITION ________

65 AR MARSHALL - MARSHALLING OF AUTORECLOSE INPUTS

65AR MAR START - MARSHALLING OF AUTORECLOSE START

65 ARS01 ________	AUTORECLOSE START 1st FUNCTION ________
65 ARS02 ________	AUTORECLOSE START 2nd FUNCTION ________
65 ARS03 ________	AUTORECLOSE START 3rd FUNCTION ________
65 ARS04 ________	AUTORECLOSE START 4th FUNCTION ________
65 ARS05 ________	AUTORECLOSE START 5th FUNCTION ________
65 ARS06 ________	AUTORECLOSE START 6th FUNCTION ________
65 ARS07 ________	AUTORECLOSE START 7th FUNCTION ________

65 ARS08	AUTORECLOSE START 8th FUNCTION
65 ARS09	AUTORECLOSE START 9th FUNCTION
65 ARS10	AUTORECLOSE START 10th FUNCTION
65 ARS11	AUTORECLOSE START 11th FUNCTION
65 ARS12	AUTORECLOSE START 12th FUNCTION
65 ARS13	AUTORECLOSE START 13th FUNCTION
65 ARS14	AUTORECLOSE START 14th FUNCTION
65 ARS15	AUTORECLOSE START 15th FUNCTION
65 ARS16	AUTORECLOSE START 16th FUNCTION
65 ARS17	AUTORECLOSE START 17th FUNCTION
65 ARS18	AUTORECLOSE START 18th FUNCTION
65 ARS19	AUTORECLOSE START 19th FUNCTION
65 ARS20	AUTORECLOSE START 20th FUNCTION

65AR MAR ST.BLOCK - MARSHALLING OF AUTORECLOSE BLOCK

65 ARB01	AUTORECLOSE BLOC. 1st FUNCTION

65 ARB02	AUTORECLOSE BLOC. 2nd FUNCTION
65 ARB03	AUTORECLOSE BLOC. 3rd FUNCTION
65 ARB04	AUTORECLOSE BLOC. 4th FUNCTION
65 ARB05	AUTORECLOSE BLOC. 5th FUNCTION
65 ARB06	AUTORECLOSE BLOC. 6th FUNCTION
65 ARB07	AUTORECLOSE BLOC. 7th FUNCTION
65 ARB08	AUTORECLOSE BLOC. 8th FUNCTION
65 ARB09	AUTORECLOSE BLOC. 9th FUNCTION
65 ARB10	AUTORECLOSE BLOC. 10th FUNCTION
65 ARB11	AUTORECLOSE BLOC. 11th FUNCTION
65 ARB12	AUTORECLOSE BLOC. 12th FUNCTION
65 ARB13	AUTORECLOSE BLOC. 13th FUNCTION
65 ARB14	AUTORECLOSE BLOC. 14th FUNCTION
65 ARB15	AUTORECLOSE BLOC. 15th FUNCTION
65 ARB16	AUTORECLOSE BLOC. 16th FUNCTION

65 ARB17 AUTORECLOSE BLOC. 17th FUNCTION

65 ARB18 AUTORECLOSE BLOC. 18th FUNCTION

65 ARB19 AUTORECLOSE BLOC. 19th FUNCTION

65 ARB20 AUTORECLOSE BLOC. 20th FUNCTION

65AR MAR CL.BLOCK - MARSHALLING OF AR COMMAND BLOCK

65 ARC01 AUTORECLOSE BLOC. COM. 1st FUNCTION

65 ARC02 AUTORECLOSE BLOC. COM. 2nd FUNCTION

65 ARC03 AUTORECLOSE BLOC. COM. 3rd FUNCTION

65 ARC04 AUTORECLOSE BLOC. COM. 4th FUNCTION

65 ARC05 AUTORECLOSE BLOC. COM. 5th FUNCTION

65 ARC06 AUTORECLOSE BLOC. COM. 6th FUNCTION

65 ARC07 AUTORECLOSE BLOC. COM. 7th FUNCTION

65 ARC08 AUTORECLOSE BLOC. COM. 8th FUNCTION

65 ARC09 AUTORECLOSE BLOC. COM. 9th FUNCTION

65 ARC10 AUTORECLOSE BLOC. COM. 10th FUNCTION

```
65 ARC11               AUTORECLOSE BLOC. COM. 11th FUNCTION
    ____________       ____________________________

65 ARC12               AUTORECLOSE BLOC. COM. 12th FUNCTION
    ____________       ____________________________

65 ARC13               AUTORECLOSE BLOC. COM. 13th FUNCTION
    ____________       ____________________________

65 ARC14               AUTORECLOSE BLOC. COM. 14th FUNCTION
    ____________       ____________________________

65 ARC15               AUTORECLOSE BLOC. COM. 15th FUNCTION
    ____________       ____________________________

65 ARC16               AUTORECLOSE BLOC. COM. 16th FUNCTION
    ____________       ____________________________

65 ARC17               AUTORECLOSE BLOC. COM. 17th FUNCTION
    ____________       ____________________________

65 ARC18               AUTORECLOSE BLOC. COM. 18th FUNCTION
    ____________       ____________________________

65 ARC19               AUTORECLOSE BLOC. COM. 19th FUNCTION
    ____________       ____________________________

65 ARC20               AUTORECLOSE BLOC. COM. 20th FUNCTION
    ____________       ____________________________
```

```
71INT.OP - INTEGRATED OPERATION

   71LANGUA                 Language
      ENGLISH           [ ] English
      DEUTSCH           [ ] German
      FRANCAIS          [ ] French
      ESPANOL           [ ] Spanish
      PYCCK.            [ ] Russian
```

```
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 accord. with IEC60780-5-103
   min. 1
   max. 254      ____

72PC-INT               Data format for PC-interface
   DIGSI V3        [ ] DIGSI V3
   ASCII           [ ] ASCII

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

72SYSINT               Data format for system-interface
   IEC com.        [ ] IEC 60870 compatible
   IEC ext.        [ ] IEC 60870 extended
   DIGSI V3        [ ] DIGSI V3

72S-MEAS               Measurement format for system-interface
   IEC com.        [ ] IEC 60870 compatible
   IEC ext.        [ ] IEC 60870 extended

72S-GAPS               Transmission gaps for system-interface
   min. 0.0            s
   max. 5.0      ____

72S-BAUD               Transmission baud rate for system-interface
   9600BAUD        [ ] 9600 Baud
   19200 BD        [ ] 19200 Baud
   1200BAUD        [ ] 1200 Baud
   2400BAUD        [ ] 2400 Baud
   4800BAUD        [ ] 4800 Baud

72S-PARI               Parity and stop-bits for system-interface
   IEC/DIGS        [ ] IEC/DIGSI V3/LSA
   8O1             [ ] Odd parity,1 stopbit
   8N2             [ ] No parity,2 stopbits
   8N1             [ ] No parity,1 stopbit

72S-SWIT               Online-switch IEC - DIGSI enabled
   NO              [ ] no
   YES             [ ] yes

72OFFsig               Character idle state of optical fibre
   lght off        [ ] light off
   light on        [ ] light on
```

```
72S-TOUT                 Monitoring time for system-interface
   min. 1                s
   max. 600/∞      ____

72S-PARA                 Parameterizing via system-interface
   NO              [ ]   no
   YES             [ ]   yes

72DpSlAd                 Profibus DP Slave Adress
   min. 1
   max. 126        ____

72DpTsEn                 Profibus DP Time Sync Enable
   NO              [ ]   no
   YES             [ ]   yes

72DpOMo                  Profibus DP System Mode
   V2Mode0         [ ]   OLM V2 Mode 0
   V2Mode1         [ ]   OLM V2 Mode 1
   V3Mode0         [ ]   OLM V3 Mode 0
   V3Mode1         [ ]   OLM V3 Mode 1

72DpORed                 Profibus DP OLM-Redundance
   ON              [ ]   ON
   OFF             [ ]   OFF

72DpONet                 Profibus DP Net Size
   Std             [ ]   Standard
   Ext             [ ]   Extended

72MbSlAd                 Modbus Slave Adress
   min. 1
   max. 247        ____

72MbMode                 Modbus Mode
   RTU             [ ]   RTU
   ASCII           [ ]   ASCII

72MbBaud                 Modbus Baudrate
   19200 BD        [ ]   19200 Baud
   38400 BD        [ ]   38400 Baud
   57600 BD        [ ]   57600 Baud
   300 BAUD        [ ]    300 BAUD
   600 BAUD        [ ]    600 BAUD
   1200BAUD        [ ]   1200 Baud
   2400BAUD        [ ]   2400 Baud
   4800BAUD        [ ]   4800 Baud
   9600BAUD        [ ]   9600 Baud

72MbParR                 Modbus Parity RTU
   NONE            [ ]   NONE
   EVEN            [ ]   EVEN
   ODD             [ ]   ODD

72MbParA                 Modbus Parity ASCII
   EVEN            [ ]   EVEN
   ODD             [ ]   ODD

72MbTset                 Modbus Time Set / use of Registers
   min. 0
   max. 1          ____
```

```
   72SW.REM                 Switching authority REMOTE is
      ON                [ ] on
      OFF               [ ] off
```

```
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       ____
```

```
95 SYST SETTING - OPERATING SYSTEM SETTINGS

   95 TEST                  Activating internal test
      NONE              [ ] none
      withREPO          [ ] With report
      BUF-OVFL          [ ] Err.buf.owerfl=moni

   95 MODUL                 Number of tested module
      min. 0
      max. 100        ____

   95S-BLOC                 Blocking of monitoring direction via sys.int
      OFF               [ ] off
      ON                [ ] on
```

To

SIEMENS AKTIENGESELLSCHAFT

Dept. PTD EA D DM

D – 13623 BERLIN

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

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