

SIEMENS

Transient earth–fault relay 7SN71

Instruction
Manual

March 1997

Transient earth-fault relay 7SN71

Instruction Manual

Order No.: E50410-A0007-U501-A1-7691



Trade marks

Microsoft and MS-DOS are registered trade marks, Windows is a registered trade mark of Microsoft Corporation. All other brand or product names may be trade marks or registered trade marks of the respective owner.

Disclaimer of liability

We have checked the contents of this document for agreement with the hardware and software described. Since deviations cannot be precluded entirely, we cannot guarantee full agreement. However, the data in this manual are reviewed regularly and any necessary corrections included in subsequent editions. Suggestions for improvement are welcomed.

Copyright

The reproduction, transmission or use of this document or its contents is not permitted without express written authority. Offenders will be liable for damages. All rights, including rights created by patent grant or registration of a utility model or design, are reserved.

Technical data subject to change.

The following list of precautions is not intended as a complete description of all safety precautions which apply to the operation of the equipment (device, module) since particular operational conditions call for additional measures.



Warning

Dangerous voltages may occur in certain components of electrical devices during operation. Incorrect use of these devices can therefore result in severe personal injury or substantial damage of property.

- The earthing screw of the device must be connected solidly to the protective earth conductor before any other connection is made.
- Hazardous voltages may be present on all circuits and components connected with the supply voltage.
- Hazardous voltages may be present in the device even after disconnection of the supply voltage (storage capacitors).
- Devices with CT circuits must be terminated.
- The limit values given in the Technical data of the manual must not be exceeded at all, not even during testing and commissioning.
- Only suitably qualified staff should work on this device. Correct and safe operation of this device is dependent on proper handling, installation, operation and maintenance.

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.

A **qualified person** is one who is familiar with the installation, construction and operation of the device and who has the appropriate qualifications, e.g.

- is trained and authorized to operate and maintain devices/systems in accordance with established safety practices for devices with electrical circuits
- is trained in the proper care and use of protective equipment in accordance with established safety practices
- is trained in first aid.

CE-Conformity

This product is in conformity with the directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Council Directive 89/336/EEC).

Conformity is proved by tests that had been performed according to article 10 of the Council Directive in accordance with the generic standards EN 50081-2 and EN 50082-2 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 255 and the German standards DIN 57 435 part 303 (corresponding to VDE 0435 part 303).

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

	Page
1	Application 1 – 1
1.1	Earth fault directional determination 1 – 1
1.2	Functions and features 1 – 4
2	Method of operation 2 – 1
2.1	Current and voltage input (see figure 2.1) 2 – 1
2.2	Evaluating logic (see figure 2.2) 2 – 3
2.3	Indication, signalling and test 2 – 3
2.4	Suppression of switching operations 2 – 4
2.5	Reset 2 – 4
2.6	Indication of the continuous earth-fault only in forward direction 2 – 4
3	Operating instructions 3 – 1
3.1	Safety precautions 3 – 1
3.2	Connection to auxiliary power supply 3 – 1
3.3	Connection to auxiliary power supply 3 – 2
3.4	Settings 3 – 3
3.5	Testing 3 – 3
3.5.1	Test equipment 7VP8300-0 3 – 3
3.5.2	Testing of the 7SN71 3 – 3
3.5.3	Earth-fault direction signal 3 – 4
3.5.4	Continuous earth-fault signal 3 – 4
4	Technical Data 4 – 1
4.1	Ordering code / MFLB 4 – 2
5	Housing types and dimensions 5 – 1
5.1	Panel flush mounting 5 – 1
5.2	Panel surface mounting 5 – 2
5.3	Front view of relay 5 – 3
A.1	Connection diagrams A – 1
A.1.1	Connection diagram of the 7SN71 (panel surface mounting with AC power supply unit) ... A – 1
A.1.2	Connection diagram of the 7SN71 (panel surface mounting with DC power supply unit) ... A – 1
X	INDEX X – I

I

List of contents

	Page
[List of] illustrations	
Figure 1.1	Charging process in compensated or isolated networks 1 – 1
Figure 1.2	Direction of the displacement voltage and the earth current (earth-fault isolates at t1) in isolated systems 1 – 2
Figure 1.3	Detection of fault location 1 – 3
Figure 2.1	Current and voltage input 2 – 2
Figure 2.2	Evaluating logic and signalling 2 – 3
Figure 2.3	Adjusting elements 2 – 4
Figure 3.1	Connection to c.t. in Holmgreen circuit 3 – 1
Figure 3.2	Connection to the auxiliary power supply 3 – 2
Figure 3.3	Test setup 3 – 4
Figure 5.1	Dimensions for housing and panel cutout (for panel flush mounting) 5 – 1
Figure 5.2	Dimensions for housing/mounting and terminal assignment (for panel surface mounting) 5 – 2
Figure 5.3	Front view of relay 5 – 3
Figure A.5.4	Connection diagram of the 7SN71 (panel surface mounting with AC power supply unit) A – 2
Figure A.5.5	Connection diagram of the 7SN71 (panel surface mounting with DC power supply unit) A – 3
[List of] tables	
Table 4.1	Technical Data 4 – 1
Table 4.2	Selection and ordering data 4 – 2

1 Application

1.1 Earth fault directional determination

The highly sensitive transient earth-fault relay 7SN71 determines the direction of transient and continuous earth faults in systems with isolated neutral, in systems with high-impedance resistive earthing and in compensated systems.

The continuous earth-faults are only indicated in conjunction with an earth-fault directional discrimination element.

In the event of an earth fault, the neutral-point voltage to earth can be as high as the full phase voltage.

The phase-to-earth capacitances of the non-earth-faulted phases are charged via the transformer inductance.

This charging process is bound up with a strong current surge (starting oscillation).

The amplitude of this current surge depends on the expansion of the system and on contact resistance values at the earth-fault location. This current flows via the phase-to-earth capacitances of the unaffected lines to earth and enters the earth-faulted phase via the earth-fault location.

The current flows via this line to the in-feed transformers.

Thus the direction of the earth-fault induced current surge is identical with that of the short-circuited current at the same location (see figure 1.1)

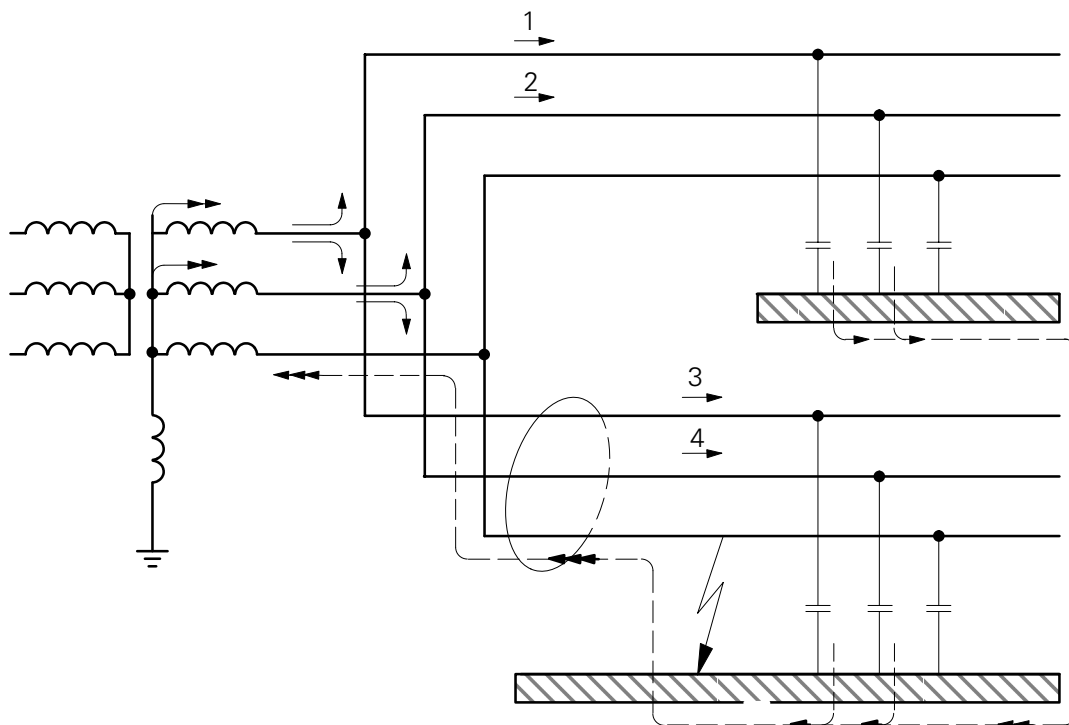


Figure 1.1 Charging process in compensated or isolated networks

1 Application

At measuring point A, as a result of the transformer summation circuit, the earth current of the faulted line is not included in the measurement, as this current portion flows through the summation transformer of the relevant Holmgreen circuit and back, thereby cancelling itself out. It is the total of the capacitive earth currents from the non-faulted system which has an effect. In the diagram they are summated on the upper line. The capacitive currents of the non-faulted lines 1, 3 and 2, 4 accumulate vectorially, which is why only three arrows instead of four are shown at measuring point A.

With a transient earth-fault relay, the equalizing current forming with a damped oscillation of 100 to more than 1 000 Hz decays after only a few periods.

The displacement voltage V_E thereupon also returns to zero. In earthed systems this takes place after a number of periods (decay of the Petersen coil – earth capacitance oscillation circuit); in non-earthed systems this occurs after a very short time (figure 1.2).

In the case of a continuous earth fault, the equalizing current in the non-earthed system changes into the mostly capacitive continuous earth current or, in compensated systems, into the relatively low residual active current.

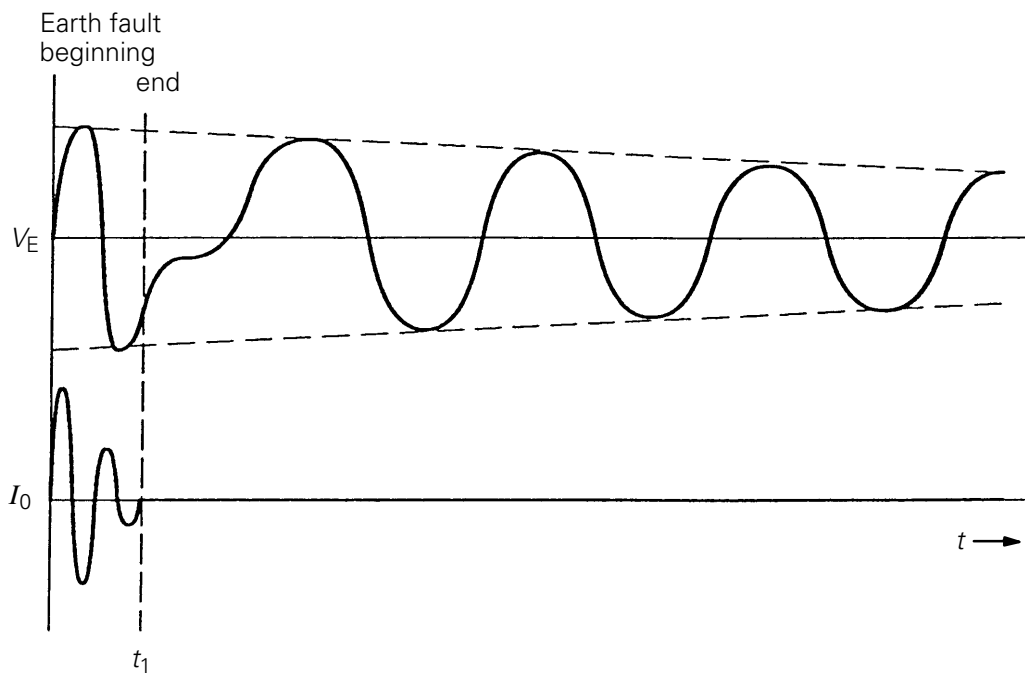


Figure 1.2 Direction of the displacement voltage and the earth current (earth-fault isolates at t_1) in isolated systems

Examples of typical applications:

If the system is of radial configuration (figure 1.3 a), the red lamp immediately indicates the faulted line. If one of the lines consists of several sections (figure 1.3 b), the fault is upstream of the last red lamp.

The transient earth-fault relay can also be used without restrictions in any type of meshed network

(figures 1.3 c and 1.3 d). The directional indications clearly identify the fault location.

Transient earth-fault relays distributed at suitable points throughout the system allow detection of the earth-fault location from the directional indications (see examples in figure 1.3).

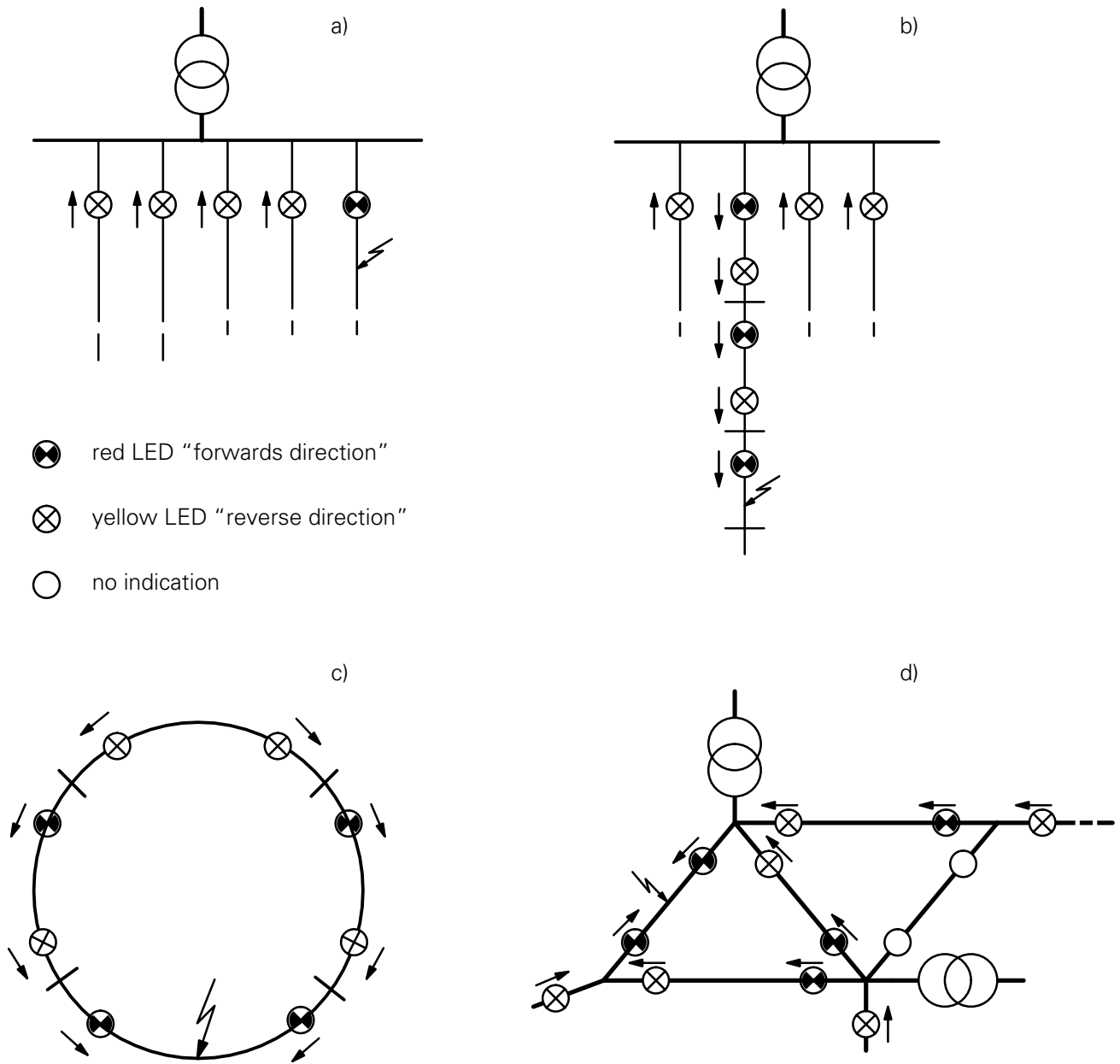


Figure 1.3 Detection of fault location

1 Application

1.2 Functions and features

- Device versions for panel surface mounting or flush mounting
- Bidirectional measurement, indication and signalling
- Indication of direction and continuous earth fault where displacement voltage $V_0 > 25$ V persists after 2 s
- High pick-up sensitivity due to separate detection and evaluation of total current and displacement voltage
- 1 A and 5 A connection for transformer current matching
- Four sensitivity stages
- Within the frequency band of 100 Hz up to 2.5 kHz the pick-up sensitivity is mostly independent of the frequency of the transient response
- Optional suppression of switching operations
- Connection to 230 V AC
- Connection to 100 V AC (voltage transformer)
- Connection to 24, 48, 60, 110/125 and 220/250 V DC.
- Remote reset (V_{reset} : 24 to 250 V DC)
- Automatic reset facility for indications and signals
- Signalling and indication of a continuous earth fault possible only in the forward direction
- Command contacts of relay for continuous earth fault

2 Method of operation

2.1 Current and voltage input (see figure 2.1)

The summation current of the cable-type CT or of the three phase-current CTs in Holgreen circuit is transformed into a proportional voltage in the input circuit and is supplied to positive and negative comparators. As soon as the positive or negative trigger threshold is exceeded, the memory for the corresponding half-cycle is set while that of the other is blocked ①.

The three phase voltages form the virtual starpoint of the voltage transformer delta via the capacitors in start-delta connection. Hence, the displacement voltage of the system is located between this point and the supplied earth potential of the transformers. This voltage is supplied to the positive and negative comparators via an input transformer. As soon as the positive or negative trigger threshold is exceeded and upon simultaneous pickup of a current trigger the corresponding memory is set while the other is blocked ②.

In order to prevent incorrect signalling during switching operations in the system, it is verified whether the displacement voltage still exceeds approx. $25 V_{\text{eff}}$ after 70 ms. Only after this verification is the evaluation of the set memories released. If this is not the case, the result are discarded and the memories are reset ③.

This function can be disabled by withdrawing the front plug " t_v ". Since in isolated networks the displacement voltage is present for only a short period of time after a transient earth-fault, the front plug " t_v " should in this case also be withdrawn.

If after approx. three seconds the displacement voltage persists above $25 V_{\text{eff}}$, the annunciation "Continuous earth fault" is released ④.

2 Method of operation

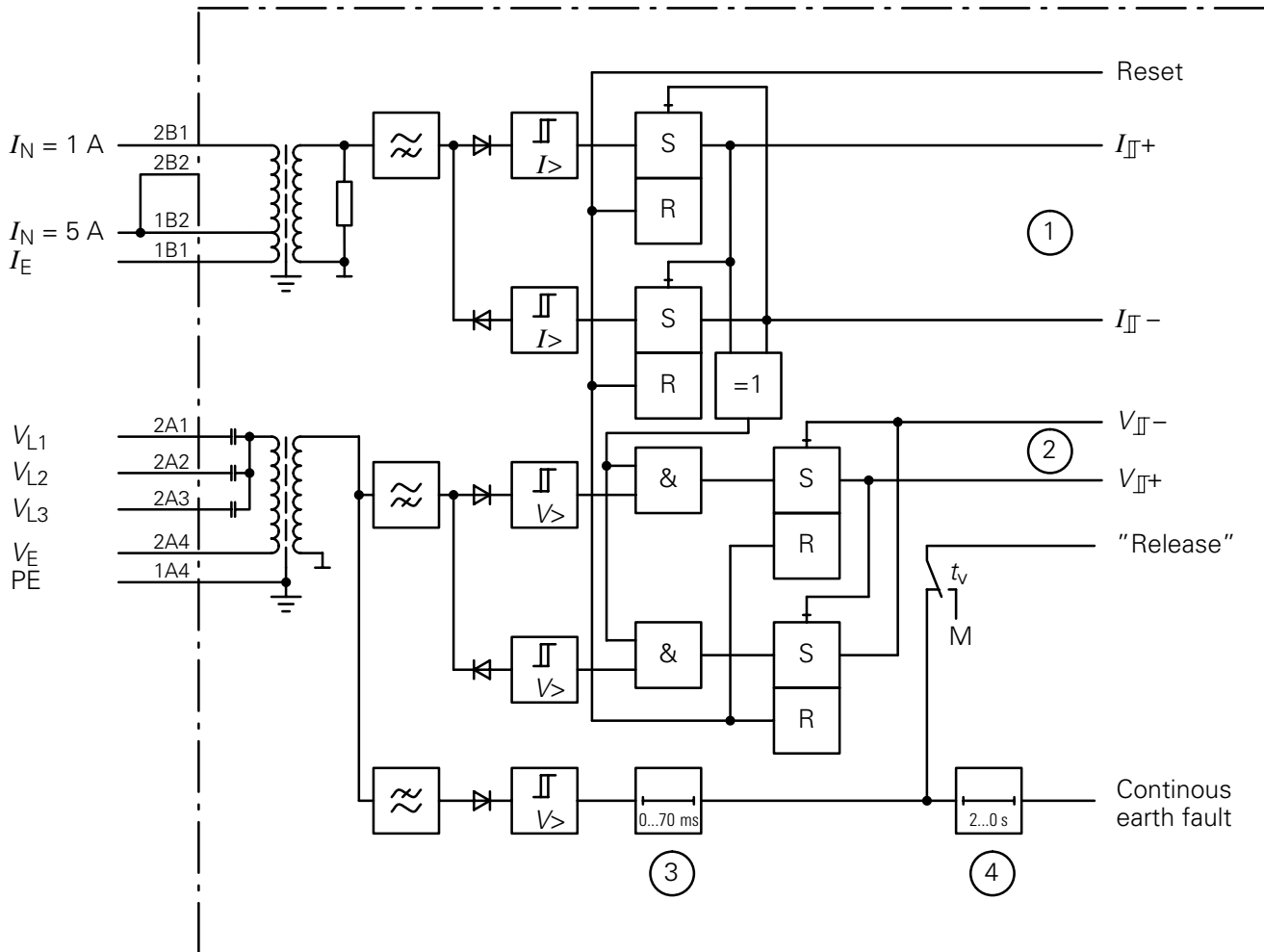


Figure 2.1 Current and voltage input

2.2 Evaluating logic (see figure 2.2)

Once the set current and voltage memories have been released (1) and evaluated (2), the memories for the directional indication are set and the corresponding relay/LED is activated (3). The respective relay or

LED is also activated (6), once the signals for directional indication and continuous earth-fault (5) are released.

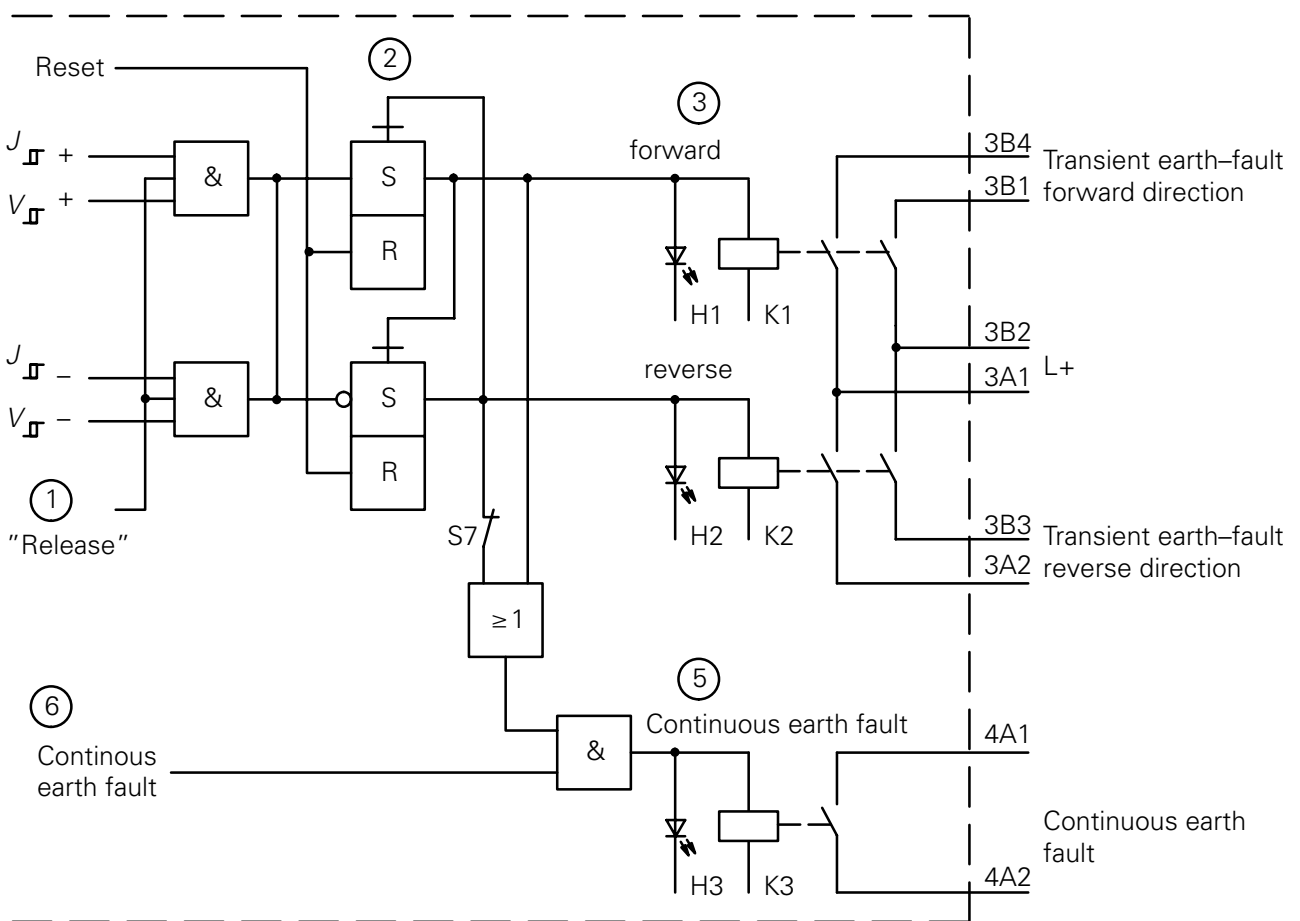


Figure 2.2 Evaluating logic and signalling

2.3 Indication, signalling and test

The indication and signalling for the direction of a transient earth fault are stored and are therefore not set anew upon further occurrence of a transient earth-fault. Indication and signalling for the "continuous earth-fault" are not stored. i.e. are discontinued upon disappearance of the displacement voltage (cf. also sections 2.4 and 2.5).

The green LED ("Operation") indicates the readiness (auxiliary voltage) of the device. An alarm signal is output in the event of an auxiliary voltage supply failure.

The test buttons for forward and reverse direction are used to test the analog evaluation, the evaluating logic, the LEDs and the alarm relays.

2 Method of operation

2.4 Suppression of switching operations

The front plug “ t_v ” is used to enable or disable the delay time for control of the displacement voltage once a directional indication has been effected through earth faults or switching operations.

If the front plug “ t_v ” is inserted, switching operations in isolated systems are not indicated or signalled.

In compensated systems, the plug should always be withdrawn.

2.5 Reset

Indications and signals can be reset

- by pressing the “Reset” button on the front plate
- via the remote reset with 24 to 250 V
- automatically by opening jumper S8 (position as delivered: closed). Indication and signalling of the transient earth-fault direction is reset approx. 3 s after the earth fault has disappeared.



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.

2.6 Indication of the continuous earth-fault only in forward direction

If jumper S7 is opened (position as delivered: closed), occurrences of continuous earth faults will only be indicated in forward direction (tripping contact !)



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.

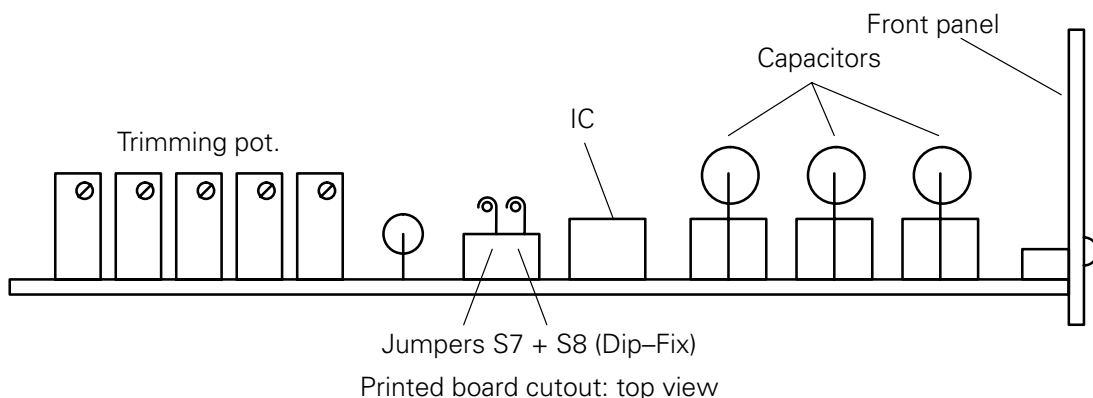


Figure 2.3 Adjusting elements

3 Operating instructions

3.1 Safety precautions

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

3.2 Connection to auxiliary power supply

Figure 3.1 shows the connection to a current transformer set in Homgreen circuit.

Here, the starpoint at the line-side of the c.t.s must be connected to terminal 1 (2B1) or 2 (1B2), while the starpoint at the bus-bar side of the c.t.s must be con-

nected to terminal 3 (1B1). The three phase voltages V_{L1} , V_{L2} and V_{L3} are connected to terminals 4 (2A1), 5 (2A2) and 6 (2A3), respectively. The earthed starpoint of the c.t. is connected to terminal 7 (2A4).

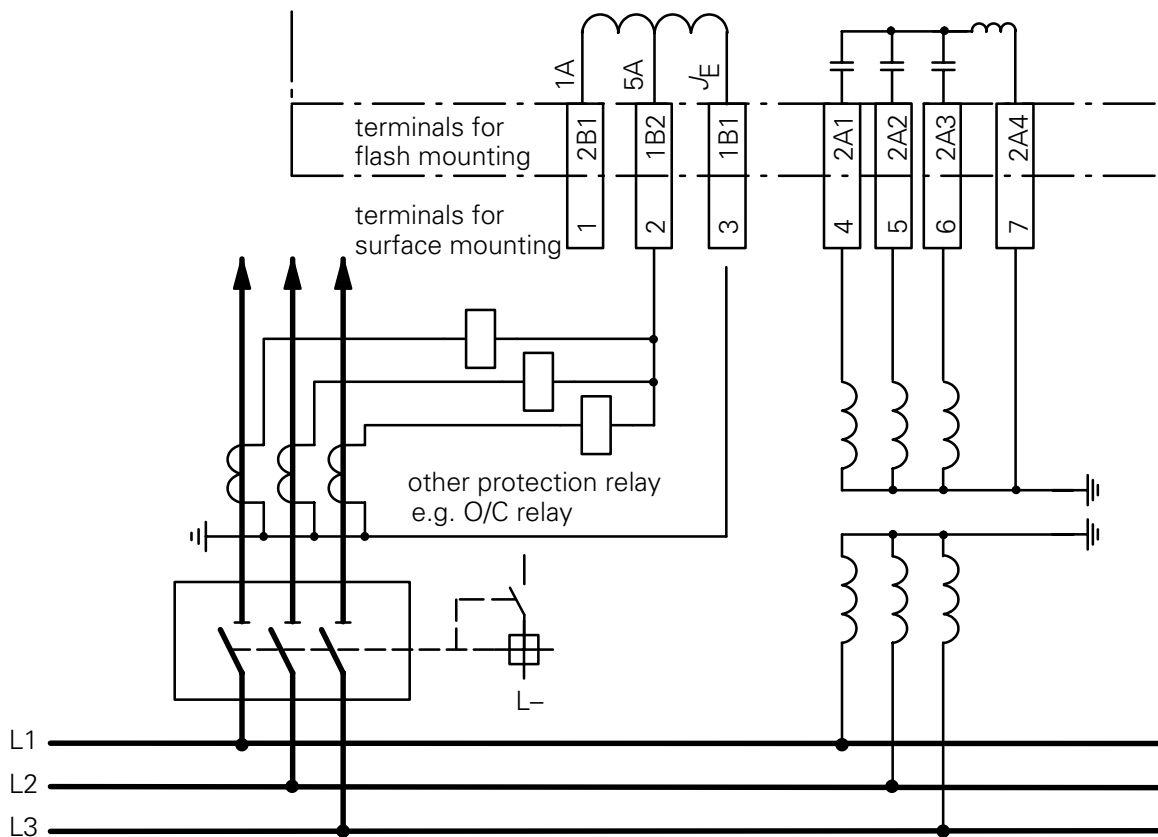


Figure 3.1 Connection to c.t. in Homgreen circuit

3

Operating instructions

3.3 Connection to auxiliary power supply

Connection is either made to the 230 V AC mains or between two phases (100 V) of the v.t.s. Connection to the station battery is also possible (see figure 3.2).

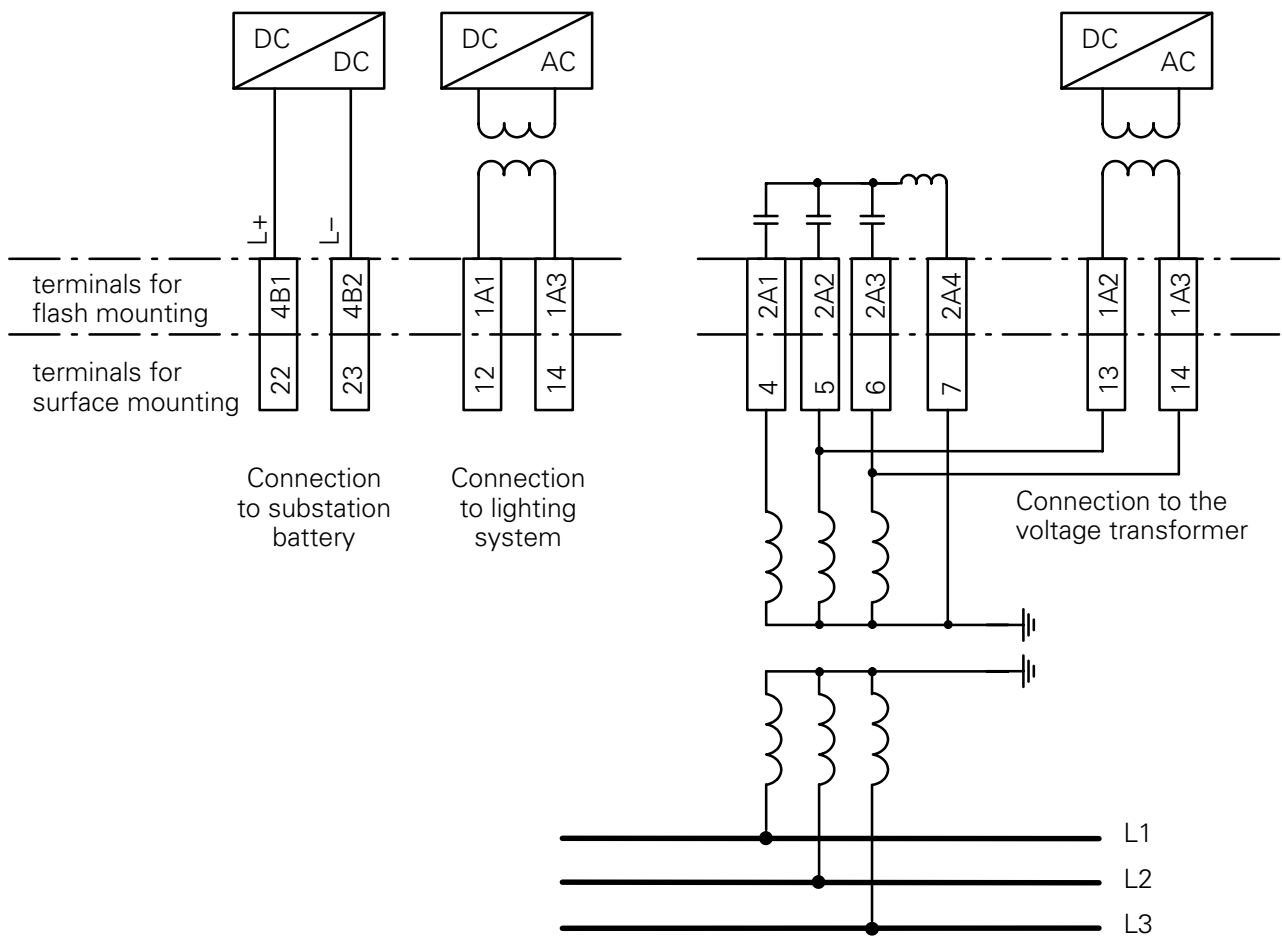


Figure 3.2 Connection to the auxiliary power supply

3.4 Settings

The pick-up sensitivity is adjusted to the system load and c.t. ratios by means of the three coding plugs on the front panel of the 1 or 5 A connection. The setting is based on the earth current I_E of the unearthed

system converted for the secondary side of the c.t.s. The coding plugs are selected according to the following table.

Zero-sequence current I_0 (sec.) Terminals for	<0.5 A 1 A	<2.5 A 1 A	<5 A 5 A	>5 A 5 A
Front plug withdrawn for normal sensitivity, plug no. for increased sensitivity, plug no.	3 all	1 2	3 all	1 2

If the marking on the plug is in vertical position, the plug is withdrawn and effective. In the in-effective, plugged-in position the marking is horizontal.

3.5 Testing

Function tests of the transient earth-fault relay, including tests of the connection wiring (e.g. of the cubicle terminals), can be carried out with test equipment 7VP8300-0.

3.5.1 Test equipment 7VP8300-0

Test equipment 7VP83 serves to test the transient earth-fault relay 7TH2300-0/7SN70 and 7SN71.

The test equipment operates at 230 V AC.

Test current I_0 and test voltage V_0 for the directional detection of the transient earth-fault are made available via the terminal sockets.

The connection of the test current/voltage and the phase rotation of the current are effected by means of pushbutton S1. Activation of the test current/voltage is indicated by LED H1.

3.5.2 Testing of the 7SN71

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

Before testing, the current and voltage inputs of the test object must be isolated.

Otherwise, the accuracy of the test results can be invalidated.

the test object is connected to test equipment 7VP83 as shown in figure 3.3.

3 Operating instructions

3.5.3 Earth-fault direction signal

If the pushbutton of 7VP83 is pressed to "forward" (>100 ms), the red "LED \rightarrow " of 7SN71 must light up. In addition, the "forward" signal (relay contact) must be released.

If the pushbutton is pressed to "reverse" (>100 ms), the yellow "LED \leftarrow " of 7SN71 must light up. In addition, the "reverse" signal (relay contact) must be released.

For the 1 A input circuit of the test object, the setting of the sensitivity (via front plugs 1 to 3) has no bearing upon the test.

For the 5 A input circuit, front plugs 1 to 3 must be withdrawn.

Connection of the test current/voltage is independent of the phase relation of the line voltage. If testing is started during zero crossing of the voltage wave, an incorrect directional detection may result. In this case, repeated measurements must be carried out.

3.5.4 Continuous earth-fault signal

In order to test the "continuous earth fault" signal, the rocking switch must be actuated for approx. 4 s until after approx. 2 s the indication for "continuous earth fault" is given (red LED and relay)

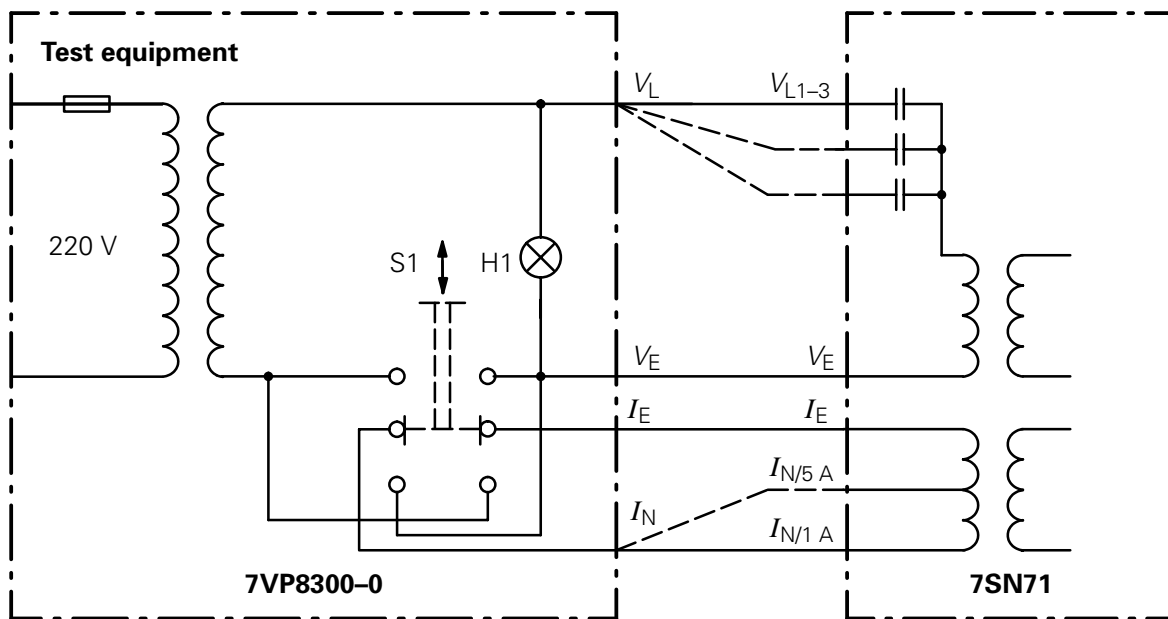


Figure 3.3 Test setup

4 Technical Data

Table 4.1 Technical Data

Measuring circuit	Rated voltage V_N	100/110 V AC	
	Rated current I_N	1 or 5 A	
	Rated frequency f_N	50 Hz	
	Thermal rating in current path, continuous	120 V AC	
	in voltage path, continuous	$4 \times I_N$	
	1 s (1 A)	100 A	
	1 s (5 A)	300 A	
	10 s	$30 \times I_N$	
Auxiliary voltage	Rated auxiliary voltage V_{AUX}	24, 48, 60 V DC	
		110/125 V DC	
		220/250 V DC	
		100 to 110/230 V AC, 50 Hz	
	Power consumption	non-energized	energized
	100 V	approx. 2.5 W	approx. 3.5 W
	110 V	approx. 3.5 W	approx. 4.5 W
	220 V	approx. 4.0 W	approx. 5.0 W
Current path	Input impedance Z at 50 Hz and $1 \times I_N$		
	$I_N = 1$ A, terminals 2B1/1B1	<0.5 Ω	
	$I_N = 5$ A, terminals 1B2/1B1	<0.2 Ω	
Earth-fault direction signal	Number of relays, forward or reverse direction	2 NO contacts	
	Switching capacity make/break	20 W/VA	
	Switching voltage	250 V AC/DC	
	Switching current	1 A	
Continuous earth-fault signal	Number of relays, continuous earth fault	1 NO contact	
	Switching capacity	make	1 000 W/VA
		break	30 W/VA
	Switching voltage	250 V AC/DC	
	Permissible switching current	continuous	5 A
		0.5 s	30 A
Version	Housing, dimensions	7XP20 (see chapter. 2)	
	Connections	for current	2 connection modules
		for voltage	6 connection modules
	Weight	approx. 4 kg	
Standards	VDE 0435, Part 303 and IEC 255-5 or IEC 255-6		

4 Technical Data

Transient earth-fault relay 7SN71 — Instruction Manual Order No.: E50410-A0007-U501-A1-7691

4.1 Ordering code / MFLB

Table 4.2 Selection and ordering data

Transient earth-fault relay 7SN71	Order number 7SN7100 - □ □ A 0 0
Auxiliary voltage V_{AUX} 100 to 110/230 V AC, 50 Hz 24 V DC 48 V DC 60 V DC 110/125 V DC 220/250 V DC	↑ ↑ 0 1 2 3 4 5
Housing (7XP20) for panel surface mounting for panel flush mounting	B C

5 Housing types and dimensions

5.1 Panel flush mounting

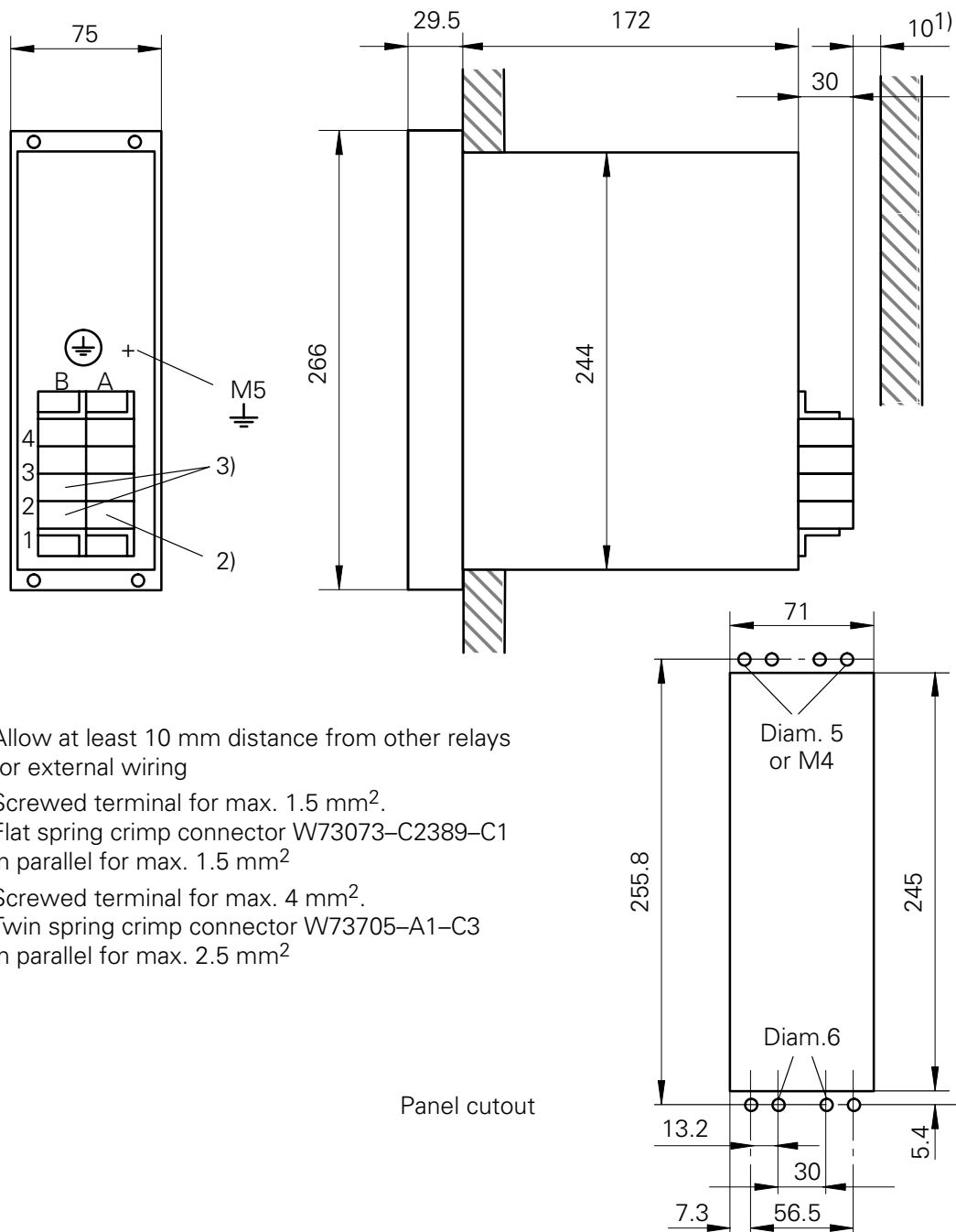


Figure 5.1 Dimensions for housing and panel cutout (for panel flush mounting)

5

Housing types and dimensions

5.2 Panel surface mounting

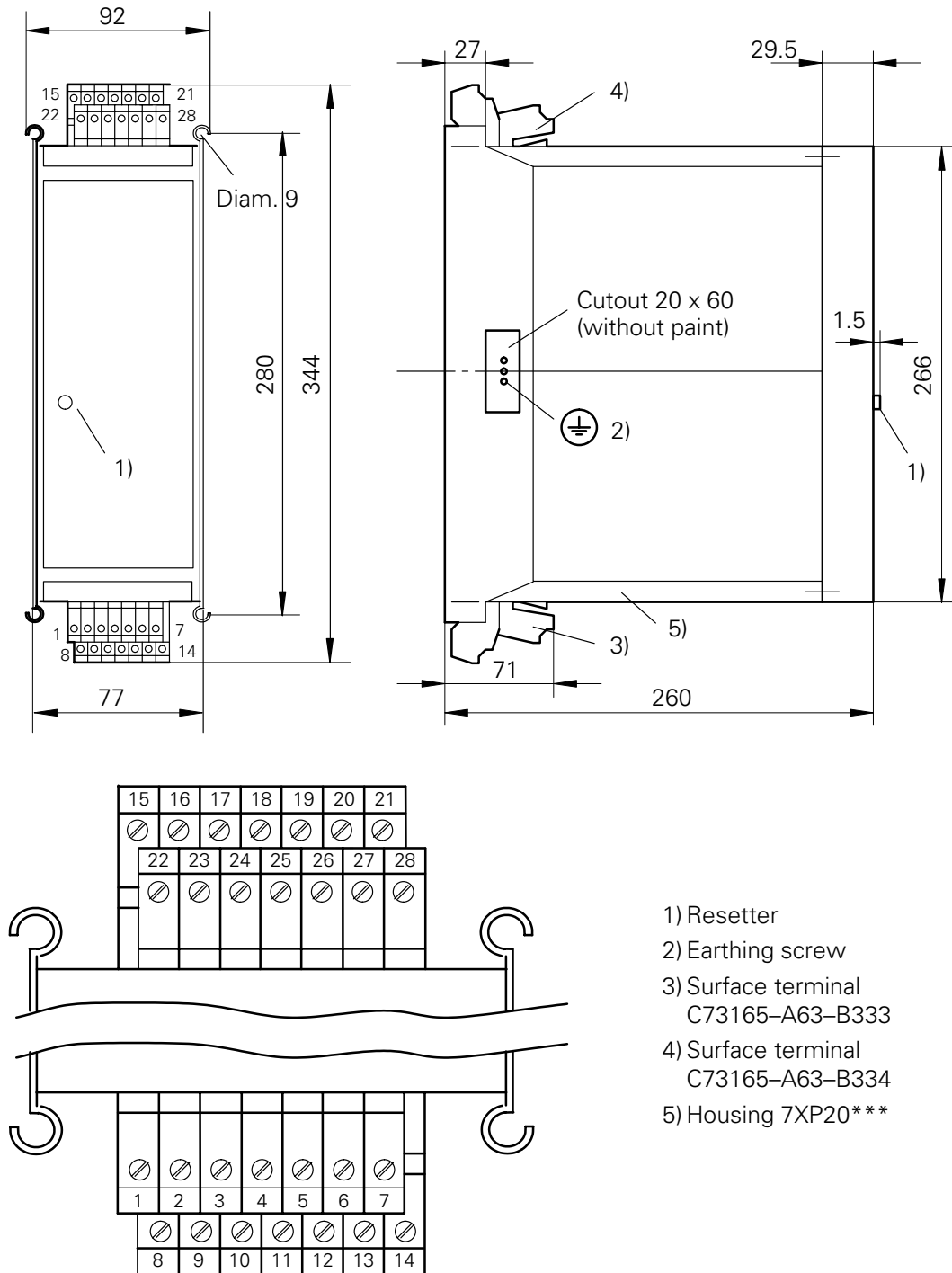


Figure 5.2 Dimensions for housing/mounting and terminal assignment (for panel surface mounting)

5.3 Front view of relay

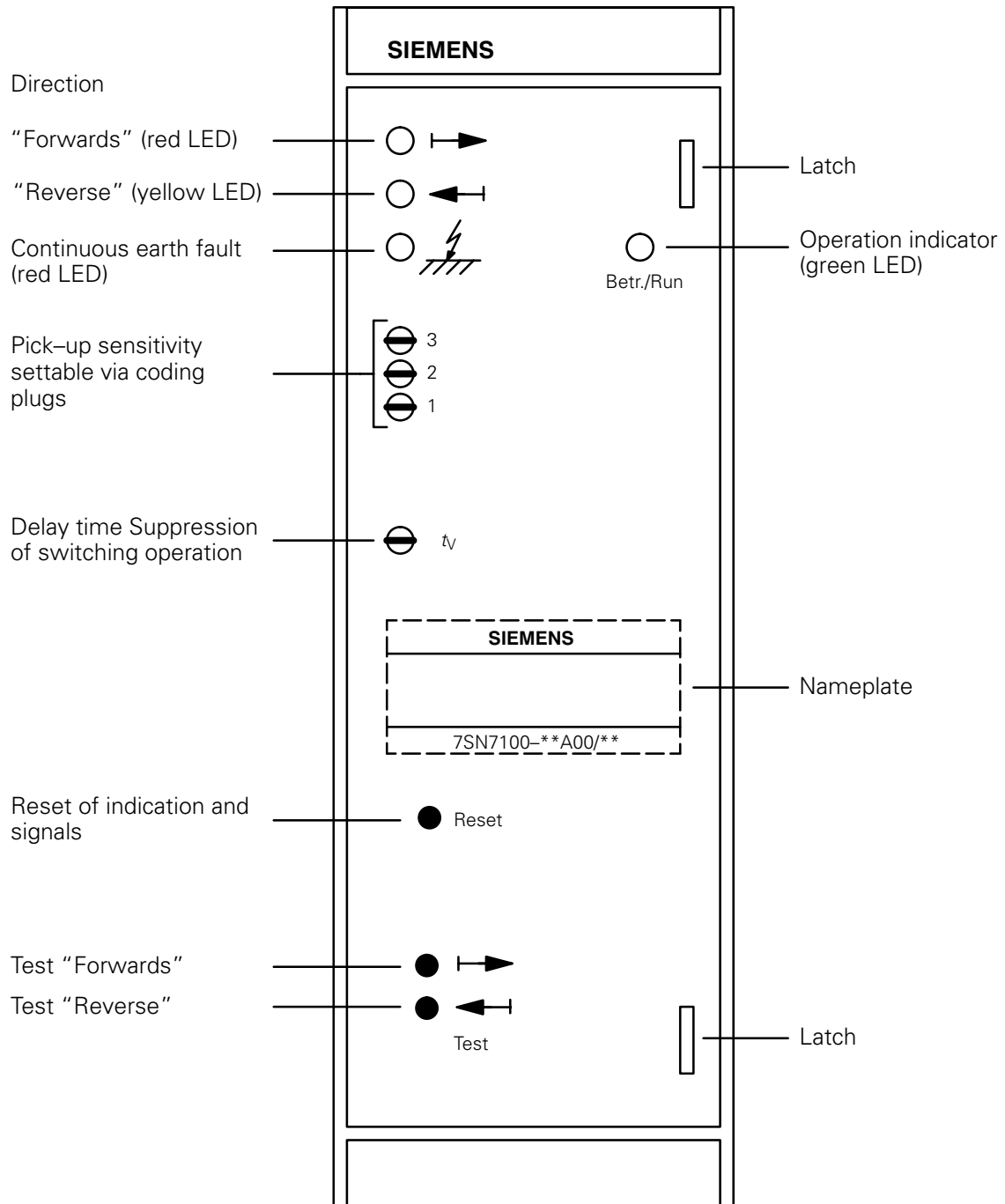


Figure 5.3 Front view of relay

5 Housing types and dimensions

Transient earth-fault relay 7SN71 — Instruction Manual

Order No.: E50410-A0007-U501-A1-7691

A.1 Connection diagrams

A.1.1 Connection diagram of the 7SN71 (panel surface mounting with AC power supply unit)

See figure A.5.4 on page A – 2.

A.1.2 Connection diagram of the 7SN71 (panel surface mounting with DC power supply unit)

See figure A.5.5 on page A – 3.

A

Appendix

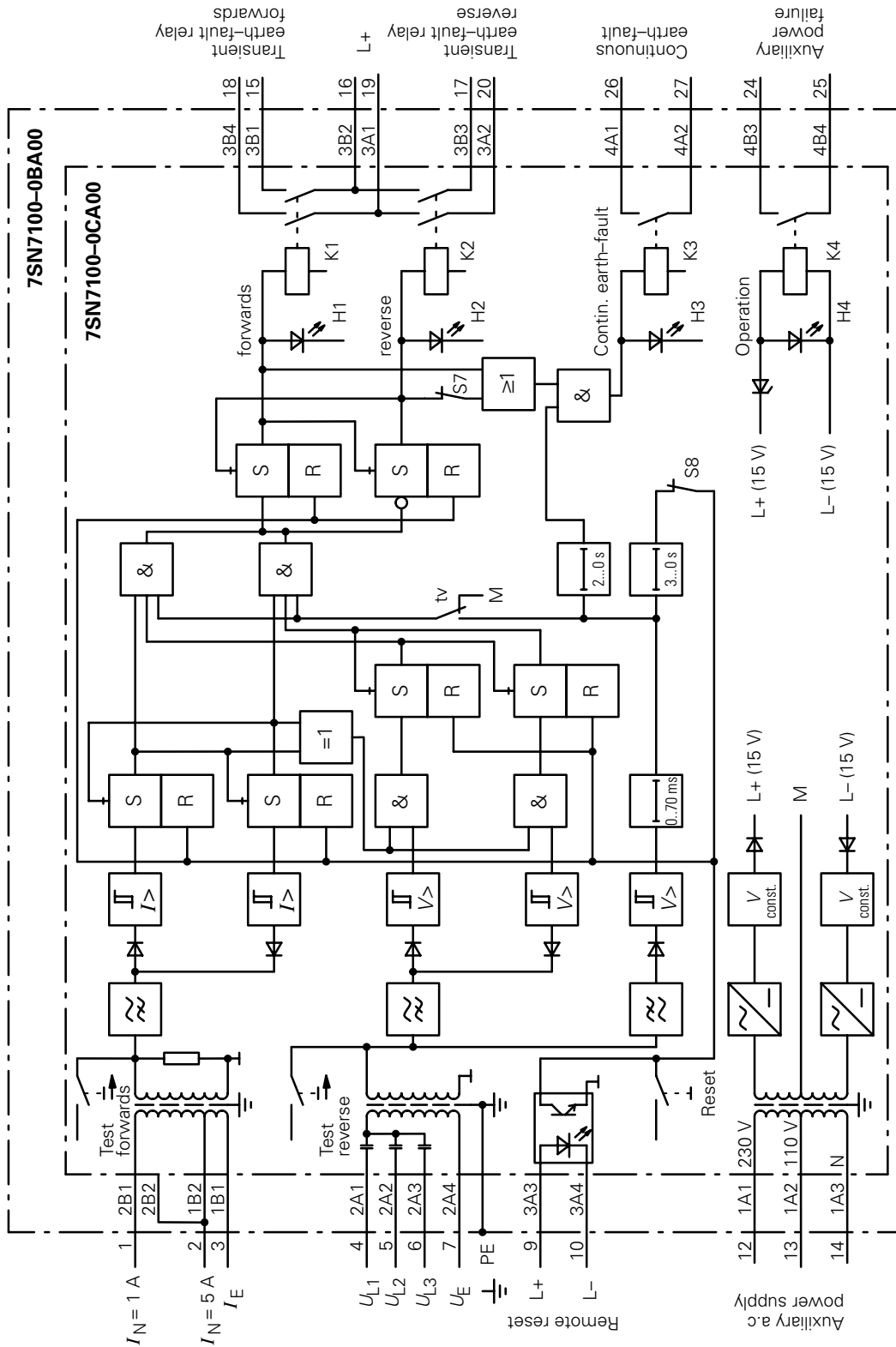


Figure A.5.4 Connection diagram of the 7SN71 (panel surface mounting with AC power supply unit)

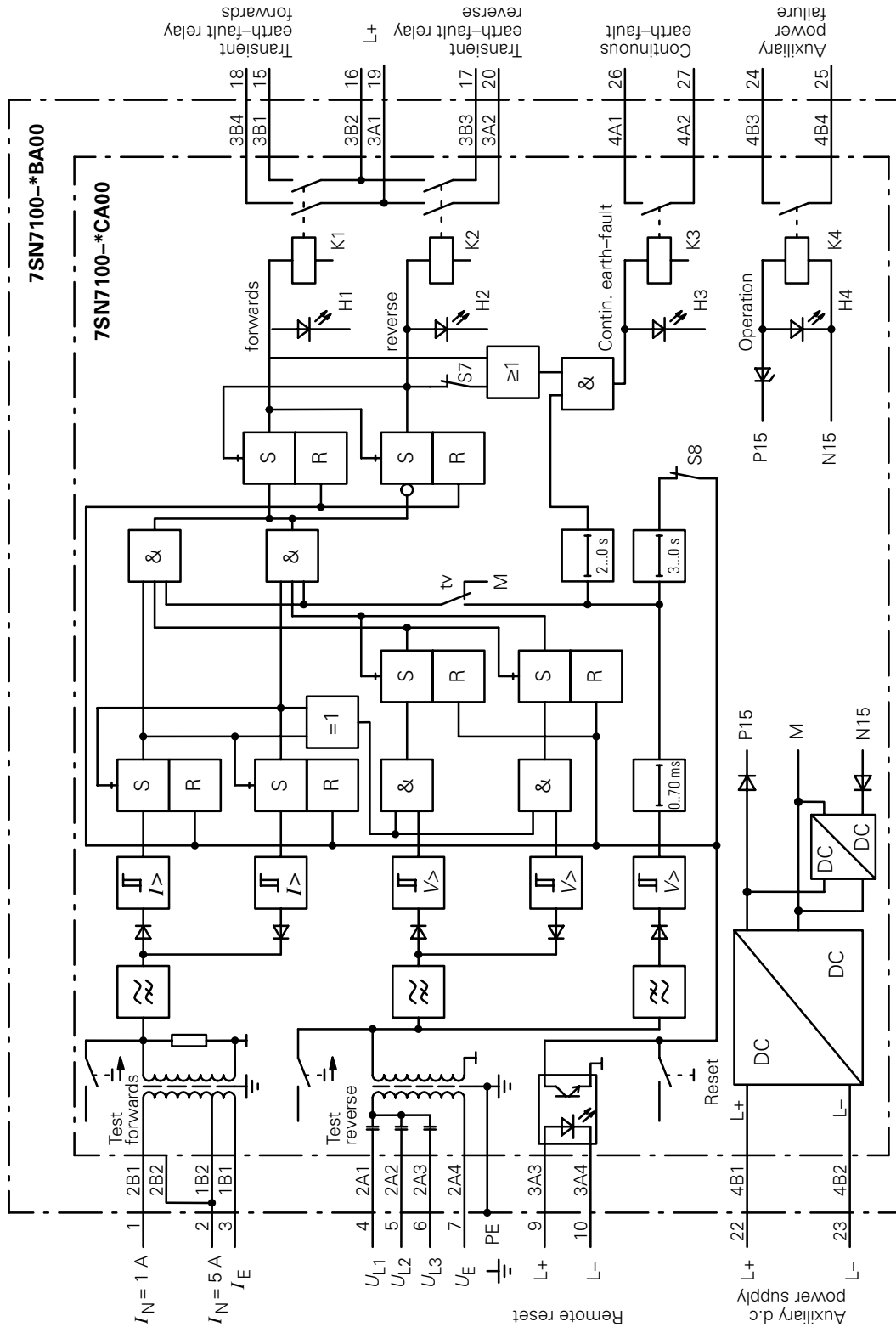


Figure A.5.5 Connection diagram of the 7SN71 (panel surface mounting with DC power supply unit)

A

Appendix

Transient earth-fault relay 7SN71 — Instruction Manual

Order No.: E50410-A0007-U501-A1-7691

A

Application, 1 – 1

C

Connection diagrams, A – 1
Connection to auxiliary power supply, 3 – 1, 3 – 2
Current and voltage input, 2 – 1

E

Earth fault directional determination, 1 – 1
Evaluating logic, 2 – 3

F

Front view of relay, 5 – 3
Functions and features, 1 – 4

H

Housing types and dimensions, 5 – 1

I

Indication of the continuous earth-fault, only in forward
direction, 2 – 4
Indication, signalling and test, 2 – 3

M

Method of operation, 2 – 1

O

Operating instruction, 3 – 1
Ordering code/MFLB, 4 – 2

P

Panel flush mounting, 5 – 1
Panel surface mounting, 5 – 2

R

Reset, 2 – 4

S

Safety precautions, 3 – 1
Settings, 3 – 3
Suppression of switching operations, 2 – 4

T

Technical Data, 4 – 1
Testing, 3 – 3
7SN71, 3 – 3
Continuous earth-fault signal, 3 – 4
Earth-fault direction signal, 3 – 4
equipment 7VP8300-0, 3 – 3

X INDEX

Transient earth-fault relay 7SN71 – Instruction Manual

Order No.: E50410–A0007–U501–A1–7691

To
Siemens Aktiengesellschaft
EV S V13
Postfach 4806
90026 Nürnberg

Fax. (+49)911/433-8301

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.

Suggestions	Corrections	
for document	order no.	version
Transient earth-fault relay 7SN71 Instruction manual	E50410-A0007-U501-A1-7691	March 1997

Siemens AG, EV S,
Substation Control and Power System Protection
PO Box 48 06
D-90026 Nuremberg
Federal Republic of Germany

Siemens Aktiengesellschaft



Power
Transmission
and Distribution

Order No.: **E50410-A0007-U501-A1-7691**
Printed in Germany