7SJ50 numerical overcurrent–time/overload protection relay

Scope of functions

50

51

50N

51N

49

Fig. 1
7SJ50 numerical overcurrent–time/overload protection relay

Application

The 7SJ50 is a numerical protection relay which can be used for definite–time or inverse–time overcurrent protection or for thermal overload protection.

As an overcurrent–time and earth–fault protection relay, the 7SJ50 can protect radial feeders as well as small or medium sized machines and transformers.

It can be used as back–up protection for differential and distance relays in HV and EHV feeder protection schemes.

It can also be used as overload protection for motors, transformers and cables.

By use of the directional relay 7SP20, the 7SJ50 can also be applied to ring feeders or to parallel lines with a single infeed.

Construction

All components, including the DC/DC converter are located on a single PCB. The device can be supplied in three case variations. The model for panel surface mounting is supplied with two–tier terminals accessible from the front. The variants for panel flush mounting or cubicle mounting have rear connection terminals and are available with or without glass cover.

Implemented functions

- Overcurrent time protection with selectable characteristics (inverse or definite–time)
- Directional overcurrent–time protection with directional relay 7SP20
- Overload protection selectable without or with memory (thermal replica)
- Overload protection with start–up time monitoring (locked rotor)
- Additional high set (instantaneous) o/c elements available with all characteristics
- Phase–failure protection
- Earth–fault protection

Mode of operation

The measuring quantities from the C.T.s are galvanically isolated, transformed and shunted by input transducers and resistor circuits. The current proportional analog measuring voltages are then converted into digital values and further processed by a microcomputer. Based on the measured values and the selected characteristic and settings, it computes the tripping time.

Measurement is performed on all phases.

Settings

Settings are performed by dual–in–line switches on the front panel.

Self monitoring

All important software components are monitored continuously. Any irregularities in the hardware or the program sequence are detected and alarmed. As a result, the security and availability of the protection relay are significantly improved.

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Overcurrent–time protection

The function is based on a common phase measurement. A definite–time or an inverse–time characteristic can be selected. For the earth currents, the same type of characteristic is used as for the phase currents. For the definite time characteristic, the tripping time t is computed as follows:

$$t = C \cdot t_p$$

Three different inverse–time characteristics according to BS 142 resp. IEC 255–4 are available:

Normal inverse (Fig. 2)

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

Very inverse (Fig. 3)

$$t = \frac{13.5}{I/I_p - 1} \cdot t_p$$

Extremely inverse (Fig. 4)

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

t tripping time
t_p time multiplier
I fault current
I_p current setting
C settable factor 1, 2 or 4

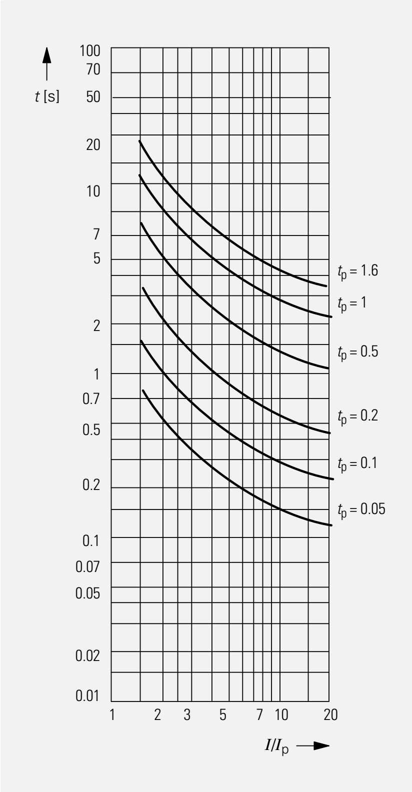


Fig. 2
Tripping time characteristics normal inverse

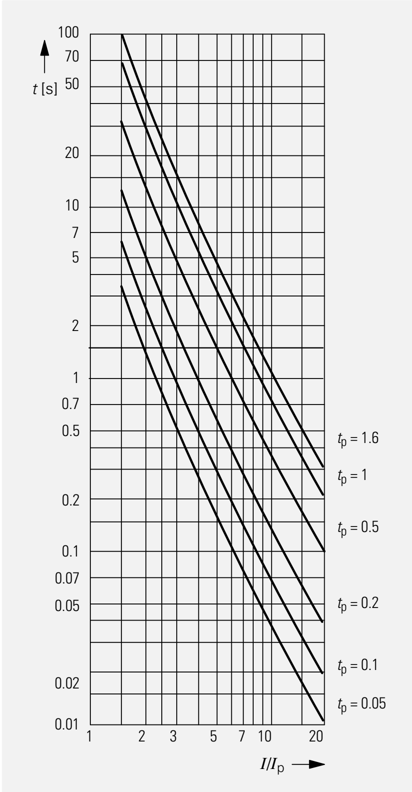


Fig. 4
Tripping time characteristics extremely inverse

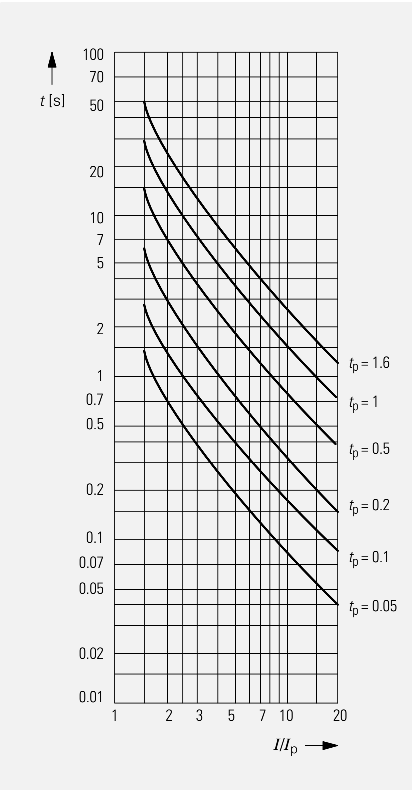


Fig. 3
Tripping time characteristics very inverse

7SJ50 numerical overcurrent–time/overload protection relay

Overload protection

If the overload protection without thermal memory feature is selected the characteristic shown in Fig. 5 is valid for fault currents

$I \geq 1.1 \cdot I_p$

For different settings of t_p, the tripping time t can be computed as follows

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

By using the overload protection with memory feature, the preload with all variations is taken into account.

The tripping time t can be computed using the following equation (total memory according to IEC 255–8)

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

- t tripping time after start of overload
- τ 35.5 t_p
- I_p current setting
- I_{pre} previous current
- k 1 (acc. to IEC 255)
- t_p time multiplier
- I overload current
- ln natural logarithm

Fig. 6 and Fig. 7 show the tripping time characteristics for total memory without (Fig. 6) and with (Fig. 7) 80 % preload.

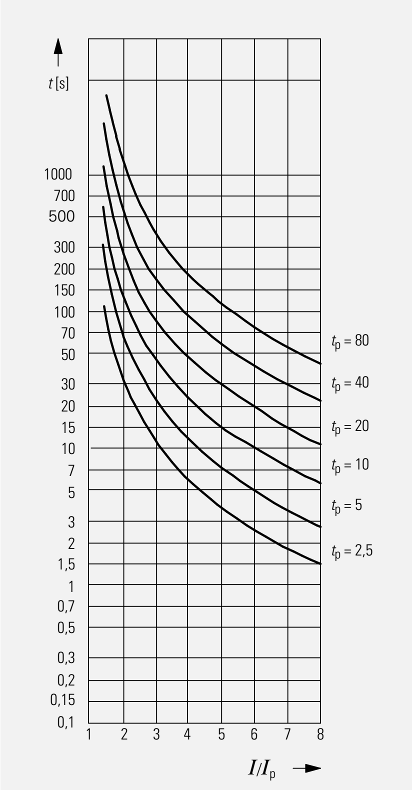


Fig. 5
Tripping time characteristics without memory feature

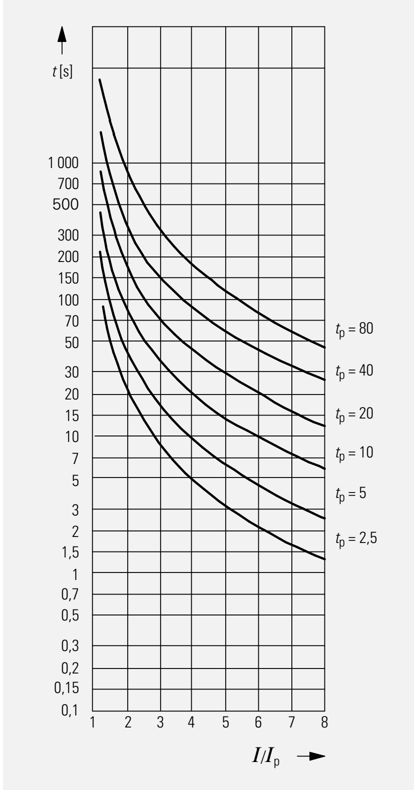


Fig. 7
Tripping time characteristics with memory feature (no preload)

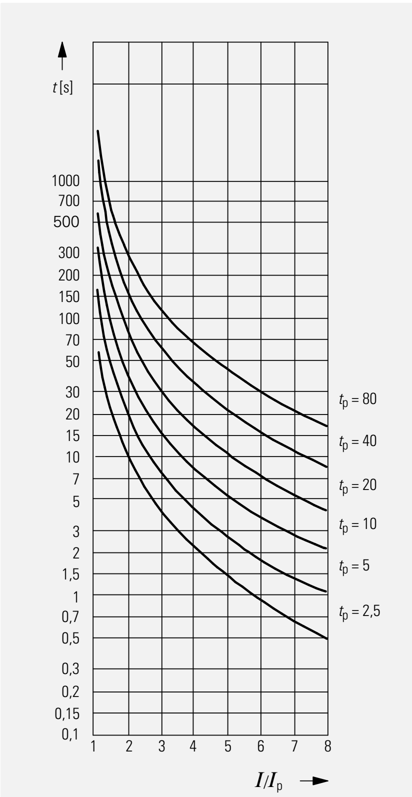


Fig. 6
Tripping time characteristics with memory feature (80 % preload)

7SJ50 numerical overcurrent–time/overload protection relay

Start–up time monitoring

In the overload protection mode, an additional settable time stage is available for monitoring the motor start–up time. It becomes effective if the current exceeds a fixed value of 2.5 times the setting current I_p and the relay issues a tripping command.

Instantaneous high set o/c element

For short–circuit protection, an instantaneous high set overcurrent element with a settable time is available to prevent response to inrush current. This element has always a definite–time characteristic.

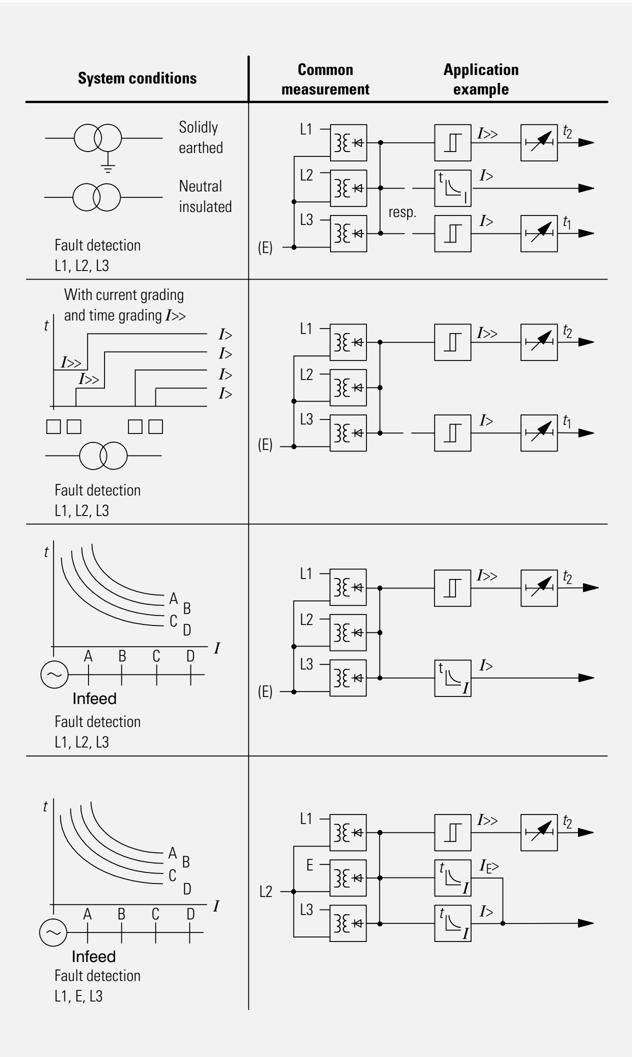
Phase–failure protection

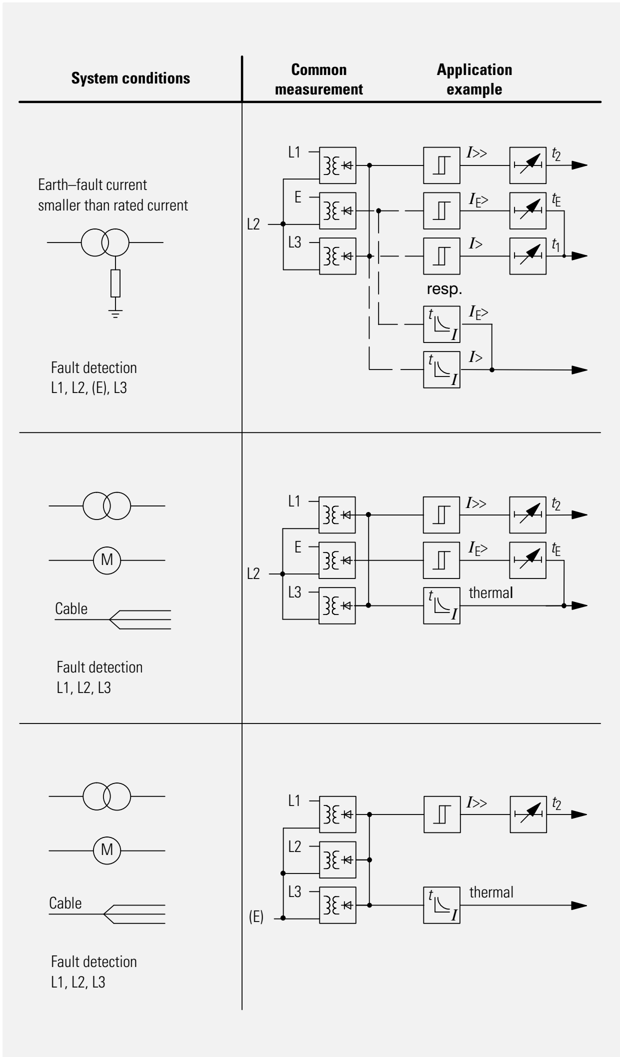
A phase unbalance function is available which detects a missing phase current if the current in the other phases is above 0.25 I_p. 10 s after the detection of a phase unbalance, a trip or an alarm is issued.

Earth–fault protection

The implemented earth–fault protection function can be applied if the earth–fault current exceeds 10 % of the rated transducer current. This is normally valid for earthed systems e. g. in four–wire systems or low–voltage motors. The earth–current element (I_E) has a separate timer.

Application examples





7SJ50 numerical overcurrent–time/overload protection relay

Technical data

Input circuits	Rated current I_N	1 or 5 A	
	Rated frequency f_N	50/60 Hz	
	Thermal overload capability of current inputs		
	continuous	4 x I_N	
	10 s	30 x I_N	
	1 s	300 x IN	
	Burden of current inputs at I_N	approx. 0.5 VA	
DC voltage supply via integrated DC/DC converter	Rated auxiliary voltage V_{aux}/permissible ranges	24, 48 V DC 60, 110, 125 V DC 220, 250 V DC	/ 19 to 56 V DC / 48 to 144 V DC / 176 to 288 V DC
	Ripple content	<12 %	
	Power consumption, quiescent	approx. 5 W	
	energized	approx. 7 W	
Setting ranges			Settable in steps of:
Definite–time overcurrent protection	Current $I>$		
	Response value of current I_p	0.4 to 3.55 x I_N	0.05 x I_N
	Tripping time t_p	0.05 to 6.4 s	$C_1 \cdot 0.05$ s, C_1 = 1, 2, 4
	Current $I\gg$		
	Response value of current I_p	2 to 19 x I_p [1], ∞	1 x I_p
	Tripping time t_p	0.025 to 3.2 s	C_3 . 0.025 s, C_3 = 1, 2, 4
	Earth current $I_E>$		
	Response value of earth current I_E	0.1 to 3.2 x I_N	0.1 x I_N
	Tripping time t_p	0.05 to 6.4 s	C_2 . 0.05 s, C_2 = 1, 2, 4
	Pick–up tolerances for I_p, I_E	±5 % of set value I_p, I_E	–
	for t_p	±3 % or ±10 ms	–
Inverse–time overcurrent protection	Current $I>$		
	Setting value of current I_p	0.4 to 3.55 x I_N	0.05 x I_N
	Time multiplier t_p	0.05 to 1.6 s	0.05 s
	Pick–up tolerances for I_p	±5 % at 1.1 x I_p	–
	for t_p normal and very inverse	±5 % at 10 x I_p	–
	extremely inverse	±7.5 % at 10 x I_p	–
	Current $I\gg$ (definite–time characteristic)		
	Response value of current I_p	2 to 19 x I_p [1], ∞	1 x I_p
	Tripping time t_p	0.025 to 0.8 s	0.025 s
	Pick–up tolerances for I_p	±5 % of set value I_p	–
	for t_p	±3 % or ±10 ms	–
	Earth current $I_E>$		
	Setting value of earth current I_E	0.1 to 3.2 x I_N	
	Time multiplier t_p	0.05 to 1.6 s	0.1 x I_N
	Pick–up tolerances for I_E	±5 % of set value	0.05 s
	for t_p normal and very inverse	±5 % at 10 x I_p	–
	extremely inverse	±7.5 % at 10 x I_p	–
Overload protection without/with memory feature	Current $I>$		
	Setting value of current I_p	0.4 to 3.55 x I_N	0.05 x I_N
	Time multiplier t_p corresponds to t_6 – time (to IEC 255)	2.5 to 80 s	2.5 s
	Pick–up tolerances for I_p	±5 % at 1.1 x I_p	–
	for t_p	±7.5 % at I = 6 x I_p	–
	Current $I\gg$ (definite–time characteristic)		
	Response value of current I_p	2 to 19 x I_p [1], ∞	1 x I_p
	Tripping time $t_{p\gg}$	0.025 to 0.8 s [2]	0.025 s
	Earth current $I_E>$ (definite–time characteristic)		
	Response value of earth current I_p	0.1 to 3.2 x I_N	0.1 x I_N
	Tripping time t_E	0.05 to 1.6 s	0.05 s
	Pick–up tolerances for $I\gg$, $I_E>$	±5 % of set value	–
	for t_p, t_E	±3 % or ±10 ms	–
Start time monitoring	Operating criteria	$I>$ 2.5 x I_p	–
	Start time t_{STA}	1.25 to 40 s	1.25 s

1) Maximum setting value = 60 I_N.
2) By using locked rotor: ON $t_p \gg$ = 50 ms.

7SJ50 numerical overcurrent–time/overload protection relay

Technical data (continued)

Phase–failure protection	Operating criteria Delay t_{ph}	Failure of one phase and $I/I_p \geq 0.25 \pm 0.05$ 10 s ±0.5 s
Pick–up tolerances	Influence on the current paths Auxiliary voltage $0.8 \leq V_{aux}/V_{aux\ N} \leq 1.15$ Frequency $0.95 \leq f/f_N \leq 1.05$ Harmonics up to 10 % of 3rd harmonic up to 10 % of 5th harmonic Temperature –5 to 20 °C 20 to 55 °C Influence on operating time	 ≤0.6 % ≤0.1 % per Hz ≤1.3 % per 1 % of 3rd harmonic ≤1 % per 1 % of 5th harmonic ≤0.6 % per 10 K ≤1.4 % per 10 K not measurable
Contacts	Number of trip relays Contacts per relay Switching capacity make break Switching voltage Permissible current continuous 0.5 s Number of alarm relays/malfunction alarm relays Contacts per relay Switching capacity make/break Switching voltage Permissible current	2 2 NO 1 000 W/VA 30 W/VA 250 V AC/DC 5 A 30 A 3/1 1 NO/ 1 NC 20 W/VA 250 V AC/DC 1 A
Construction	For panel surface mounting Weight approx. For panel flush mounting/cubicle mounting Weight approx.	7XP20 20 housing 6 kg 7XP20 20 housing 5 kg
Input	Number of input relays Power consumption, energized DC operating voltage	1 0.075 to 1.7 W, depending on DC operating voltage 24 to 60 V 110 to 250 V

Selection and ordering data

7SJ50 numerical overcurrent–time/ overload protection relay	Order No. **7SJ50 0 □ – □ □ □ □ 0**
Rated current I_N	
1 A	**1**
5 A	**5**
Rated auxiliary voltage V_{aux} for the built–in converter	
24, 48 V DC	**2**
60, 110, 125 V DC	**4**
220, 250, V DC	**5**
Construction	
Panel flush mounting	**C**
Panel surface mounting	**D**
Panel surface mounting (without glass cover)	**E**
Directional relay interface	
without termination connector	**A 0**
with termination connector	**A 1**

7SJ50 numerical overcurrent–time/overload protection relay

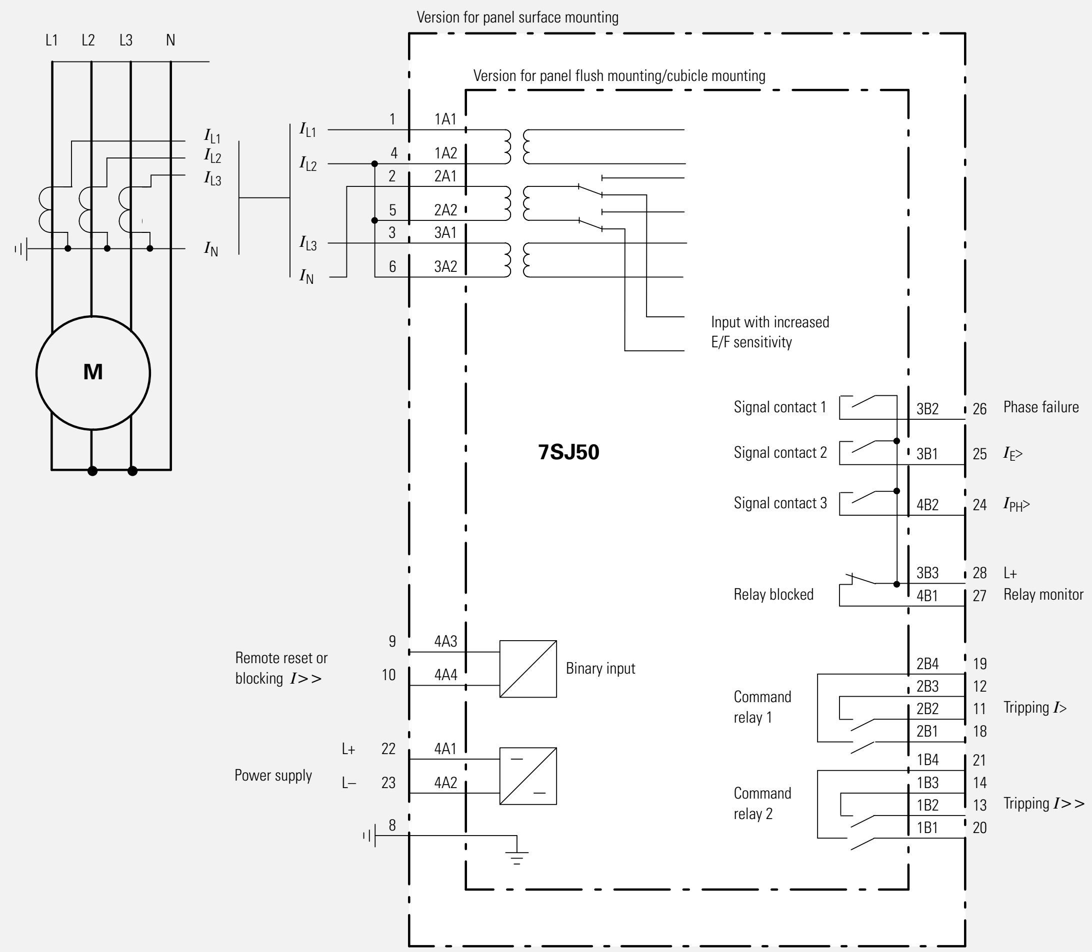


Fig. 8
Connection diagram for motor overload and short–circuit protection with sensitive detection of neutral current (four–wire system)

7SJ50 numerical overcurrent–time/overload protection relay

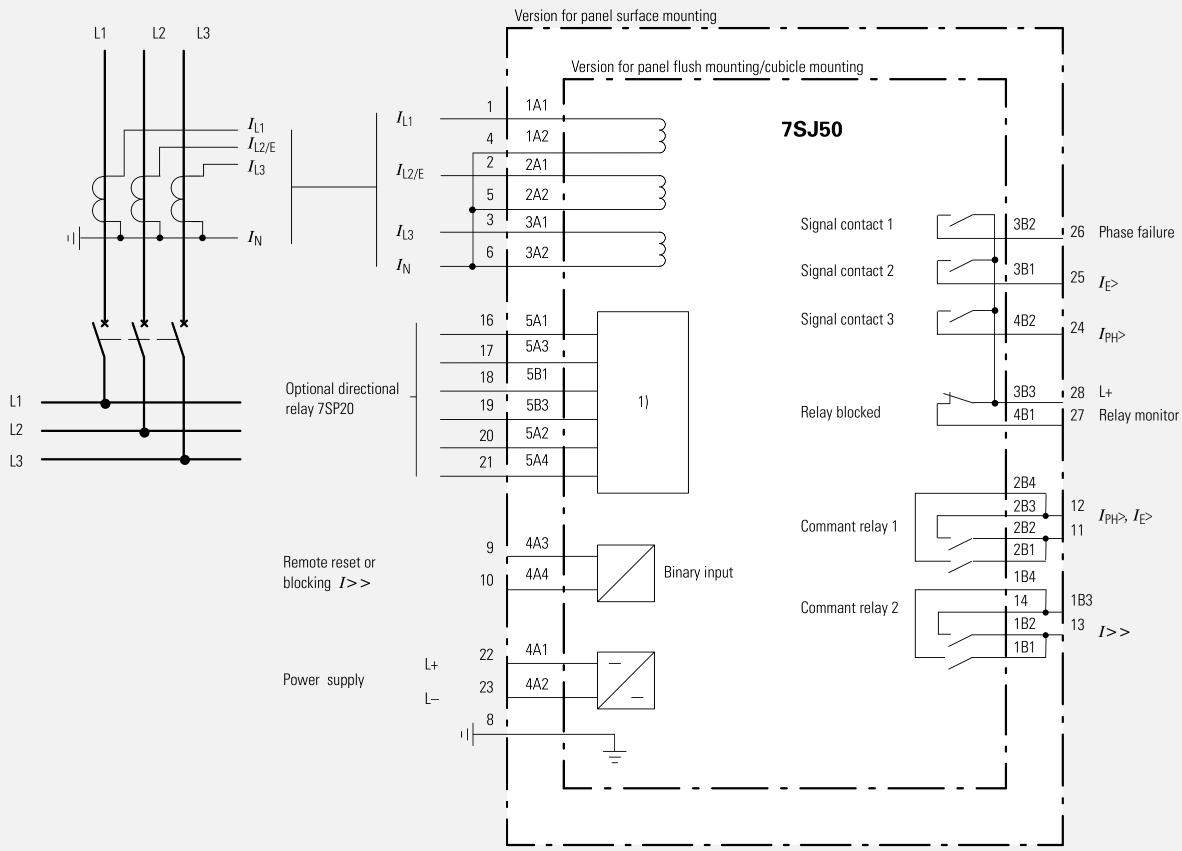


Fig. 9
Connection diagram for motor overload and short–circuit protection with sensitive detection of neutral current (four–wire system)

1) Option (only with 7SJ50.0–.. A10. connections for directional relay)

Dimension drawings in mm

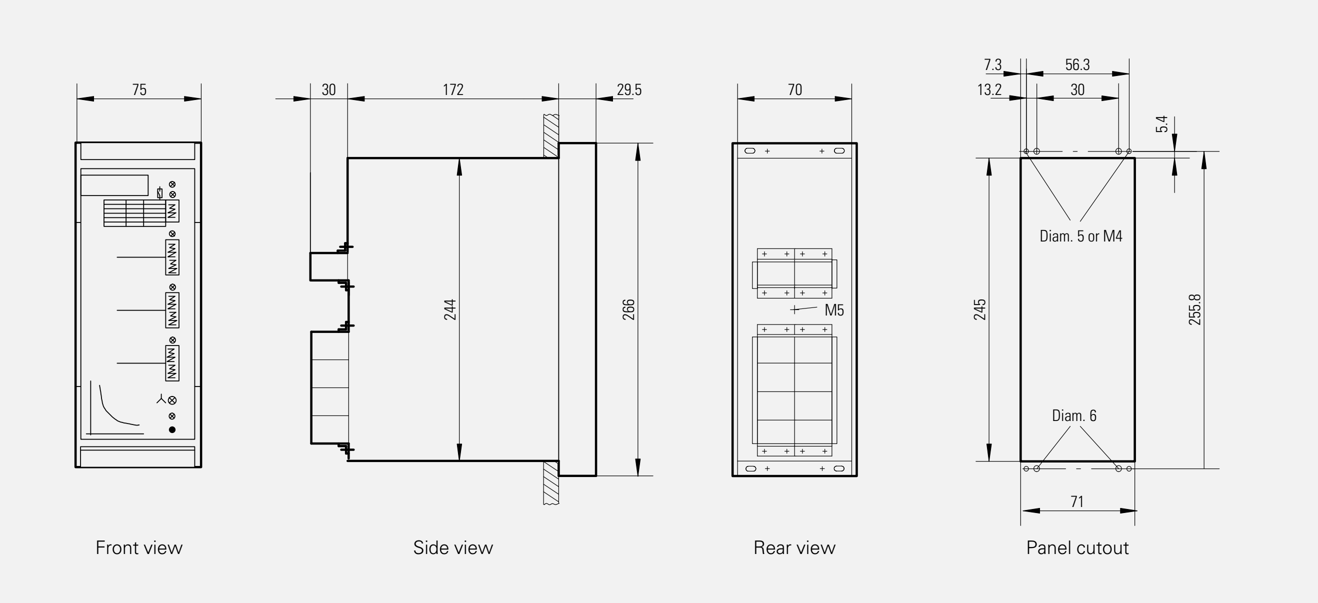


Fig. 10
7SJ50 with housing 7XP2020–2 (for panel flush mounting)

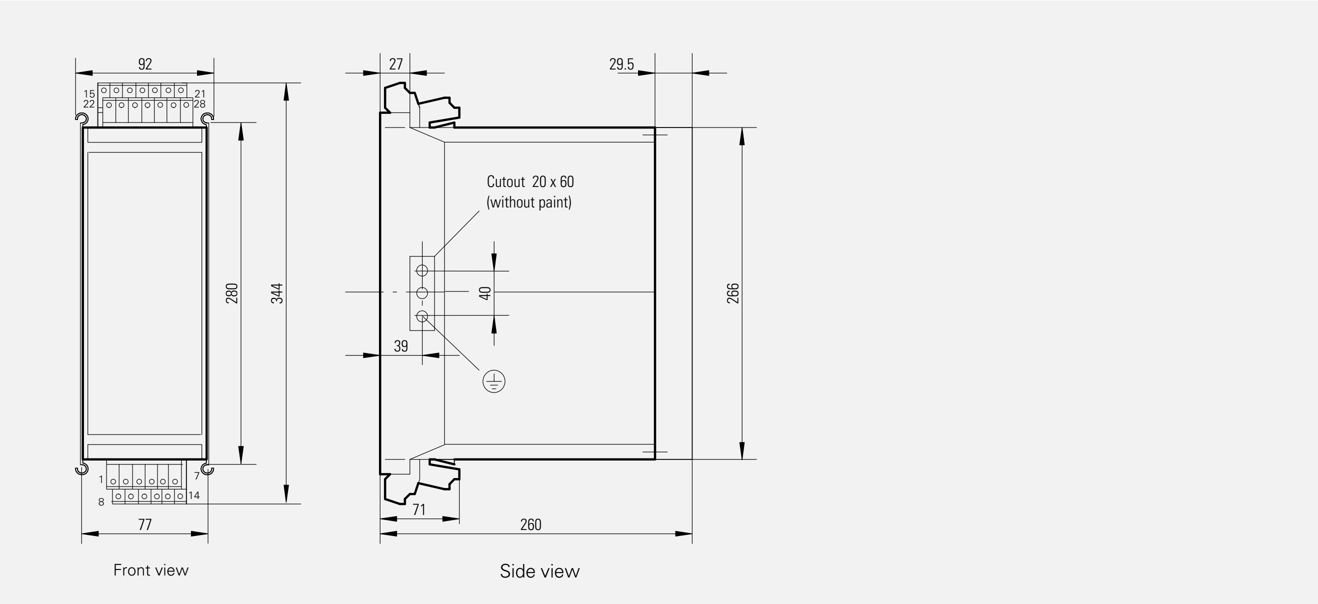


Fig. 11
7SJ50 with housing 7XP2020–1 (for panel surface mounting)

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