



**Features**

- Two-stage directional earth-fault relay for distribution networks
- Directional low-set earth-fault stage with definite time characteristic
- Directional high-set earth-fault stage with instantaneous operation or definite time characteristic
- Operation direction of the high-set earth-fault stage either the same as that of the low-set stage, or the opposite
- Output relay functions to be freely configured by the user
- Flexible adaptation of the relay to different applications
- Manual selection or remote control of the operation characteristic  $I_0 \sin \phi$  or  $I_0 \cos \phi$
- Digital display of settings, measured quantities, recorded fault values, etc.
- Extensive two-way data communication via fibre-optic serial bus
- Continuous self-supervision of hardware and software including auto-diagnosis
- Powerful software support for parameterization and supervision of the relay

**Application**

The directional earth-fault relay SPAS 120 C is designed to be used for selective feeder earth-fault protection in isolated neutral and impedance earthed networks. The relay is especially useful in networks, where the operation characteristic of the earth-fault relay must be remotely controllable.

The directional earth-fault relay can also be used for the earth-fault protection of power generators and large motors.

## Design

The directional earth-fault relay SPAS 120 C is a secondary relay which is connected to the current and voltage transformers of the object to be protected. The earth-fault current can be measured either via a set of three phase current transformers in a residual current connection or via a window-type core-balance current transformer.

When an earth fault occurs, the relay delivers an alarm signal, trips the circuit breaker or starts an external auto-reclose relay, depending on the application and the configuration of the relay.

When the energizing voltage exceeds the set start value  $U_0 >$  and the energizing current and the phase angle between voltage and current are such that  $I_0 \sin \varphi$  or  $I_0 \cos \varphi$  exceeds the set start current  $I \varphi >$ , the earth-fault relay starts. After the set operate time  $t >$  the relay operates. In the same way the high-set stage starts when the energizing voltage exceeds the set start value  $U_0 >$  and the energizing current and the phase angle between voltage and current are such that  $I_0 \sin \varphi$  or  $I_0 \cos \varphi$  exceeds the set start current  $I \varphi >>$ . After the set operate time  $t >>$  the relay operates.

The direction of operation of the high-set stage can be the same as that of the low-set stage, or the opposite.

The start signal from the earth-fault relay is obtained as a contact function. The start signal can be used, for instance, for blocking cooperating protection relays.

The earth-fault relay has one optically isolated binary input for external incoming control signals, e.g. for blocking protection stages or for selecting the operation characteristic.

## Data communication

The relay is provided with a serial interface on the rear panel. By means of a bus connection module type SPA-ZC 17 or SPA-ZC 21 the relay can be connected to the fibre-optic SPA bus. The bus connection module type SPA-ZC 21 is powered from the host relay, whereas the bus connection module SPA-ZC 17 is provided with a built-in power unit, which can be fed from an external secured power source. The relay communicates with higher-level data acquisition and control systems over the SPA bus.

## Self-supervision

The relay incorporates a sophisticated self-supervision system with auto-diagnosis, which increases the availability of the relay and the reliability of the system. The self-supervision system continuously monitors the hardware and the software of the relay. The system also supervises the operation of the auxiliary supply module and the voltages generated by the module.

When a permanent internal relay fault is detected, the IRF indicator on the relay front panel is lit. At the same time the output relay of the self-supervision system operates and a fault message is transmitted to the higher-level system over the serial bus. Further, in most fault situations, a fault code is shown in the display of the protection relay module. The fault code indicates the type of the fault that has been detected.

## Auxiliary supply voltage

The auxiliary supply of the relay is obtained from an internal plug-in type power supply module. Two auxiliary power module versions are available: type SPTU 240S1 for the supply voltage range 80...265 V ac/dc and type SPTU 48S1 for the supply voltage range 18...80 V dc. The power supply module forms the internal voltages required by the protection relay and the I/O module.

Technical data

**Table 1: Energizing inputs, current inputs**

Terminals		25-27	25-26
Rated current $I_n$		1 A	5 A
Thermal withstand capability	continuously	4 A	20 A
	for 10 s	25 A	100 A
	for 1 s	100 A	500 A
Dynamic current withstand capability	Half-wave value	250 A	1250 A
Input impedance		<100 mΩ	<20 mΩ
Rated frequency $f_n$ , according to order		50 Hz or 60 Hz	

**Table 2: Energizing inputs, voltage inputs**

Terminals		28-29	28-30
Rated voltage $U_n$		100 V	110 V
Continuous withstand		$2 \times U_n$	$2 \times U_n$
Power consumption at rated voltage $U_n$		<0.5 VA	
Rated frequency $f_n$ , according to order		50 Hz or 60 Hz	

**Table 3: Output contact ratings**

Type of contact		Tripping	Signalling
Terminals		65-66, 68-69	70-71-72, 73-74-75, 77-78, 80-81
Rated voltage		250 V ac/dc	
Thermal withstand capability	Carry continuously	5 A	5 A
	Make and carry for 0.5 s	30 A	10 A
	Make and carry for 3 s	15 A	8 A
Breaking capacity for dc, when the control/ signalling circuit time constant $L/R \leq 40$ ms, at the control voltages	220 V dc	1 A	0.15 A
	110 V dc	3 A	0.25 A
	48 V dc	5 A	1 A
Contact material		AgCdO <sub>2</sub>	

Technical data (cont'd)

**Table 4: Control input, communication and power supply**

External control input for selection of operation characteristic $I_0\sin\phi$ or $I_0\cos\phi$	Terminals		11-12
	Control voltage level		18...265 V dc or 80...265 V ac
	Power consumption when input activated		2...20 mA
Data communication	Transmission mode		Fibre-optic serial bus
	Data code		ASCII
	Selectable data transfer rates		300, 1200, 2400, 4800 or 9600 Bd
	Fibre-optic bus connection module, powered from the host relay	for plastic fibre cables	SPA-ZC 21BB
		for glass fibre cables	SPA-ZC 21MM
	Fibre-optic bus connection module with a built-in power supply unit	for plastic fibre cables	SPA-ZC 17BB
for glass fibre cables		SPA-ZC 17MM	
Auxiliary supply modules	Power supply and I/O modules and voltage ranges	SPTU 240S1	80...265 V ac/dc
		SPTU 48S1	18...80 V dc
	Power consumption	under quiescent conditions	~4 W
		under operating conditions	~6 W

**Table 5: Directional neutral overcurrent relay module SPCS 3C4**

Low-set neutral overcurrent stage $I_{\phi>}$	Start current $I_{\phi>}$	1.0...10.0% of $I_n$
	Start time	60...150 ms
	Operation characteristic	$I_0\sin\phi$ or $I_0\cos\phi$
	Operate time $t_{>}$	0.1...10.0 s
	Reset time, typically	120 ms
	Drop-off/pick-up ratio, typically	0.90
	Operation time accuracy	±2% of set value or ±50 ms
	Operation accuracy	±3% of maximum set value of stage $I_{\phi>}$ + inaccuracy caused by ±1° phase displacement
High-set neutral overcurrent stage $I_{\phi>>}$	Start current $I_{\phi>>}$	1.0...40.0% of $I_n$ and ∞, infinite
	Start time	60...150 ms
	Operation characteristic	± $I_0\sin\phi$ or ± $I_0\cos\phi$
	Operate time $t_{>>}$	0.1...1.0 s
	Reset time, typically	120 ms
	Drop-off/pick-up ratio, typically	0.90
	Operate time accuracy	±2% of set value or ±50 ms
	Operation accuracy	±3% of maximum set value of stage $I_{\phi>>}$ + inaccuracy caused by ±1° phase displacement
Residual voltage $U_0$	Start voltage $U_{0>}$ , fixed values	2%, 5%, 10% or 20% of $U_n$

**Table 6: Tests and standards**

Test voltages	Dielectric test voltage (IEC 60255-5)	2.0 kV, 50 Hz, 1 min
	Impulse test voltage (IEC 60255-5)	5 kV, 1.2/50 $\mu$ s, 0.5 J
	Insulation resistance (IEC 60255-5)	>100 M $\Omega$ , 500 V dc
Interference tests	High-frequency (1 MHz) disturbance test (IEC 60255-22-1), common mode	2.5 kV
	High-frequency (1 MHz) disturbance test (IEC 60255-22-1), differential mode	1.0 kV
	Fast transients (IEC 60255-22-4, class III and IEC 60801-4, level 4), power supply inputs	4 kV, 5/50 ns
	Fast transients (IEC 60255-22-4, class III and IEC 60801-4, level 4), other inputs	2 kV, 5/50 ns
	Electrostatic discharge (IEC 60255-22-2 and IEC 60801-2, class III), air discharge	8 kV
	Electrostatic discharge (IEC 60255-22-2 and IEC 60801-2, class III), contact discharge	6 kV
Environmental conditions	Service temperature range	-10...+55°C
	Transport and storage temperature range (IEC 60068-2-8)	-40...+70°C
	Damp heat test (IEC 60068-2-3)	<95%, +40°C, 96 h
	Relative humidity (IEC 60068-2-30)	93...95%, +55°C, 6 cycles
	Degree of protection by enclosure when panel mounted	IP 54
	Weight	3 kg

Block diagram

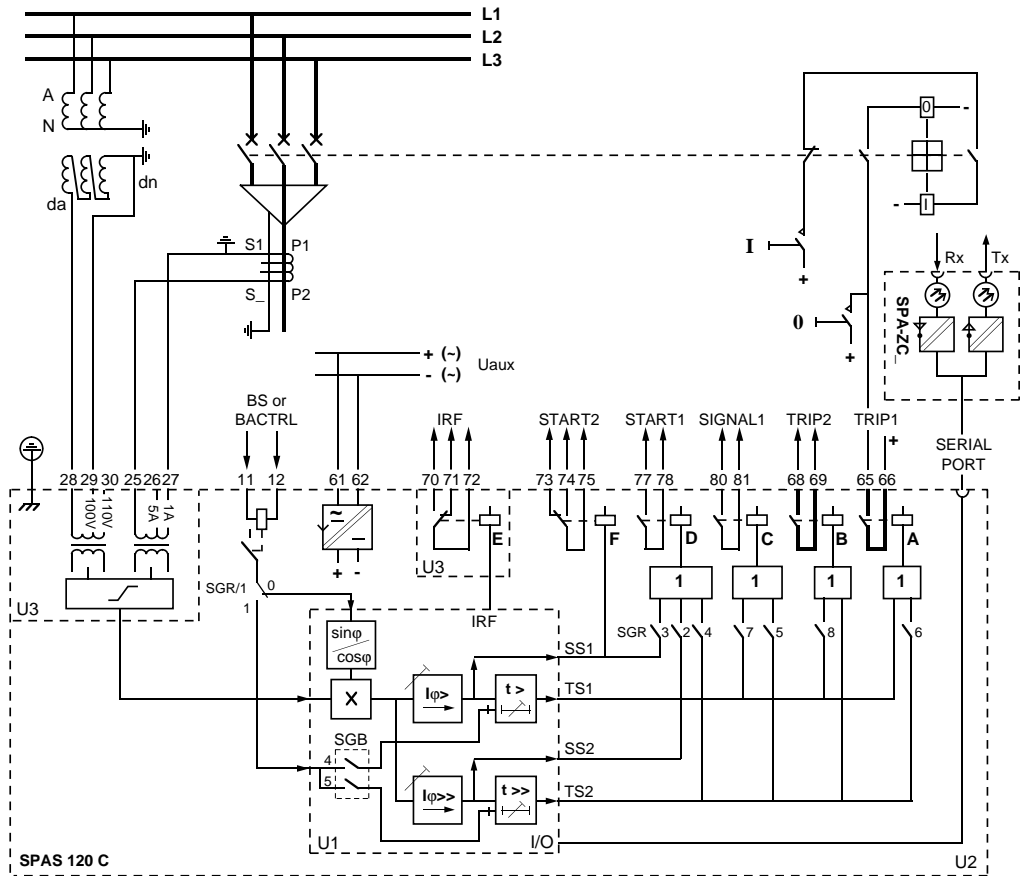


Fig. 1 Block diagram and sample connection diagram

**Mounting and dimensions**

**Flush mounting**

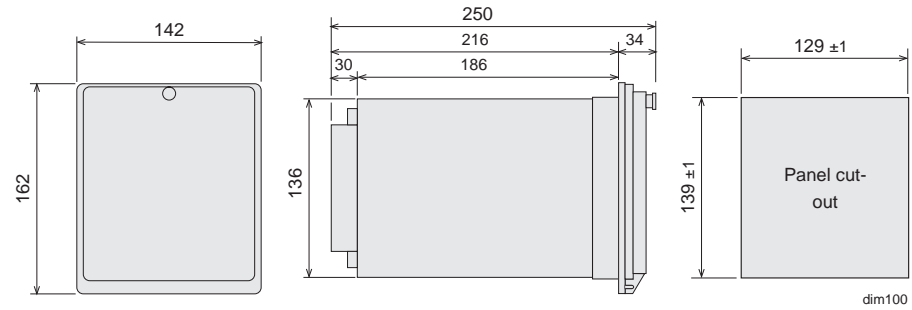


Fig. 2 Flush-mounting relay case (dimensions in mm)

**Semi-flush mounting**

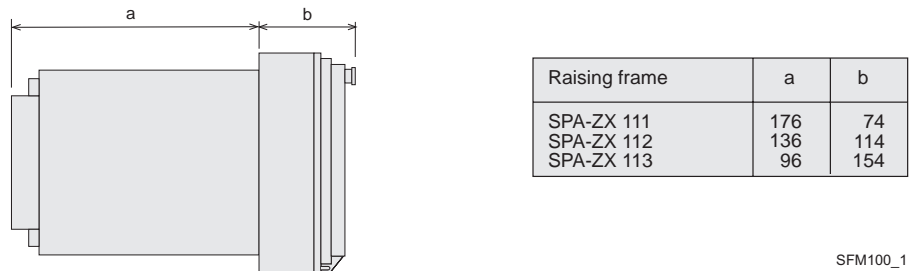


Fig. 3 Semi-flush mounting relay case (dimensions in mm)

**Mounting in 19 inch cabinets and frames**

An ancillary mounting plate, height 4U (~177 mm), is recommended to be used when the protection relays are to be mounted in 19 inch frames or cabinets. The ancillary mounting plate type SPA-ZX 104 accommodates three relays, type SPA-ZX 105 two relays and type SPA-ZX 106 one relay.

**Projecting mounting**

When projecting mounting is preferred, a relay case type SPA-ZX 110 is used. The relay case for projecting mounting is provided with front connectors.

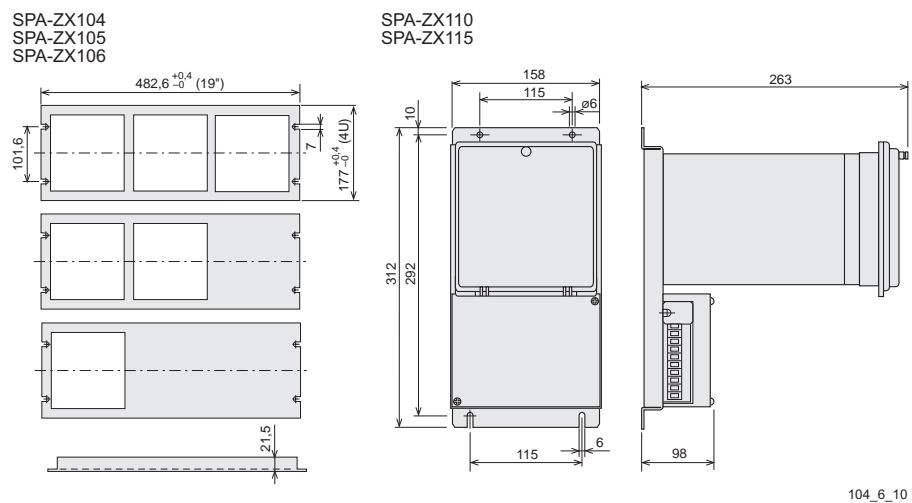


Fig. 4 Mounting cabinets and frames as well as projecting mounting (dimensions in mm)

**Ordering****When ordering, please specify:**

Ordering information	Ordering example
1. Type designation and quantity	SPAS 120 C, 5 pieces
2. Order number	RS 431 010-AA
3. Rated frequency	$I_n=5$ A, $U_n=110$ V, $f_n=50$ Hz
4. Auxiliary voltage	$U_{aux}=110$ V dc
5. Accessories	-
6. Special requirements	-

**Order numbers**

Directional earth-fault relay SPAS 120 C without test adapter	RS 431 010-AA, CA, DA, FA
Directional earth-fault relay SPAS 120 C including test adapter RTXP 18	RS 431 210-AA, CA, DA, FA
The last two letters of the order number indicate the rated frequency $f_n$ and the auxiliary voltage $U_{aux}$ of the relay as follows:	AA equals $f_n = 50$ Hz and $U_{aux} = 80\dots265$ V ac/dc
	CA equals $f_n = 50$ Hz and $U_{aux} = 18\dots80$ V dc
	DA equals $f_n = 60$ Hz and $U_{aux} = 80\dots265$ V ac/dc
	FA equals $f_n = 60$ Hz and $U_{aux} = 18\dots80$ V dc

**References****Additional information**

Brochure "Voltage and current measuring relays"	1MRS 750270-MDS EN
Manual "Directional earth-fault relay SPAS 120 C"	1MRS 750639-MUM EN



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