

Combined Overcurrent and Earth-fault Relay

SPAJ 144 C

Product Guide



Features

- Phase and neutral overcurrent protection relay for distribution feeders
- Three-phase overcurrent protection with three stages: I>, I>> and I>>>
- Non-directional earth-fault protection with sensitive low-set stage I0> and additional high-set stage I0>>
- Phase discontinuity protection for detection of the loss of one phase or severe phase unbalance
- Integrated circuit-breaker failure protection for enhanced system reliability
- Four standardized inverse definite minimum time (IDMT) time-current curve sets as per IEC and BS, plus two special inverse-time curve sets entitled RI and RXIDG
- Fault records, event records and diagnostic data can be read remotely via the serial port and locally
- High immunity to electrical interference and robust aluminum case to class IP54
- Improved system reliability supported by a built-in self-supervision system with auto-diagnosis
- Serial communication capability for extensive exchange of data between the protection relay and the substation control level
- Powerful optional PC tool for reading, setting and recording relay data and parameters
- CE marking according to the EC directive for EMC

Application

The combined phase and neutral overcurrent relay SPAJ 144 C is used for the selective short-circuit and time overcurrent protection of radial feeders in distribution networks. The relay is also used for feeder earth-fault protection in isolated neutral networks and networks with resistively earthed neutral. The overcurrent unit includes three protection stages and the earth-fault unit two. Further, the relay includes a phase discontinuity protection unit and an integrated circuit-breaker failure protection unit.

The phase and neutral overcurrent relay is provided with serial communication capabilities. Vital relay information is immediately available to the relay operator, locally or remotely. Therefore, the phase and neutral overcurrent relays can be used for any application, ranging from stand-alone relay applications to advanced applications comprising fully remote-controlled substations.

Design

The combined overcurrent and earth-fault relay SPAJ 144 C is a secondary relay that is connected to the current transformers of the object to be protected. The phase currents are measured with a set of normally three phase current transformers. The earth-fault current can be measured either via a set of three phase current transformers in a residual current connection or a core-balance current transformer. When a short circuit or earth-fault occurs, the relay delivers an alarm signal, trips the circuit breaker or starts an external auto-reclose relay, depending on the selected configuration and parameterization of the relay in the concerned application.

Overcurrent unit

When the phase current exceeds the set start value of the low-set stage $I_{>}$, the overcurrent unit starts. When, at definite time operation, the set operate time $t_{>}$ or, at inverse time operation, the calculated operate time $t_{>}$, expires, the relay operates. In the same way the high-set stage $I_{>>}$ starts once the set start value is exceeded and, when the set operate time $t_{>>}$ expires, the relay operates. The high-set stage $I_{>>>}$ operates in the same way as stage $I_{>>}$. Stage $I_{>>}$ and $I_{>>>}$ have definite time characteristic, but can also be given instantaneous operation.

Earth-fault unit

When the neutral current exceeds the set start value $I_{0>}$ of the low-set stage, the earth-fault unit starts. When, at definite time operation, the set operate time $t_{0>}$ or, at IDMT operation, the calculated operate time $t_{0>}$, expires, the relay operates. In the same way the high-set stage starts once the set start value $I_{0>>}$ is exceeded and, when the set operate time $t_{0>>}$ expires, the relay operates. Stage $I_{0>>}$ can also be given instantaneous operation.

The low-set stages of the overcurrent and earth-fault units can be given either definite-time or inverse-time characteristic. At inverse time characteristic four inverse time curve sets with different steepness are available, i.e. Normal inverse, Very inverse, Extremely inverse and Long-time inverse. These curve sets comply with the BS 142 and IEC 255 standards.

Phase discontinuity unit

When the phase current difference $\Delta I = (I_{\max} - I_{\min})/I_{\max} \times 100\%$ exceeds the set start value, the phase discontinuity unit starts.

When the set operate time t_{Δ} expires, the relay operates. The phase discontinuity unit operates with definite time characteristic.

Circuit-breaker failure protection

The circuit breaker failure protection (CBFP) generates a trip signal after the set operate time 0.1...1.0 s after the primary trip signal has been issued by the relay. The CBFP normally controls backup circuit-breaker upstreams in the power system.

The relay contains one optically isolated logic input for an external incoming control signal, e.g. a reset signal, a change of settings signal or a blocking signal.

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 the self-supervision system detects a permanent internal relay fault, 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 ver-

sions are available: type SPTU 240R1 for the supply voltage range 80...265 V ac/dc and type SPTU 48R1 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

Terminals		1-3, 4-6, 7-9, 25-27	1-2, 4-5, 7-8, 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: Output contact ratings

Type of contact		Tripping	Signalling
Terminals		65-66, 74-75	70-71-72, 68-69, 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

Table 3: Control input, communication and power supply

External control input	Terminals	10-11		
	Control voltage level	18...265 V dc or 80...265 V ac		
	Current drain at activated input	2...20 mA		
Data communication	Transmission mode	Fibre-optic serial bus		
	Data code	ASCII		
	Selectable data transfer rates	4800 or 9600 Bd		
	Bus connection module, powered from the host relay	for plastic core cables	SPA-ZC 21BB	
		for glass fibre cables	SPA-ZC 21MM	
	Bus connection module, powered from the host relay or from an external power source	for plastic core cables	SPA-ZC 17BB	
for glass fibre cables		SPA-ZC 17MM		
Auxiliary supply modules	Power supply and I/O modules, rated voltages and operative range	SPTU 240R1	110/120/230/240 V ac, 110/125/220 V dc, 80...265 V ac/dc	
		SPTU 48R1	24/48/60 V dc, 18...80 V dc	
	Power consumption	under quiescent conditions	~4 W	
		under operating conditions	~8 W	

Technical data (cont'd)

Table 4: Relay module SPCJ 4D28, overcurrent unit

Features		Stage I>	Stage I>>	Stage I>>>
Start current	at definite time	$0.5...5.0 \times I_n$	$0.5...40.0 \times I_n$ and ∞	$0.5...40.0 \times I_n$ and ∞
	at inverse time	$0.5...2.5 \times I_n$	–	–
Start time, typically		70 ms	40 ms	40 ms
Operate time at definite time characteristic		0.05...300 s	0.04...300 s	0.04...30 s
Time/current characteristic at inverse time mode		Extremely inverse Very inverse Normal inverse Long-time inverse RI type inverse RXIDG type inverse	–	–
Time multiplier k		0.05...1.0	–	–
Reset time, typically		40 ms	40 ms	40 ms
Retardation time		<30 ms		
Reset ratio, typically		0.96		
Operate time accuracy at definite time mode		$\pm 2\%$ of set value or ± 25 ms		
Accuracy class index E at inverse time mode		5	–	–
Operation accuracy		$\pm 3\%$ of set value	$\pm 3\%$ of set value	$\pm 3\%$ of set value

Table 5: Relay module SPCJ 4D28, earth-fault and phase discontinuity unit

Features		Stage I ₀ >	Stage I ₀ >>	Stage ΔI>
Start current		$0.1...0.8 \times I_n$	$0.1...10.0 \times I_n$ and ∞	10...100% and ∞
Start time, typically		70 ms	50 ms	150 ms
Operate time at definite time characteristic		0.05...300 s	0.05...300 s	1...300 s
Time/current characteristic at inverse time mode		Extremely inverse Very inverse Normal inverse Long-time inverse RI type inverse RXIDG type inverse	–	–
Time multiplier k		0.05...1.0	–	–
Reset time, typically		40 ms	40 ms	80 ms
Retardation time		<30 ms	<30 ms	–
Reset ratio, typically		0.96	0.96	0.90
Operate time accuracy at definite time mode		$\pm 2\%$ of set value or ± 25 ms		
Accuracy class index E at inverse time mode		5	–	–
Operation accuracy		$\pm 3\%$ of set value	$\pm 3\%$ of set value	± 1 unit $\pm 3\%$ of set value

Technical data (cont'd)

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 μ s, 0.5 J
	Insulation resistance (IEC 60255-5)	>100 M Ω , 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 61000-4-4), power supply inputs	4 kV, 5/50 ns
	Fast transients (IEC 60255-22-4, class III and IEC 61000-4-4), other inputs	2 kV, 5/50 ns
	Electrostatic discharge (IEC 60255-22-2 and IEC 61000-4-2), air discharge	8 kV
	Electrostatic discharge (IEC 60255-22-2 and IEC 61000-4-2), contact discharge	6 kV
Mechanical test	Vibration test (IEC 60255-21-1)	class 1
	Shock/bump test (IEC 60255-21-2)	class 1
Environmental conditions	Service temperature range	-10...+55°C
	Transport and storage temperature range (IEC 60068-2-8)	-40...+70°C
	Damp heat test (IEC 60068-2-30)	93...95%, +55°C, 6 cycles
	Degree of protection by enclosure when panel mounted	IP 54
	Weight	~3.5 kg

Block diagram

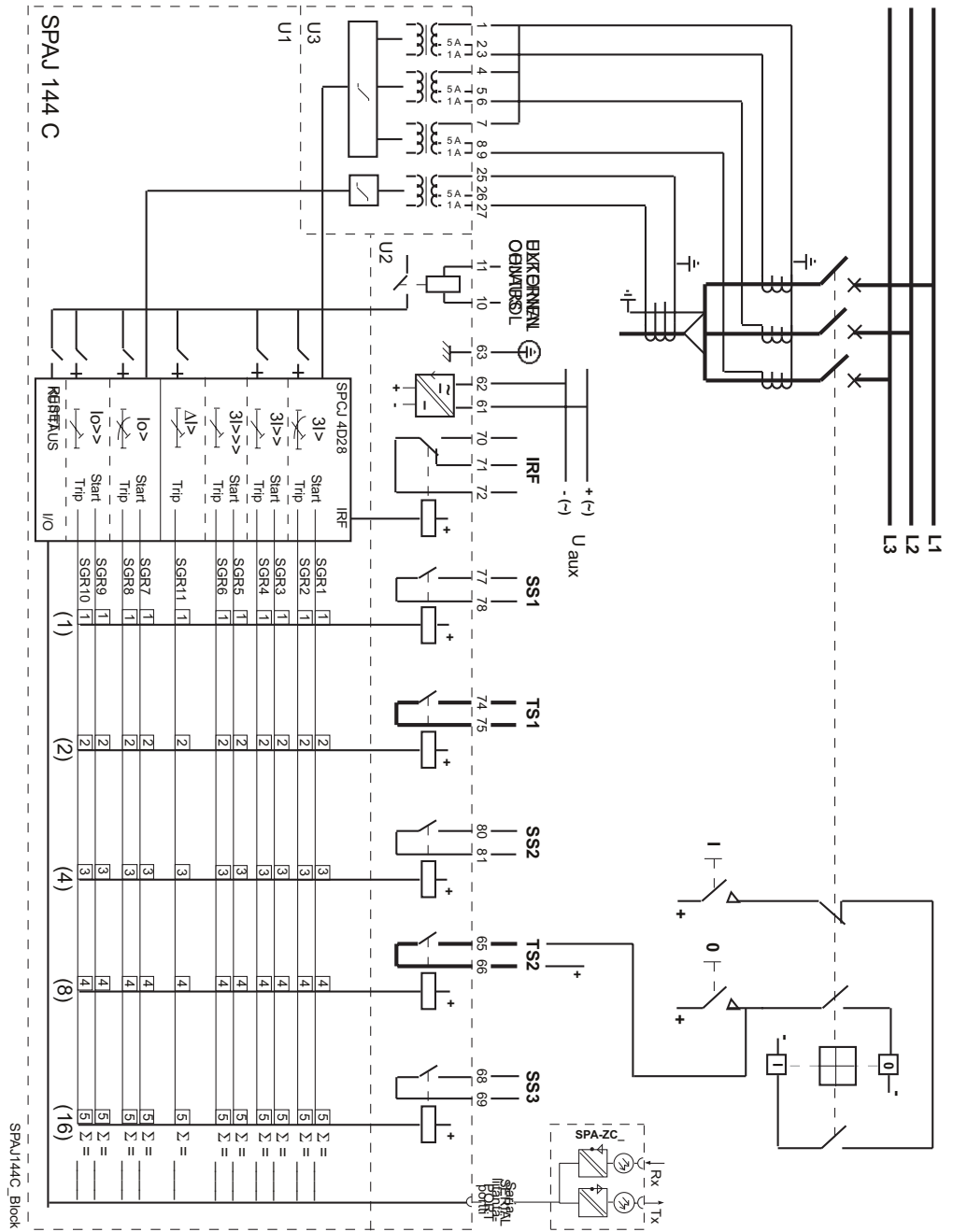


Fig. 1 Block diagram and sample connection diagram

SPAJ144C_block

Mounting and dimensions

Flush mounting

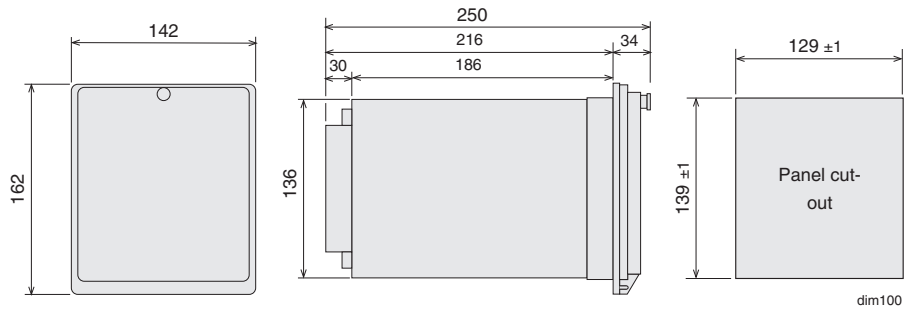


Fig. 2 Flush-mounting relay case (dimensions in mm)

Semi-flush mounting

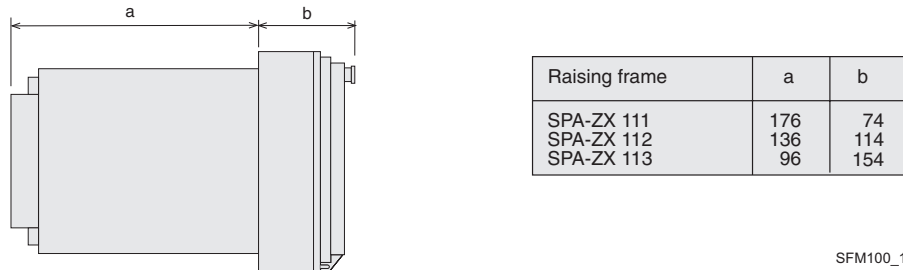


Fig. 3 Semi-flush mounting relay case (dimensions in mm)

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.

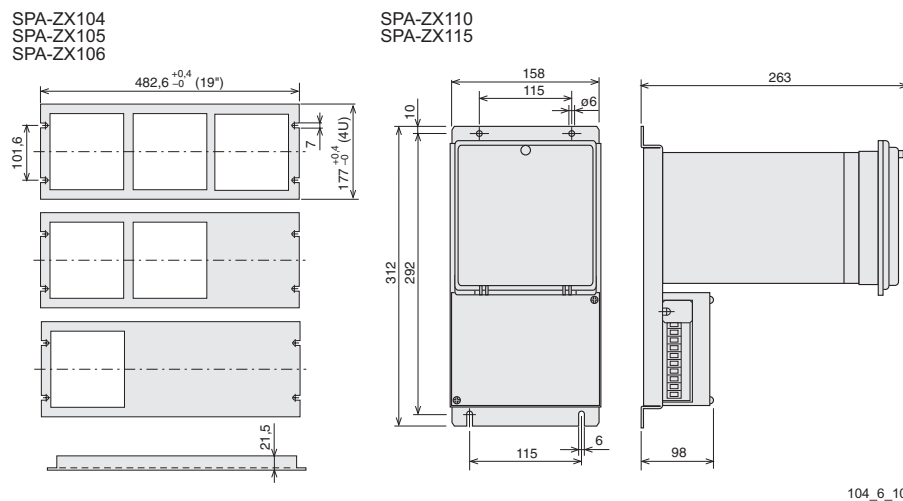


Fig. 4 Mounting cabinets and frames as well as projecting mounting (dimensions in mm)

Ordering

When ordering, please specify:

Ordering information	Ordering example
1. Type designation and quantity	SPAJ 144 C, 5 pieces
2. Order number	RS 611 040-AA
3. Rated values	$I_n=5\text{ A}$, $f_n=50\text{ Hz}$
4. Auxiliary voltage	$U_{aux} = 110\text{ V dc}$
5. Accessories	-
6. Special requirements	-

Order numbers

Combined overcurrent and earth-fault relay SPAJ 144 C without test adapter	RS 611 040-AA, CA, DA, FA
Combined overcurrent and earth-fault relay SPAJ 144 C including test adapter RXP 18	RS 611 240-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 $f_n = 50\text{ Hz}$ and $U_{aux} = 80\dots265\text{ V ac/dc}$
	CA equals $f_n = 50\text{ Hz}$ and $U_{aux} = 18\dots80\text{ V dc}$
	DA equals $f_n = 60\text{ Hz}$ and $U_{aux} = 80\dots265\text{ V ac/dc}$
	FA equals $f_n = 60\text{ Hz}$ and $U_{aux} = 18\dots80\text{ V dc}$

References

Additional information

Manual "Combined overcurrent and earth-fault relay SPAJ 144 C"	1MRS 750043-MUM EN
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