Capacitor protection relay

SPAJ 160 C

1MRS 750420-MBG

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Data subject to change without notice

Features

- One-, two- and three-phase overload stage with definite time characteristic
- One-, two- and three-phase overload stage with inverse (ANSI) time characteristic
- Phase unbalance protection stage with definite time characteristic
- Phase unbalance protection stage with inverse time characteristic
- Undercurrent protection for detection of capacitor disconnection. Reconnection time with wide setting range
- Compensation for natural unbalance current
- Fully user-selectable output relay configuration
- Easy selection of appropriate operational scheme for various applications
- Numerical display of setting values, measured current values, memorized values, etc.
- Continuous self-supervision of hardware and software
- Serial interface for connecting the relay to the fibre-optic SPA bus and further to higher-level data acquisition, reporting and/or control systems
- Powerful software support for parameterization of the relay, for reading measured and recorded values, events, etc., and for storing readings
- Member of the SPACOM product family and ABB's Substation Automation system
- CE marking according to the EC directive for EMC

Application

The numerical capacitor relay SPAJ 160 C is an integrated current measuring multi-function relay designed to be used for the protection of capacitor banks. Capacitor banks are used in the power system for compensating the reactive power and for filtering harmonics.

The capacitor banks are usually protected against overload caused by harmonic currents and overvoltage caused by internal faults in the bank. Protection against unintentional reconnection of a charged capacitor to an energized network is also to be included. All these functions are incorporated in the capacitor protection relay.

A complete protection system for capacitor banks should also include overcurrent, short circuit and earth-fault protection. The capacitor protection relay SPAJ 160 C is easily supplemented with adequate overcurrent and earth-fault relays from the SPACOM product range.

Design

The capacitor protection relay includes a three-phase, two-stage overload unit, a two-stage unbalance unit, an undercurrent unit and a reconnection inhibit timer.

The relay measures the phase currents of the capacitor bank. The relay also measures the unbalance current of a split capacitor bank. The current transformer output can be adapted to the rated current of the relay by means of a matching setting. Equally, the unbalance unit is provided with a compensation feature which allows the “natural” unbalance current of a capacitor bank to be eliminated from the calculations.

The phase currents measured by the relay are transformed to voltage images describing the voltages of the capacitor bank. Because harmonic components cause overloading of capacitor banks the relay measures harmonic components up to and including the 13th harmonic. The overload unit protects the capacitors against overvoltage. The first stage of the overload unit operates with inverse time operation characteristic, whereas the second overload protection stage has a definite time characteristic. The inverse time curve is based on ANSI/IEEE C37.99 and IEC 871-1 recommendations for voltage withstand related to time for capacitor banks. The slope of the curve is adjustable.

The unbalance unit is also provided with two operation stages. i.e. an inverse time stage according to BS 142 and a definite time stage. The former is normally used for tripping and the latter for signalling.

The purpose of the undercurrent protection unit is to detect disconnection of the capacitor bank and to prevent a charged capacitor bank from being switched to the network. The start value, the operate time and the reconnection inhibit time are adjustable.

The capacitor protection relay is provided with one external control input. The control input can be used for blocking one or more of the protection stages, for carrying out an external trip command, for inhibiting a reconnection attempt and/or for resetting a latched output relay in the manual reset mode of operation.

Data communication

The feeder protection relay is provided with a serial interface on the rear panel. By means of a bus connection module type SPA-ZC 21 or SPA-ZC 17 the feeder protection relay can be connected to the fibre-optic SPA bus. The bus connection module SPA-ZC 21 is powered from the host relay, whereas the bus connection module type 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 240R2 for the supply voltage range 80…265 V ac/dc and type SPTU 48R2 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

Phase current inputs		1-3, 4-6, 7-9	1-2, 4-5, 7-8
Unbalance current inputs		25-27	25-26
Rated current I_n		1 A	5 A
Thermal current withstand	continuously	4 A	20 A
	for 1 s	100 A	500 A
Dynamic current withstand	Half-wave value	250 A	1250 A
Input impedance		<100 mΩ	<20 mΩ
Phase current monitoring range		0…8.5 x I_n	
Phase unbalance current monitoring range		0…212% ΔI_n	
Rated frequency f_n		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 circuit time constant L/R ≤ 40 ms, at the control voltage levels	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		$AgCdO_2$	

Table 3: External control input

Blocking and control input	10-11
External control voltage level	18…265 V dc or 80…265 V ac
Typical control current of activated input circuit	2…20 mA

Table 4: Data communication

Transmission mode		Fibre-optic serial bus
Data code		ASCII
Transfer rates, selectable		4800 or 9600 Bd
Optional bus connection module, powered from an external power source	for plastic core cables	SPA-ZC17BB
	for glass fibre cables	SPA-ZC17MM
Optional bus connection module, powered from the host relay	for plastic core cables	SPA-ZC21BB
	for glass fibre cables	SPA-ZC21MM

Technical data (cont'd)

Table 5: Capacitor protection relay module SPCJ 4D40

Overload stage I_b>	Start current I_b>	0.30…1.50 × I_n
	Start time	<80 s
	Operation characteristic	ANSI inverse
	Time multiplier k	0.2…2.0
	Reset time	<100 ms
	Drop-off/pick-up ratio, typically	0.95
	Operate time accuracy	±3% of set value
	Operation accuracy	±3% of set value
Overload stage I_a>	Start current I_a>	80…120% of I_b>
	Operate time	0.5…100 s
	Reset time	<250 ms
	Drop-off/pick-up ratio, typically	0.95
	Operate time accuracy	±2% of set value
	Operation accuracy	±3% of set value
Undercurrent stage I<	Start current I<	0.10…0.70 × I_n
	Operate time	1.0…100 s
	Reconnection inhibit time t_{rec}	0.5…100 min
	Reset time	<80 ms
	Drop-off/pick-up ratio, typically	1.1
	Operate time accuracy	±2% of set value or ±75 ms
	Operation accuracy within the range of 0.25…0.70 × I_n	±3% of set value
Phase unbalance ΔI_1>	Start current ΔI_1>	1.0…100% of ΔI_n
	Operate time tΔ1	1.0…300 s
	Reset time	<100 ms
	Drop-off/pick-up ratio, typically	0.90
	Operate time accuracy	±2% of set value or ±75 ms
	Operation accuracy within the range of 1.5…100% I_n	±3% of set value
Phase unbalance ΔI_2>	Start current ΔI_2>	2.0…80.0% of ΔI_n
	Start time	<70 s
	Operation characteristic	Inverse time characteristic
	Time multiplier $k_{\Delta 2}$	0.1…1.0
	Reset time	<100 ms
	Drop-off/pick-up ratio, typically	0.90
	Operate time accuracy of theoretical characteristic	7.5% or ±35 ms
	Operation accuracy	±3% of set value
	Shortest possible operate time	~100 ms
Unbalance compensation	Compensation current ΔI_{cs}	0.0…20.0% of I_n
	Operation accuracy	<3% of I_n

Table 6: Auxiliary supply modules

Supply and output relay module SPTU 240R2	operative voltage range	80…265 V ac/dc
Supply and output relay module SPTU 48R2	operative voltage range	18…80 V dc
Power consumption, quiescent/operation conditions		~4 W/~6 W

Table 7: Tests and standards

Test voltages	Dielectric test voltage (IEC 255-5)	2.0 kV, 50 Hz, 1 min
	Impulse test voltage (IEC 255-5)	5 kV, 1.2/50 μs, 0.5 J
	Insulation resistance (IEC 255-5)	>100 MΩ, 500 V dc
Interference tests	High-frequency (1 MHz) disturbance test (IEC 255-22-1), common mode	2.5 kV
	High-frequency (1 MHz) disturbance test (IEC 255-22-1), differential mode	1.0 kV
	Fast transients (IEC 255-22-4, class III and IEC 801-4, level 4), power supply inputs	4 kV, 5/50 ns
	Fast transients (IEC 255-22-4, class III and IEC 801-4, level 4), other inputs	2 kV, 5/50 ns
	Electrostatic discharge (IEC 255-22-2 and IEC 801-2, class III), air discharge	8 kV
	Electrostatic discharge (IEC 255-22-2 and IEC 801-2, class III), contact discharge	6 kV
Environmental conditions	Service temperature range	-10…+55°C
	Transport and storage temperature range (IEC 68-2-8)	-40…+70°C
	Damp heat test (IEC 68-2-3)	<95%, +40°C, 56 d/a
	Degree of protection by enclosure when panel mounted	IP 54
	Weight	~3.5 kg

Block diagram

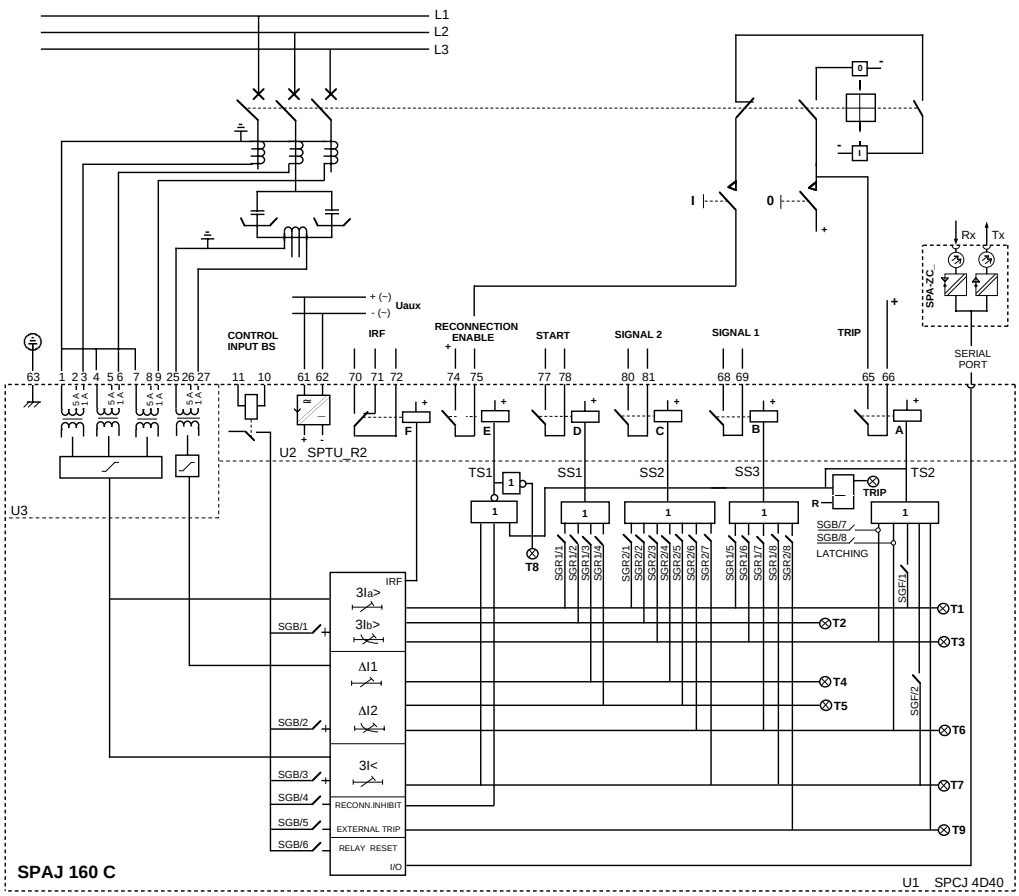


Fig. 1 Block diagram and sample connection diagram

Mounting and dimensions

Flush mounting

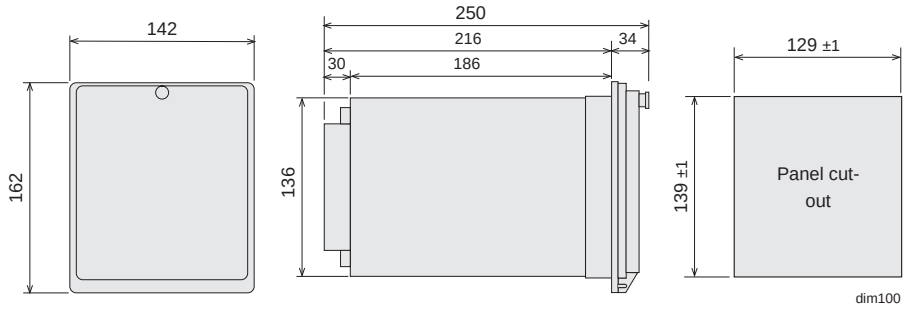
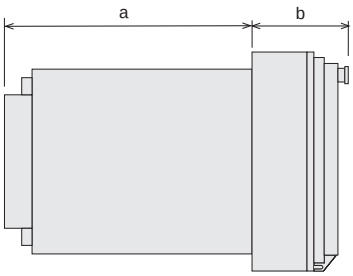


Fig. 2 Flush-mounting relay case (dimensions in mm)

Semi-flush mounting



Raising frame	a	b
SPA-ZX 111	176	74
SPA-ZX 112	136	114
SPA-ZX 113	96	154

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.

SPA-ZX104
SPA-ZX105
SPA-ZX106

SPA-ZX110
SPA-ZX115

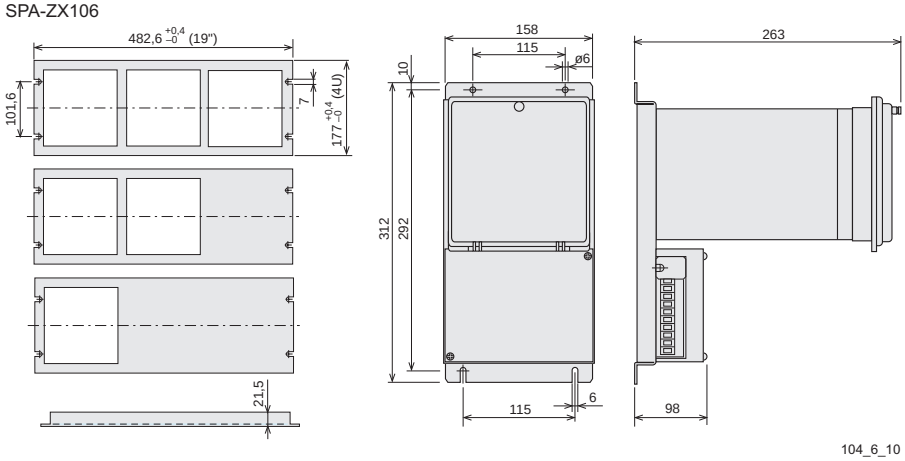


Fig. 4 Mounting cabinets and frames as well as projecting mounting (dimensions in mm)

Ordering

When ordering, please specify:

Ordering information	Ordering example
1. Type designation and quantity	SPAJ 160 C, 5 pieces
2. Order number	RS 611 051-AA
3. Rated values	I_n=5 A, f_n=50 Hz
4. Auxiliary voltage	U_{aux}=110 V dc
5. Accessories	-
6. Special requirements	-

Order numbers

Capacitor protection relay SPAJ 160 C without test adapter	RS 611 051-AA, CA, DA, FA
Capacitor protection relay SPAJ 160 C including test adapter RTXP 18	RS 611 251-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…265 V ac/dc
	CA equals f_n = 50 Hz and U_{aux} = 18…80 V dc
	DA equals f_n = 60 Hz and U_{aux} = 80…265 V ac/dc
	FA equals f_n = 60 Hz and U_{aux} = 18…80 V dc

References

Additional information

Brochure “Capacitor protection relay SPAJ 160 C”	1MRS 750246-MDS EN
Manual “Capacitor bank overload and unbalance protection relay SPAJ 160 C”	1MRS 750064-MUM EN

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