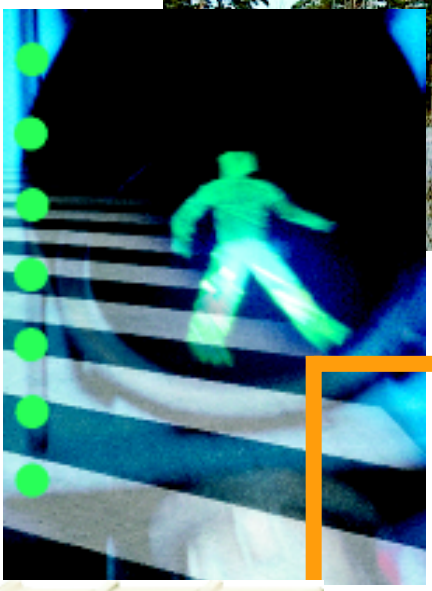
SPAD 346 C
Stabilized differential relay



Stabilized Differential Relay Type SPAD 346 C

Features

- Integrated three-phase differential relay, three-phase overcurrent relay and multi-configurable earth-fault relay
- Stabilized differential relay module providing winding short-circuit and interturn fault protection for two-winding power-transformers and generator-transformer units, and interwinding short-circuit protection for generators.
- Earth-fault relay module providing protection for the transformer HV and LV side according to the selected principle: stabilized differential current principle, high-impedance principle, residual current principle or neutral current principle
- Three-stage overcurrent module providing protection for power transformers and generators and two-stage back-up earth-fault protection
- Short operate time even at partial saturation of the current transformers
- Operation characteristic of differential relay module easily adapted for different applications
- Stabilized against unwanted operations at faults occurring outside the protected area and at transformer inrush
- Second harmonic restraint for prevention of unwanted relay operations at transformer inrush
- Fifth harmonic restraint for prevention of unwanted relay operations at transformer overexcitation - The fifth harmonic restraint can be aborted if the ratio of the fifth harmonic and the basic frequency component rises too high at dangerous overvoltages
- Wide CT ratio correction range - accurate correction through digital setting
- No interposing current transformers needed for the protection of two-winding power transformers - numerical vector group matching on HV and LV side
- Four heavy-duty output relays for circuit breaker tripping and five output relays for signalling
- Five programmable external control inputs intended for alarm and trip signals from gas relays, oil temperature sensors and other sensors of transformer auxiliary devices
- Integrated circuit breaker failure protection with adjustable operate time
- Differential relay and earth-fault relay modules provided with integrated disturbance recorder functions for analog and digital signals - signals to be used for triggering selectable
- Sensitive phase current and phase angle displays facilitate checking of energizing circuit connections and vector group matchings
- High immunity to electrical and electromagnetic interference allows the relay to be used in severe environments
- High availability and system reliability due to continuous supervision of hardware and software
- Powerful software supports relay parametrization and reading of measured, recorded and event data
- CE marking according to the EC directive for EMC.

Application

The stabilized differential relay SPAD 346 C is designed for protecting two-winding power transformers and generator-transformer units against winding short-circuit, interturn fault, earth fault and short circuit, and generators and motors against interwinding short-circuit and pole short circuit. In addition, the relay can be used for the protection of three-winding power transformers, provided 75% of the short circuit power to the power transformer is supplied from the same direction, and for the protection of compensating chokes and short cable lines.

No interposing transformers are needed for the protection of two-winding power transformers, as the relay allows the vector group matching, the elimination of the zero-sequence component of the phase currents and the CT ratio corrections to be carried out numerically.

Earth faults outside the protected area can cause differential currents if the star point of the power transformer to be protected is earthed on the HV side or the LV side. Normally, unwanted relay operations can be avoided by eliminating the zero-sequence components of the phase currents in the vector group matching. Should the LV side of a Y/D-connected transformer with earthed star point be earthed via a zig-zag connected earthing transformer, the zero-sequence components can be numerically eliminated in the relay.

At single-phase or two-phase earth faults within the protected area the sensitivity of the normal, phase current measuring differential protection will not be sufficient, in particular, if the star point of the transformer is earthed via a resistor. The earth-fault relay module provides coverage for these situations as well.

The combined overcurrent and earth-fault relay module provides phase overcurrent protection and back-up earth-fault protection for the protected object.

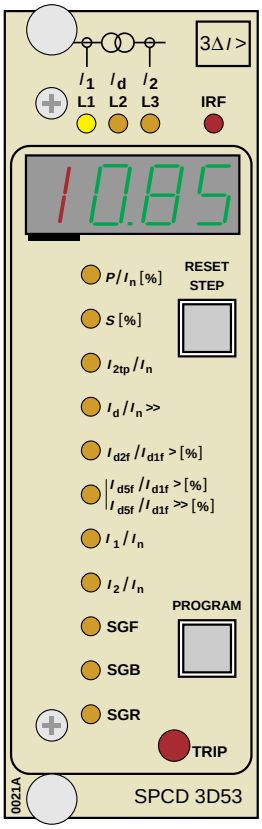
The current transformer connections and the vector group matching are easily checked by means of a low-voltage test and the sensitive phase current and phase angle displays of the relay. The test includes the current transformers on both the HV side and the LV side of the power transformer.

The disturbance recording functions integrated into the differential relay module and the earth-fault relay module can be started, for example, by an external control signal or the operate signals of the module. The disturbance record provides vital information about current magnitudes, curve forms and digital relay module signals, for instance, after a fault situation.

The differential relay is provided with push-buttons and displays for local man-machine communication and a serial interface for remote communication with higher-level systems. The relay is a member of the SPACOM substation equipment system, which is part of ABB's Distribution Automation system and ABB's Panorama concept.

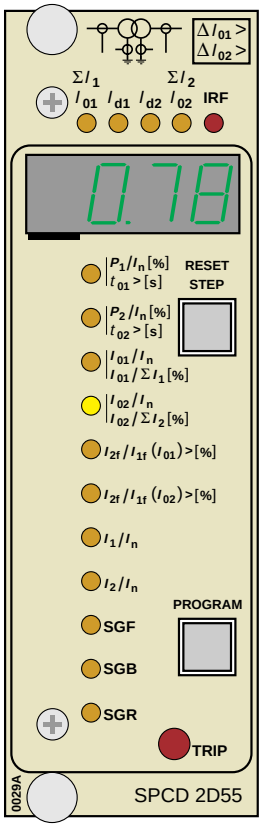
Relay module features

Differential relay module SPCD 3D53



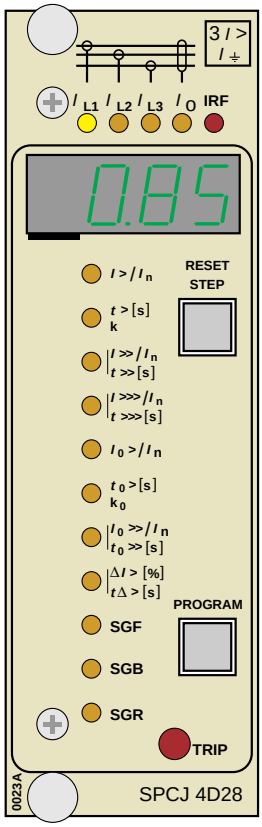
- Three-phase stabilized differential relay module for protecting two-winding power transformers and generator-transformers units against interwinding short circuit and interturn faults, and power-generators against winding short circuit and pole short circuit.
- The operation of the module is based on measuring the fundamental frequency component of the phase currents; the DC components and the harmonics of the phase currents are digitally filtered
- Numerical setting of the power transformer vector group
- The zero-sequence component of the phase currents can be separately eliminated from the phase currents
- Numerical setting of the correction of the CT ratio
- The operation characteristic of the stabilized differential current stage matchable to the requirements of the application
- Adjustable start current value of the instantaneous differential current stage
- Adjustable second and fifth harmonic restraint
- Software matrix for linking the trip, blocking and control signals to desired output relays
- Local and remote numerical presentation of phase current amplitudes and phase differences
- Integrated circuit-breaker failure protection with adjustable operate time
- Integrated disturbance recorder for phase currents and digital relay signals
- Local man-machine communication via push-buttons and display
- Continuous self-supervision of electronic circuits and program execution

Earth-fault relay module SPCD 2D55



- Provides winding earth-fault protection for two-winding power transformers
- Four earth-fault protection principles available: high-impedance, numerical stabilized differential current, residual overcurrent, or neutral overcurrent principle
- Basic setting and operate time to be separately adjusted for the HV side and the LV side
- Adjustable second harmonic restraint
- Software matrix for linking the start, trip, blocking and control signals to the desired output relays
- Integrated circuit-breaker failure protection with adjustable operate time
- Integrated disturbance recorder for phase currents, neutral currents and digital relay signals
- Local man-machine communication via push-buttons and display
- Continuous self-supervision of electronic circuits and program execution

Combined overcurrent and earth-fault relay module SPCJ 4D28



- Three three-phase overcurrent stages for protecting power transformers, generators and generator-transformer units against short circuit
- Low-set overcurrent stage with definite time or inverse time characteristic, high-set and superhigh-set overcurrent stage with definite time characteristic
- Two non-directional earth-fault stages for back-up protection of the power transformers and the generator-transformer unit
- Low-set earth-fault stage with definite time or inverse time characteristic, high-set stage with definite time characteristic
- Sensitive phase unbalance unit providing protection against phase discontinuity, single-phasing and generator unbalance
- Software matrix for linking the start and trip signals to the desired output relays
- Integrated circuit-breaker failure protection with adjustable operate time
- Local man-machine communication via push-buttons and display
- Continuous self-supervision of electronic circuits and program execution

Block and connection diagram

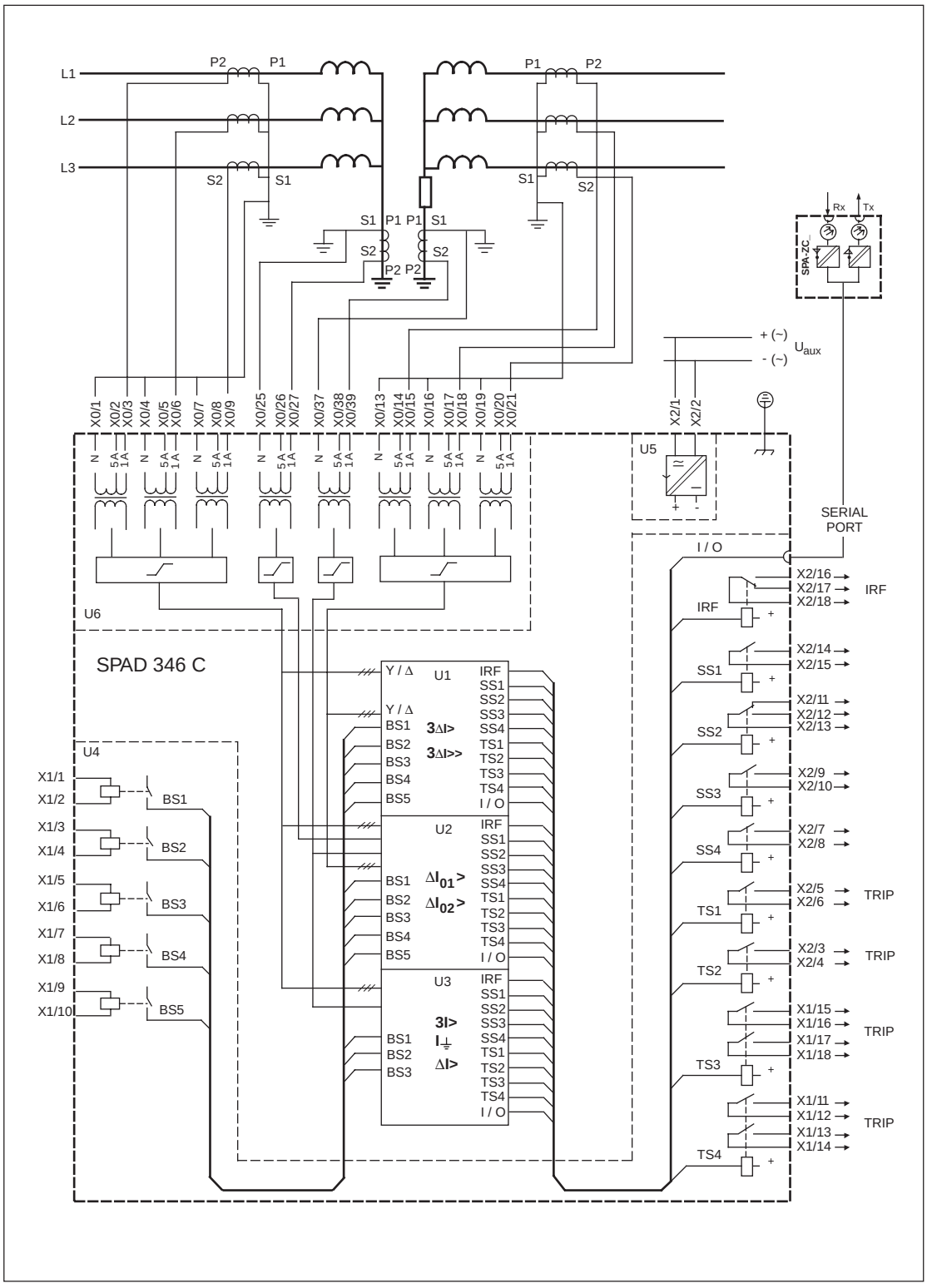


Fig. 1. Block and connection diagram for the stabilized differential relay SPAD 346 C

Technical data

Energizing inputs

Rated current I_n	1 A	5 A
Terminal numbers	X0/1-3, 4-6, 7-9	X0/1-2, 4-5, 7-8
	X0/13-15, 16-18	X0/13-14, 16-17
	X0/19-21, 25-27	X0/19-20, 25-26
	X037-39	X0/ 37-38
Thermal current withstand		
– continuously	4 A	20 A
– for 10 s	25 A	100 A
– for 1 s	100 A	500 A
Dynamic current withstand		
– half-wave value	250 A	1250 A
Input impedance	<100 mΩ	<20 mΩ
Rated frequency f_n acc. to order	50 Hz or 60 Hz	

Output relays

Trip relays	
Terminal numbers	X1/11-12-13-14 X1/15-16-17-18 X2/3-4, 5-6
Rated voltage	250 V ac/dc
Continuous current carrying capacity	5 A
Make and carry for 0.5 s	30 A
Make and carry for 3 s	15 A
Breaking capacity for dc when the control circuit time constant L/R ≤40 ms at the control voltage levels	
48/110/220 V dc	5 A/3 A/1 A
Contact material	$AgCdO_2$

Signal relays

Terminal numbers	X2/ 7-8, 9-10, 11-12-13 X2/14-15, 16-17-18
Rated voltage	250 V ac/dc
Continuous current carrying capacity	5 A
Make and carry for 0.5 s	10 A
Make and carry for 3 s	8 A
Breaking capacity for dc when the signal circuit time constant L/R ≤40 ms at the signalling voltage levels	
48/110/220 V dc	1 A/0.25 A/0.15 A
Contact material	$AgCdO_2$

Control inputs

Terminal numbers	X1/1-2, 3-4, 5-6, 7-8, 9-10
Control voltage	
– operative range	18...265 V dc or 80...265 V ac
Current drain of activated control input	2...20 mA
Active state of input	
– input active when	energized
– input active when	non-energized

Auxiliary power supply

Terminal numbers	X2/1-2
Supply module type SPGU 240A1:	
– rated voltages	U_n = 110/120/230/240 V ac U_n = 110/125/220 V dc
– operative range	U = 80...265 V ac/dc
Module type SPGU 48B2	
– rated voltages	U_n = 24/48/60 V ac
– operative range	U = 18...80 V dc
Power consumption under quiescent/operation conditions	12 W/18 W

Data communication

Transmission mode	Fibre-optic serial bus
Coding	ASCII
Data transfer rate, selectable	4800 Bd or 9600 Bd
Electrical/optical bus connection module powered from the host relay	
– for plastic core cables	SPA-ZC 21BB
– for glass fibre cables	SPA-ZC 21 MM
Electrical/optical bus connection module powered from the host relay and/or an externalpower source	
– for plastic core cables	SPA-ZC 17BB
– for glass fibre cables	SPA-ZC 17 MM

Software support

Substation monitoring program	SMS 010
Evaluation program for disturbance records	DR-COM

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

Disturbance tests

High-frequency disturbance test (IEC 255-22-1, class III)	
– common mode	2.5 kV, 1 MHz,
– differential mode	1.0 kV, 1 MHz,
Electrostatic discharge (IEC 255-22-2 and IEC 801-2, class III)	
– air discharge	8 kV
– contact discharge	6 kV
Fast transients (IEC 255-22-4, class III) and IEC 801-4, level IV	
– power supply inputs	4 kV
– other inputs	2 kV

Environmental conditions

Service temperature range	-10...+55°C
Transport and storage temperature range (IEC 68-2-8)	-40...+70°C
Temperature influence	0.1%/°C
Relative humidity (IEC 68-2-30)	93…95%, +55°C, 6 cycles
Degree of protection by enclosure of flush mounting relay case (IEC 529)	IP 54
Weight of fully equipped relay	6 kg

RELAY MODULE DATA

Stabilized differential relay module SPCD 3D53

Selectable rated frequency f_n	16 2/3...60 Hz
CT ratio correction range on power transformer HV side I_1/I_n	0.40...1.50
CT ratio correction range on power transformer LV side I_2/I_n	0.40...1.50
Stabilized differential current stage 3ΔI>	
Basic start ratio P/I_n	5...50%
Starting ratio setting S	10...50%
Second turning point I_{2tp}/I_n of characteristic curve	1.0...3.0
Harmonics blocking ratio I_{d2f}/I_{d1f}>	7...20%
Harmonics blocking ratio I_{d5f}/I_{d1f}>	10...50%
Harmonics deblocking ratio I_{d5f}/I_{d1f}>>	10...50%
Operate time (including heavy duty output relays)	
– at currents 1.5…4 x operate value	<50 ms
– at currents above 4 x operate value	<45 ms
Operation accuracy	±4% of set value or ±2% x I_n
Instantaneous differential current stage 3ΔI>>	
Start ratio I_d/I_n>>	5...30
Operate time (including heavy-duty output relays)	
– at ratios in the range 1.1...2.6 x I_d/I_n>>	<35 mm
– at ratios above 2.6 x I_d/I_n>>	<30 ms
Operation accuracy	±4% of set value of 2% x I_n
Circuit breaker failure protection	
Operate time	0.1...1.0 s
Integrated disturbance recorder	
Recording length	38 cycles
Recording memory capacity	1 recording = 38 cycles
Sampling frequency	40 samples/cycle
Signals to be recorded	6 analog signals 11 digital signals
Triggering	
– when the selected digital signal	is activated
– when the selected digital signal	resets
Length of recording preceding triggering	0...38 cycles

Earth-fault relay module SPCD 2D55

Selectable rated frequency f_n	16 2/3...60 Hz

Stabilized differential relay principle

Basic start ratio on HV side P_1/I_n	5...50%
Operate time on HV side $t_{01}>$	0.03...100 s
Basic start ratio on LV side P_2/I_n	5...50%
Operate time setting on LV side $t_{02}>$	0.03...100 s
Correction range of HV side neutral connection CT ratio I_{01}/I_n	0.40...1.50
Setting of minimum ratio of HV side neutral current and residual current of phase currents $I_{01}/\Sigma I_1$	0...20%
Correction range of LV side neutral connection CT ratio I_{02}/I_n	0.40...1.50
Setting of minimum ratio of LV side neutral current and residual current of phase currents $I_{02}/\Sigma I_2$	0...20%
Second harmonics restraint ratio I_{2f}/I_{1f} of HV side neutral current I_{01}	10...50%
Second harmonics restraint ratio I_{2f}/I_{1f} of LV side neutral current I_{02}	10...50%
Correction range of HV side phase CT ratio I_1/I_n	0.40...1.50
Correction range of LV side phase CT ratio I_2/I_n	0.40...1.50
Operate time at minimum delay (including heavy-duty output relays)	30...40 ms
Operation accuracy	±4% of set value or ±2% x I_n

Principle based on calculated residual current

Basic start ratio P_1/I_n on HV side	5...50%
Operate time $t_{01}>$ on HV side	0.03...100 s
Basic start ratio P_2/I_n on LV side	5...50%
Operate time $t_{02}>$ on LV side	0.03...100 s
Correction range of HV side phase CT ratio I_1/I_n	0.40...1.50
Correction range of LV side phase CT ratio I_2/I_n	0.40...1.50
Operate time at minimum delay (including heavy-duty output relays)	30...40 ms
Operation accuracy	±4% of set value or ±2% x I_n

Principle based on measured residual current or neutral current

Basic start ratio P_1/I_n on HV side	5...50%
Operate time $t_{01}>$ on HV side	0.03...100 s
Basic start ratio P_2/I_n on LV side	5...50%
Operate time $t_{02}>$ on LV side	0.03...100 s
Correction range of HV side neutral connection CT ratio I_{01}/I_n	0.40...1.50
Correction range of LV side neutral connection CT ratio I_{02}/I_n	0.40...1.50
Second harmonics restraint ratio I_{2f}/I_{1f} of HV side neutral current I_{01}	10...50%
Second harmonics restraint ratio I_{2f}/I_{1f} of LV side neutral current I_{02}	10...50%
Operate time at minimum delay (including heavy-duty output relays)	30...40 ms
Operation accuracy	±4% of set value or ±2% x I_n

Restricted earth-fault principle (high-impedance type earth-fault protection)

Basic start ratio P_1/I_n on HV side	5...50%
Operate time $t_{01}>$ on HV side	0.03...100 s
Basic start ratio P_2/I_n on LV side	5...50%
Operate time $t_{02}>$ setting on LV side	0.03...100 s
Correction range of HV side neutral connection CT ratio I_{01}/I_n	0.40...1.50
Correction range of LV side neutral connection CT ratio I_{02}/I_n	0.40...1.50
Operate time at minimum delay (including heavy-duty output relays)	30...40 ms
Operation accuracy	±4% of set value or ±2% x I_n

Circuit-breaker failure protection

Operate time	0.1...1.0 s

Integrated disturbance recorder

Recording length	30 cycles
Recording memory capacity	1 recording = 30 cycles
Sampling frequency	40 samples/cycle
Signals to be recorded	8 analog signals 12 digital signals
Triggering	
– when the selected digital signal	is activated
- when the selected digital signal	resets
Length of recording preceding triggering	0...30 cycles

Overcurrent and earth-fault relay module SPCJ 4D28

Low-set overcurrent stage I>

Start current I>	
– definite time characteristic	0.5...5.0 x I_n
– inverse time characteristic	0.5…2.5 x I_n *
Start time, typ.	70 ms
Operation characteristic	
– definite time characteristic	
– operate time	0.05...300 s
– inverse time characteristic	
acc. to BS 142 and IEC 255-4	Extremely inverse
	Very inverse
	Normal inverse
	Long-time inverse
– special characteristic acc.	
to ABB practice	RI-type inverse
	RXIDG-type inverse
– time multiplier k	0.05...1.00
Reset time, typ.	40 ms
Retardation time	<30 ms
Drop-off/pick-up ratio, typ.	0.96
Operate time accuracy at definite time operation characteristic	±2% of set time or ±25 ms
Operate time accuracy class E at inverse time characteristic	5
Operation accuracy	±3% of set current

High-set overcurrent stage I>>

Start current I>>	0.5...40.0 x I_n or ∞, infinite
Start time, typ.	40 ms
Operate time	0.04...300 s
Reset time, typ.	40 ms
Retardation time	<30 ms
Drop-off/pick-up ratio, typ.	0.96
Operate time accuracy	±2% of set time or ±25 ms
Operation accuracy	±3% of set current

Superhigh-set overcurrent stage I>>>

Start current I>>>	0.5...40.0 x I_n or ∞, infinite
Start time, typ.	40 ms
Operate time	0.04...30 s
Reset time, typ.	40 ms
Retardation time	<30 ms
Drop-off/pick-up ratio, typ.	0.96
Operate time accuracy	±2% of set time or ±25 ms
Operation accuracy	±3% of set current

Low-set residual earth-fault stage I_0>

Start current I_0>	0.1…0.8 x I_n
Start time, typ.	70 ms
Operation characteristic	
– definite time characteristic	
– operate time	0.05...300 s
– inverse time characteristic	
acc. to BS 142 and IEC 255-4	Extremely inverse
	Very inverse
	Normal inverse
	Long-time inverse
– special characteristic acc.	
to ABB practice	RI-type inverse
	RXIDG-type inverse
– time multiplier k_0	0.05...1.00
Reset time, typ.	40 ms
Retardation time	<30 ms
Drop-off/pick-up ratio, typ.	0.96
Operate time accuracy at definite time operation characteristic	±2% of set time or ±25 ms
Operate time accuracy class E at inverse time characteristic	5
Operation accuracy	±3% of set current

High-set residual earth-fault stage I_0>>

Start current I_0>>	0.1...10.0 x I_n or ∞, infinite
Start time, typ.	50 ms
Operate time	0.05...300 s
Reset time, typ.	40 ms
Drop-off/pick-up ratio, typ.	0.96
Operate time accuracy	±2% of set time or ±25 ms
Operation accuracy	±3% of set current

Phase discontinuity protection stage ΔI>

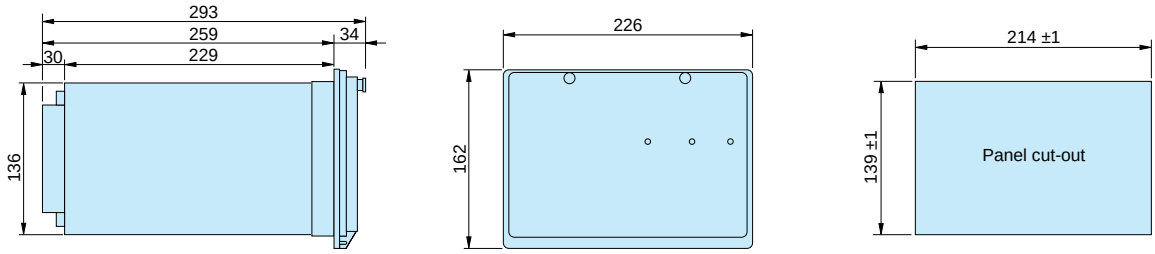
Start current ΔI>	10...100% x I_n or ∞, infinite
Start time, typ.	150 ms
Operate time	1...300 s
Reset time, typ.	80 ms
Drop-off/pick-up ratio, typ.	0.90
Operate time accuracy	±2% of set value or ±25 ms
Operation accuracy	±1 unit ±3% of set current

* At inverse time characteristic the effective setting range is 0.5…2.5 x I_n, although setting values greater than 2.5 x I_n can be set on the relay.

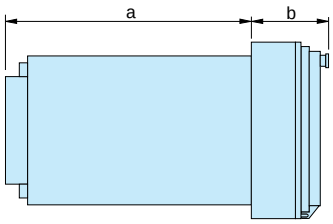
Mounting and Dimensions

Flush mounting relay case

(dimensions in millimetres)



Semi-flush mounting



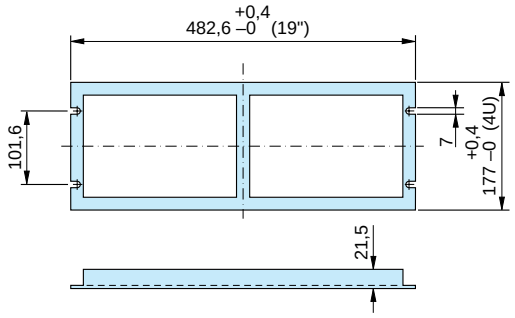
Raising frame	a	b
SPA-ZX 301	219	74
SPA-ZX 302	179	114
SPA-ZX 303	139	154

Mounting in 19 inch cabinets and frames

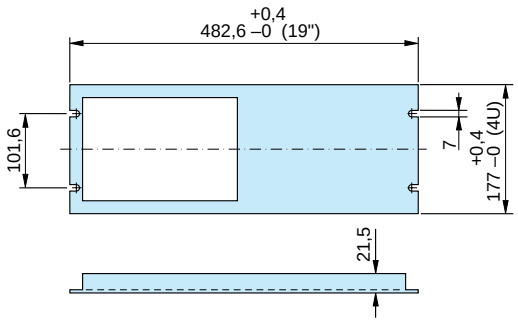
An ancillary mounting plate, height 4U (~177 mm), is recommended to be used when the protection relays are to be mounted in 19 inch frames or cabinets. The ancillary mounting plate type SPA-ZX 304 accommodates two size 300 relays and type SPA-ZX 305 one size 300 relay.

Projecting mounting

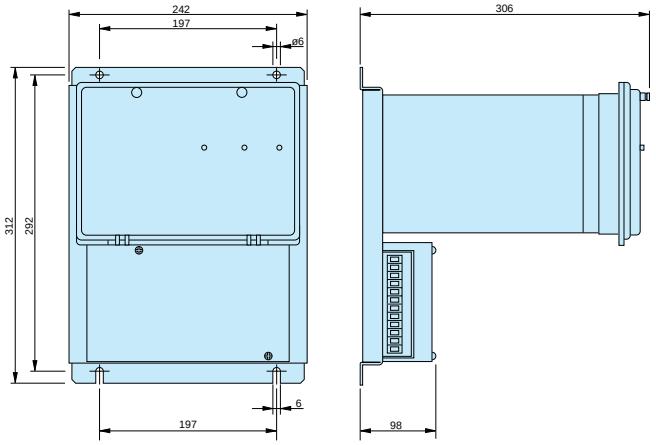
When projecting mounting is preferred a relay case type SPA-ZX 318 is used. The relay case for projecting mounting is provided with front connectors.



SPA-ZX 304



SPA-ZX 305



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