SPAA 341 C
Feeder protection relay
Feeder Protection Relay
Type SPAA 341 C

General Features

- Comprehensive numerical feeder protection relay consisting of two multi-function protection relay modules and a flexible auto-reclose relay module
- Overall scheme comprising time overcurrent protection, short-circuit protection, phase discontinuity protection, non-directional and directional earth-fault protection, general earth-fault supervision, auto-reclose facilities, circuit-breaker failure protection and circuit-breaker condition monitoring
- 1 A and 5 A tappings on the energizing current inputs of the overcurrent and non-directional earth-fault protection and 0.2 A and 1 A tappings on the energizing inputs of the directional earth-fault protection
- Selectable rated energizing input voltages of the directional earth-fault protection: 100 V, 110 V or 120 V
- Four heavy-duty relays for CB tripping and five weak current relays for signalling purposes
- Double-pole or single-pole circuit-breaker control
- Five configurable control inputs for the external control of the protection stages and the auto-reclose module
- Remote control of circuit-breaker via auto-reclose module
- Local man-machine communication via push-buttons and a digital display on the front panels of the protection relay modules
- Serial interface for connecting the relay to higher-level data acquisition systems, local or remote control systems or other host systems
- Local fault indication by means of LED indicators with memory functions and the digital display
- High immunity to electrical and electromagnetic interference
- Continuous self-supervision of relay hardware and software for enhanced system reliability and availability
- Auto-diagnostic fault indication to facilitate fault location and repair after detection of an internal relay fault
- Powerful software support for parametrization of the relay, for reading measured and recorded values, events, etc., and for storing readings
- CE marking according to the EC directive for EMC
- Member of the SPACOM product family and PYRAMID®, ABB’s coordinated protection and control concept.
Application
The feeder protection relay SPAA 341 C is designed to be used for the protection of radial isolated neutral networks or networks earthed via a resistor or via an arc suppression coil with or without a parallel resistor. The feeder protection relay features time overcurrent protection, short-circuit protection and phase discontinuity protection. Further, a wide choice of earth-fault protection functions is available, including directional and non-directional earth-fault and residual over-voltage. The feeder protection relay also includes a flexible multi-shot auto-reclose module for three-phase auto-reclosing of circuit breakers.

The system reliability and availability is enhanced by a built-in circuit breaker failure protection function, a circuit-breaker condition monitor and a sophisticated hardware and software self-supervision system.

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

Mechanical design
The feeder protection relay is housed in a rigid size 300 aluminium case to IP54. The basic case design is intended for flush mounting. The case dimensions and the mounting accessories are shown on the back page. The colour of the mounting case is beige. All input and output terminals including the serial communication port are located on the rear panel.

When the mounting depth is limited the flush mounting relay case can be provided with a 40 mm, 80 mm or 120 mm raising frame which reduces the depth behind the panel correspondingly. These semi-flush mounted relay cases are also rear connected. The feeder protection relay is also available in a relay case for projecting mounting. Then all input and output terminals are located on the front side of the relay case. For dimensional drawings see page 11.

The fully equipped feeder protection relay comprises of five modules: a connection module, an I/O module, a combined overcurrent and earth-fault relay module, a directional earth-fault relay module and an auto-reclose relay module. The relay modules are multi-functional microprocessor-based plug-in units. The feeder protection relay is available in several versions, ranging from the fully equipped feeder protection relay to versions omitting one or two modules. The relay modules are provided with local man-machine communication interfaces.
Module Characteristics

Combined Overcurrent and Earth-fault Relay Module SPCJ 4D28

- Three-phase low-set overcurrent stage with definite time or inverse time characteristic for time overcurrent protection
- Three-phase high-set overcurrent stage and three-phase superhigh-set stage with instantaneous function or definite time characteristic for short-circuit protection
- Non-directional low-set residual overcurrent stage with definite time or inverse time characteristic for earth-fault protection
- Non-directional high-set residual overcurrent stage with definite time characteristic for earth-fault protection
- Sensitive phase unbalance stage for detection of phase discontinuity
- Integrated circuit-breaker failure protection for enhanced substation operational reliability
- Local man-machine communication interface

Directional and Non-directional Earth-fault Relay Module SPCS 2D26

- Directional or non-directional low-set residual overcurrent stage with definite time characteristic for directional earth-fault protection
- Directional or non-directional high-set residual overcurrent stage with definite time characteristic for earth-fault protection
- Sensitive three-stage residual overvoltage protection with definite time characteristic for general earth-fault supervision
- Integrated circuit-breaker failure protection for enhanced substation operational reliability
- Four selectable basic angles for the direction measuring circuit
- Local man-machine communication interface
Auto-reclose Module SPCT 5D54

- Five programmable auto-reclose shots
- Three internal auto-reclose initiation signal lines from the overcurrent and earth-fault stages
- One external auto-reclose initiation signal line
- Auto-reclose functions initiated either by the start signal or the trip signal of a relay module
- In the former case the auto-reclose module provides the trip signal after a programmable time delay
- Counters recording the number of shots initiated via separate AR lines
- Circuit-breaker condition monitor indicating when CB maintenance is needed
- Local man-machine communication interface
Fig. 1. Simplified block diagram and connection diagram for the feeder protection relay SPAA 341 C
Auto-reclosure

The shot pointer indicates the shot to start when the auto-reclose module receives its AR initiation signal through one of the initiation lines AR1...AR4. The boxes beneath the initiation lines AR1...AR4 determine the action to be taken when an auto-reclose initiation signal is received. Start means that an auto-reclose shot is initiated, block means that the auto-reclose shot is prevented from starting and a dash means that no action will be taken. The programmable start delay associated with the boxes in the shaded area in Fig. 2 is activated, if the auto-reclose shot is initiated by the start signal of a protection stage. After the start delay the circuit breaker is opened by the auto-reclose module. When the dead time has elapsed, the circuit breaker is closed and the discrimination time starts running, if employed. A new initiation signal received during the discrimination time will inhibit the whole AR sequence. An auto-reclose request during the reclaim time will move the shot pointer and check whether a function has been selected or not. If not, the shot pointer moves down to the bottom horizontal line and a definite tripping will occur. At this point the AR module is blocked during the reclaim time, after which the shot pointer is reset and the module is prepared for a new AR sequence.

Serial Communication

The feeder protection relay is equipped with a serial communication port on the rear panel. The serial port is used for connecting the relay to the SPA bus via an optional bus connection module. Two bus connection module types are available: SPA-ZC17 and SPA-ZC21. The first one can be powered from the host relay and from a separate power source at the same time, while the other type is powered from the host relay via the D type connector.

Output Relays and CB Control

The feeder protection relay is provided with nine output auxiliary relays, four of which are heavy-duty output relays for the direct control of the circuit breaker. Single-pole or double-pole circuit breaker control can be used. One of the five signalling relays is permanently allocated for the self-supervision system. The functions of the other four can be defined by the user.

Auxiliary Power Supply

The auxiliary supply of the feeder protection relay is obtained via an internal plug-in type power module. Two auxiliary power module types are available: type SPGU 240A1 for ac or dc supply within the operative voltage range 80...265 V and type SPGU 48B2 for dc supply within the operative voltage range 18...80 V. The power module forms the internal voltages required by the protection relay modules and the I/O module. The operation of the power module is continuously supervised.
Technical Data

Energizing inputs

<table>
<thead>
<tr>
<th>Current inputs</th>
<th>Rated current $I_n$</th>
<th>0.2 A</th>
<th>1 A</th>
<th>5 A</th>
</tr>
</thead>
</table>

Terminal numbers

<table>
<thead>
<tr>
<th>X0/1-3</th>
<th>X0/1-2</th>
<th>X0/4-6</th>
<th>X0/4-5</th>
<th>X0/7-9</th>
<th>X0/7-8</th>
<th>X0/37-39</th>
<th>X0/37-38</th>
<th>X0/25-27</th>
<th>X0/25-26</th>
</tr>
</thead>
</table>

Thermal current withstand

- continuously 1.5 A
- for 10 s 5 A
- for 1 s 20 A

Dynamic current withstand

- half-wave value 50 A
- for 10 s 250 A
- for 1 s 100 A

Input impedance

$<750 \text{ m}\Omega$, $<100 \text{ m}\Omega$, $<20 \text{ m}\Omega$

Voltage inputs

<table>
<thead>
<tr>
<th>Rated voltage $U_n$</th>
<th>100 V, 110 V or 120 V</th>
</tr>
</thead>
</table>

Continuous voltage withstand

200 V

Rated burden of voltage input at $U_n$

$<0.5 \text{ VA}$

Rated frequency $f_n$, acc. to order

50 Hz or 60 Hz

Output contacts

Trip contacts

<table>
<thead>
<tr>
<th>Terminal numbers</th>
<th>X1/15-16, 11-12-13-14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage</td>
<td>250 V ac/dc</td>
</tr>
</tbody>
</table>

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 $L/R \leq 540 \text{ ms}$ at the control voltage levels

- 48 V dc
- 110 V dc
- 220 V dc

Contact material

AgCdO$_2$

Signalling contacts

<table>
<thead>
<tr>
<th>Terminal numbers</th>
<th>X2/5-6, 7-8, 9-10-11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage</td>
<td>250 V ac/dc</td>
</tr>
</tbody>
</table>

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 control circuit time constant $L/R \leq 540 \text{ ms}$ at the control voltage levels

- 48 V dc
- 110 V dc
- 220 V dc

Contact material

AgCdO$_2$

External control inputs

Blocking inputs

<table>
<thead>
<tr>
<th>terminal numbers</th>
<th>X1/1-2, 3-4</th>
</tr>
</thead>
</table>

CB position message input

<table>
<thead>
<tr>
<th>terminal numbers</th>
<th>X1/5-6</th>
</tr>
</thead>
</table>

Auto-reclose feedback inputs

<table>
<thead>
<tr>
<th>terminal numbers</th>
<th>X1/7-8, 9-10</th>
</tr>
</thead>
</table>

Control voltage

Operative voltage range

180...250 V dc or 800...250 V ac

Current drain of activated control input

2...20 mA

Auxiliary power supply

<table>
<thead>
<tr>
<th>Terminal numbers</th>
<th>X0/61-62</th>
</tr>
</thead>
</table>

Power module type SPGU 240A1

- rated voltages
  - $U_n = 110/120/230/240 \text{ V ac}$
  - $U_n = 110/125/220 \text{ V dc}$
  - operative voltage range
  - 80...265 V ac/dc

Power module type SPGU 48B2

- rated voltages
  - $U_n = 24/48/60 \text{ V dc}$
  - operative voltage range
  - 18...80 V dc

Power consumption, relay under quiescent/operation conditions

- 10 W, 15 W

Data communication

Transmission mode

Fibre-optic serial bus

Coding

ASCII

Data transfer rate, selectable

4800 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 21MM

Electrical/optical 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

Test voltages

Dielectric test voltage according to IEC 255-5

- 2.0 kV, 50 Hz, 1 min

Impulse test voltage according to IEC 255-5

- 5 kV, 1.2/50 µs, 0.5 J

Insulation resistance according to IEC 255-5

- >100 MΩ, 500 V dc

Disturbance tests

High-frequency (1 MHz) disturbance test according to IEC 255-22-1, class III

- common mode
  - 2.5 kV
- differential mode
  - 1.0 kV

Fast transients according to IEC 255-22-4, class III and IEC 801-4, level 4

- power supply inputs
  - 4 kV, 5/50 ns
- other inputs
  - 2 kV, 5/50 ns

Electrostatic discharge test according to IEC 255-22-2 and IEC 801-2, class III

- air discharge
  - 8 kV
- contact discharge
  - 6 kV

Environmental conditions

Service temperature range

-10...+55°C

Transport and storage temperature range according to IEC 68-2-8

-40...+70°C

Temperature influence

0.2%/°C

Damp heat test, cyclic (12 h + 12 h)

according to IEC 68-2-30

+25°C/+55°C

RH = 93%, 6 cycles

Degree of protection by enclosure of flush mounting relay case

IP 54

Weight of fully equipped relay including flush mounting relay case

-6 kg
RELAY MODULE DATA

Overcurrent and earth-fault relay module SPCJ 4D28

**Low-set overcurrent stage I>**

Start current I>  
– definite time characteristic 0.5…5.0 x Iₙ  
– inverse time characteristic 0.5…2.5 x Iₙ *  
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

**Low-set earth-fault stage I₀>**

Start current I₀> 0.1…0.8 x Iₙ  
Start time, typ. 70 ms  
Operation characteristic  
– definite time characteristic 0.5…1.00  
– inverse time characteristic extremely inverse

**High-set overcurrent stage I>>**

Start current I>> 0.5…40.0 x Iₙ or ∞, infinite  
Start time, typ. 40 ms  
Operation 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 at definite time operation ±2% of set time or ±25 ms  
Operation accuracy ±3% of set current

**High-set earth-fault stage I₀>>**

Start current I₀>> 0.1…10.0 x Iₙ or ∞, infinite  
Start time, typ. 50 ms  
Operation 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> 0.1…100% x Iₙ or ∞, infinite  
Start time, typ. 150 ms  
Operation time 1…300 s  
Reset time, typ. 80 ms  
Drop-off/pick-up ratio, typ. ±2% of set value or ±25 ms  
Operation accuracy ±1 unit ±3% of set current

**Superhigh-set overcurrent stage I>>>**

Start current I>>> 0.5…40.0 x Iₙ or ∞, infinite  
Start time, typ. 40 ms  
Operation 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

* At inverse time characteristic the effective setting range is 0.5…2.5 x Iₙ, although setting values greater than 2.5 x Iₙ can be set on the relay.
### Directional earth-fault relay module SPCS 2D26

**Residual voltage stage U₀b**
- Start voltage $U_{0b}$: $2.0 \ldots 80.0\%$ of $U_n$
- Start time, typ.: $60$ ms
- Operate time $t_0$: $0.1 \ldots 300$ s
- Reset time, typ.: $60$ ms
- Drop-off/pick-up ratio, typ.: $0.96$
- Operate time accuracy: $\pm 2\%$ of set time or $\pm 25$ ms
- Operation accuracy: $\pm 3\%$ of set voltage

**Low-set stage I₀₁** or $U₀₁$
- Operation direction of stage $I₀₁$
- Basic angle $\phi_b$, selectable
- Operation sector $\Delta \phi$
- Mode of operation of stage $I₀₁$
- Start current $I₀₁$
- Start voltage $U₀₁$
- Start time, typ.: $80$ ms
- Operate time $t₁$: $70$ ms
- Reset time, typ.: $70$ ms
- Drop-off/pick-up ratio, typ.: $0.96$
- Operate time accuracy: $\pm 2\%$ of set time or $\pm 25$ ms
- Operation accuracy: $\pm 3\%$ of set value + $0.0005 \times I_n$

**High-set stage I₀₂** or $U₀₂$
- Operation direction of stage $I₀₂$
- Basic angle $\phi_b$, selectable
- Operation sector $\Delta \phi$
- Mode of operation of stage $I₀₂$
- Start current $I₀₂$
- Start voltage $U₀₂$
- Start time, typ.: $80$ ms
- Operate time $t₂$: $70$ ms
- Reset time, typ.: $70$ ms
- Drop-off/pick-up ratio, typ.: $0.96$
- Operate time accuracy: $\pm 2\%$ of set time or $\pm 25$ ms
- Operation accuracy: $\pm 3\%$ of set value + $0.0005 \times I_n$

### Auto-reclose relay module SPCT 5D54

- Number of auto-reclose shots: $1 \ldots 5$
- AR start delay time: $0 \ldots 10.0$ s
- Dead time: $0.20 \ldots 300$ s
- Discriminating time: $0 \ldots 30.0$ s
- Reclaim time: $0.2 \ldots 300$ s
- Final trip time: $0.00 \ldots 5.00$ s
- Length of CB close pulse: $0.10 \ldots 2.00$ s
- Length of CB open pulse: $0.10 \ldots 2.00$ s
- Operate time accuracy: $\pm 1\%$ of set value or $\pm 30$ ms
Mounting and Dimensions

Flush mounting relay case

Semi-flush mounting

<table>
<thead>
<tr>
<th>Raising frame</th>
<th>a</th>
<th>b</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPA-ZX 301</td>
<td>219</td>
<td>74</td>
</tr>
<tr>
<td>SPA-ZX 302</td>
<td>179</td>
<td>114</td>
</tr>
<tr>
<td>SPA-ZX 303</td>
<td>139</td>
<td>154</td>
</tr>
</tbody>
</table>

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 317 is used. The relay case for projecting mounting is provided with front connectors.