



**POWERFACTORY**

# PowerFactory 2021

Technical Reference

ABB SPAJ 110C

PF2021

**POWER SYSTEM SOLUTIONS**  
MADE IN GERMANY

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## Contents

<b>1 Model information</b>	<b>1</b>
<b>2 General description</b>	<b>1</b>
<b>3 Supported features</b>	<b>1</b>
3.1 Measurement and acquisition . . . . .	1
3.1.1 Available Units . . . . .	1
3.1.2 Functionality . . . . .	2
3.1.3 Data input . . . . .	2
3.2 Protective elements . . . . .	2
3.2.1 Available Units . . . . .	2
3.2.2 Functionality . . . . .	2
3.2.3 Data input . . . . .	3
3.3 Output logic . . . . .	3
3.3.1 Available Units . . . . .	3
3.3.2 Functionality . . . . .	3
3.3.3 Data input . . . . .	4
<b>4 Features not supported</b>	<b>5</b>
<b>5 References</b>	<b>6</b>

## 1 Model information

**Manufacturer** ABB

**Model** SPAJ 110C

**Variants** This PowerFactory relay model type simulates the ABB SPAJ 110C relay which is a protection assembly containing the non-directional earth-fault relay module SPCJ 1C8.

## 2 General description

The ABB SPAJ 110C is a microprocessor earth fault relay designed to be used for selective earth-fault protection either primary or back-up protection, in solidly earthed or low-resistance earthed power systems. The relay has two protection stages: a low-set overcurrent stage I> and a high-set overcurrent stage I>>. The low-set stage operates with definite time characteristic or with inverse time characteristic, while the high-set stage operates with definite time characteristic only. The earth-fault relay is used both as primary and back-up earth-fault protection for feeders, transformers, generators and motors.

The ABB SPAJ 110C relay has been modeled using one PowerFactory relay model which includes all the protective elements and most of the features available in the relay.

The PowerFactory ABB SPAJ 110C relay model types can be found at:  
\\Library\\Relays\\Relays\\Overcurrent Relays\\ABB\\Westinghouse\\SPAJ\\SPAJ 110C

The model implementation has been based on the information available in the relay documentation provided by the manufacturer and freely available [2] [1].

## 3 Supported features

### 3.1 Measurement and acquisition

It represents the interface between the power system and the relay protective elements. The currents flowing in the power system are converted by an element simulating a 3 phase CT or a single phase CT; the secondary current is then measured by an element modeling the analog filter of the relay.

The "Io> block" block and the "Io>> block" relay input signals are available.

#### 3.1.1 Available Units

- one 3/single phase current transformer ("Ct-3I0" block)
- one single measurement element ("Measure" block)

### 3.1.2 Functionality

The "Ct-3I0" block represents an ideal CT. Using the CT default configuration the current at the primary side are converted to the secondary side using the CT ratio. The CT saturation and/or its magnetizing characteristic are not considered. Please set the "Detailed Model" check box in the "Detailed Data" tab page of the CT dialog and insert the data regarding the CT burden, the CT secondary resistance and the CT excitation parameter if more accurate simulation results are required.

The "Measure" block models a second order low pass analog filter with DC component filter; it's time constant is 10 ms.

If no core CT is available, please select a 3 phases CT in the "Ct-3I0" slot: the earth current will be calculated assuming that an Holmgreen's connection of the phases is used.

The "Io>" block" relay input signal can be used to block the "Io>" protective element.

The "Io>>" block" relay input signal can be used to block the "Io>>" protective element.

### 3.1.3 Data input

The CT secondary rated current (1 or 5 A) value must be set in the measurement element ("Measure" block, "*Nominal current*" parameter).

## 3.2 Protective elements

An inverse time and a definite time overcurrent elements are modeling the relay protective functions. All protective functions available in the relay are available as well in the PowerFactory relay model .

### 3.2.1 Available Units

- one earth current inverse time overcurrent element ("Io> t" block)
- one earth current definite time overcurrent element ("Io>>" block)

### 3.2.2 Functionality

All the inverse characteristics available in the relay are supported by the inverse time overcurrent element. In such trip characteristics the relationship between current and time complies with the standards BS 142.1966 and IEC 255-4.

The following trip characteristics are modeled:

- Normal Inverse
- Very Inverse
- Extremely Inverse
- Long Time Inverse
- Definite Time 0.05-100

The functionalities of the two definite time elements are mocked up in detail including a *Start time*, a *Reset time* and a *Reset ratio*. The model parameters can be set to any value between the relay setting minimum and maximum allowed values. At this regard please notice that the ranges available in the model are including any relay setting range that can be enabled operating the "SG1/1", "SG1/2", "SG1/6", "SG1/7" and "SG1/8" dip switches.

### 3.2.3 Data input

The relationships between the relay settings and the model parameters can be found in the following table:

Address	Relay Setting	Model block	Model Parameter	Note
	Low-set $I_{o>}$ start current	lo> t	Current Setting ("Ipset")	Set in the model "Definite Time 0.05-100"
	Switch 3 of switch group SG1	lo> t	Characteristic ("pcharac")	
	Low-set $I_{o>}$ characteristic	lo> t	Characteristic ("pcharac")	Used in the relay for the definite time characteristic
	Low-set $I_{o>}$ operate time t>	lo> t	Time Dial ("Tpset")	
	Low-set $I_{o>}$ time multiplier k	lo> t	Time Dial ("Tpset")	Used in the relay for the inverse time characteristics
	High-set $I_{o>>}$ Start Current	lo>>	Current Pickup ("Ipset")	
	High-set $I_{o>>}$ Operate Time	lo>>	Time Delay ("Tset")	

## 3.3 Output logic

It represents the output stage of the relay; it's the interface between the relay and the power breaker.

### 3.3.1 Available Units

- one output element ("Logic" block)

### 3.3.2 Functionality

The "Logic" block is collecting the trip signals and the starting signals coming from the protective elements; it's operating the relay output contacts and the power breaker.

The output contacts are "START1", "SIGNAL1", "TRIP1" and "TRIP2".

The "Logic" block provides also 7 *dip switches* ("SGR2", "SGR3" ... "SGR8") simulating the "SGR" relay switch group. They are used to configure the trip and alarm output signal logic.

The following logic is implemented in the ABB SPAJ 110C model:

- TRIP1 is tripping when one of the following conditions is verified
  - The "lo>" element is tripping
  - The "lo>>" element is tripping and the "SGR6" dip switch has been set "on"
- TRIP2 is tripping when when one of the following conditions is verified
  - The "lo>>" element is tripping

- The "lo>" element is tripping and the "SGR8" dip switch has been set "on"
- SIGNAL1 is tripping when one of the following conditions is verified
  - The "lo>" element is tripping and the "SGR7" dip switch has been set "on"
  - The "lo>>" element is tripping and the "SGR5" dip switch has been set "on"
- START1 is tripping when one of the following conditions is verified
  - The "lo>>" element is starting and the "SGR2" dip switch has been set "on"
  - The "lo>" element is starting and the "SGR3" dip switch has been set "on"
  - The "lo>>" element is tripping and the "SGR4" dip switch has been set "on"

#### 3.3.3 Data input

To set the "SGR" relay switch group set the relevant dip switches in the "Dip Settings" tab page of the "Logic" block dialog.

The "TRIP1" and "TRIP2" relay output signals can be set to operate the breaker using the "Tripping signal" ("sTripsig") parameter in the "Basic Data" tab page of the "Logic" block dialog. By default both are operating the breaker.

To disable completely the relay model ability to open the power circuit breaker disable the "Logic" block.

## 4 Features not supported

The following features are not supported:

- "START2" relay output signal
- "SGR1" dip switch
- Automatic doubling of the start value of the high-set current stage Io>>



## 5 References

- [1] ABB Oy Distribution Automation, P.O.box 699, FI-65101 Vaasa , FINLAND. *Earth-fault relay SPAJ 110 C User's manual and Technical description 1MRS 750801-MUM EN Issued 97-07-02 Version A*, 1997.
- [2] ABB Oy Distribution Automation, P.O.box 699, FI-65101 Vaasa , FINLAND. *Earth-fault relay SPAJ 110 C 1MRS 750351-MBG Issued: April 1999*, 1999.