



POWERFACTORY

PowerFactory 2021

Technical Reference

ABB RADS-B

POWER SYSTEM SOLUTIONS
MADE IN GERMANY

F2021

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May 6, 2019
PowerFactory 2021
Revision 892

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1 Model information

Manufacturer ABB

Model RADS-B

Variants This PowerFactory relay model type models the ABB RADS-B relay which is a protection assembly containing a 3phase transformer differential relay with second and fifth harmonic restrain.

2 General description

The ABB RADS-B protective relay is a static 3-phase differential protection with two, three, five or six through-current restraint inputs. The static measuring circuits have with active filters for optimum utilization of harmonics in the current circuits: they provide second harmonic restraint from all three phases for inrush security and fifth harmonic restraint from all three phases for overexcitation security. The relay has a variable percentage restraint for external fault security and unrestrained operation settable feature.

The ABB RADS-B relay has been modeled using one PowerFactory relay model which includes most of the features available in the relay.

The model implementation has been based on the information available in the relay documentation provided by the manufacturer and freely available [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 two elements modeling two 3 phase CTs; the secondary currents are then measured by six elements modeling the analog filters of the relay.

3.1.1 Available Units

- Two 3 phase current transformers ("Winding 1 Ct" and "Winding 2 Ct" block)
- Six measurement elements ("Measure 1", "Measure 2", "Diff 2nd Harmonic 1", "Diff 5th Harmonic 1", "Diff 2nd Harmonic 2", "Diff 5th Harmonic 2" block)

3.1.2 Functionality

The "Winding 1 Ct" and the "Winding 2 Ct" block represent ideal CTs. 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 measurement blocks calculate the harmonic component using a DFT filter operating over a full cycle.

There are 3 measurement elements for each 3 phase Ct, each of them is extracting an unique harmonic from the input current waves:

- "Measure 1" (fundamental frequency of the current converted by "Winding 1 Ct").
- "Diff 2nd Harmonic 1" (2^{nd} harmonic of the current converted by "Winding 1 Ct").
- "Diff 5th Harmonic 1" (5^{th} harmonic of the current converted by "Winding 1 Ct").
- "Measure 2" (fundamental frequency of the current converted by "Winding 2 Ct").
- "Diff 2nd Harmonic 2" (2^{nd} harmonic of the current converted by "Winding 2 Ct").
- "Diff 5th Harmonic 2" (5^{th} harmonic of the current converted by "Winding 2 Ct").

3.1.3 Data input

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

3.2 Protective elements

A differential element with an ancillary RMS calculation element simulates the relay differential features. All protective functions available in the relay are available also in the PowerFactory relay model.

3.2.1 Available Units

- one 3 phase differential element ("Differential logic" block).
- one measurement element ("Diff RMS meas" block).

3.2.2 Functionality

The following features are available in the differential element ("Differential logic" block):

- Harmonic and percentage restraint differential with user configurable threshold (available threshold values: 20%, 25%, 35%, 50%).
- Unrestrained differential with user configurable threshold (available threshold values: $8 I_n$, $13 I_n$, $20 I_n$).
- 2^{nd} harmonic restrain of the first differential with fixed threshold (15%).

- 5th harmonic restrain of the first differential with fixed threshold (38%).

The differential element calculates for each phase the average of the currents measured by "Measure 1" and by "Measure 2". The average values are then used to calculate the differential threshold considering a 60% linear percentage restrain.

The measurement element ("Diff RMS meas" block) is used to calculate the RMS value of the differential current. The differential current vector components (or instantaneous values during the EMT simulation) are calculated by the differential element.

3.2.3 Data input

The relationships between the relay settings and the model parameters can be found in the following table (the relay model parameter names are listed between brackets):

Address	Relay Setting	Model block	Model Parameter	Note
	I_{sr} restraint	Differential logic	Differential Current base threshold ("Idiff")	
	I_{su} unrestrained	Differential logic	Unrestrained Differential threshold ("Idiffunrest")	

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 gets the trip signal coming from the differential element; it operates the relay output contact and the power breaker.

The relay output contact is "OUT1".

3.3.3 Data input

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

4 Features not supported

The three, five or six through-current restraint inputs relay versions are not supported.

Moreover the following approximations have been used:

- The active filters extracting the harmonic components are modeled by digital filters.
- The non linear percentage restrain characteristic is approximated by a linear characteristic (60% slope).

5 References

- [1] ABB Relays, S-721 71, Vasteras, Sweden. *Transformer differential protection RADSB User's Guide 1MRK 504 002-UEN Replaces 1MDU04007-EN Version 1.1 September 1997, 1997.*