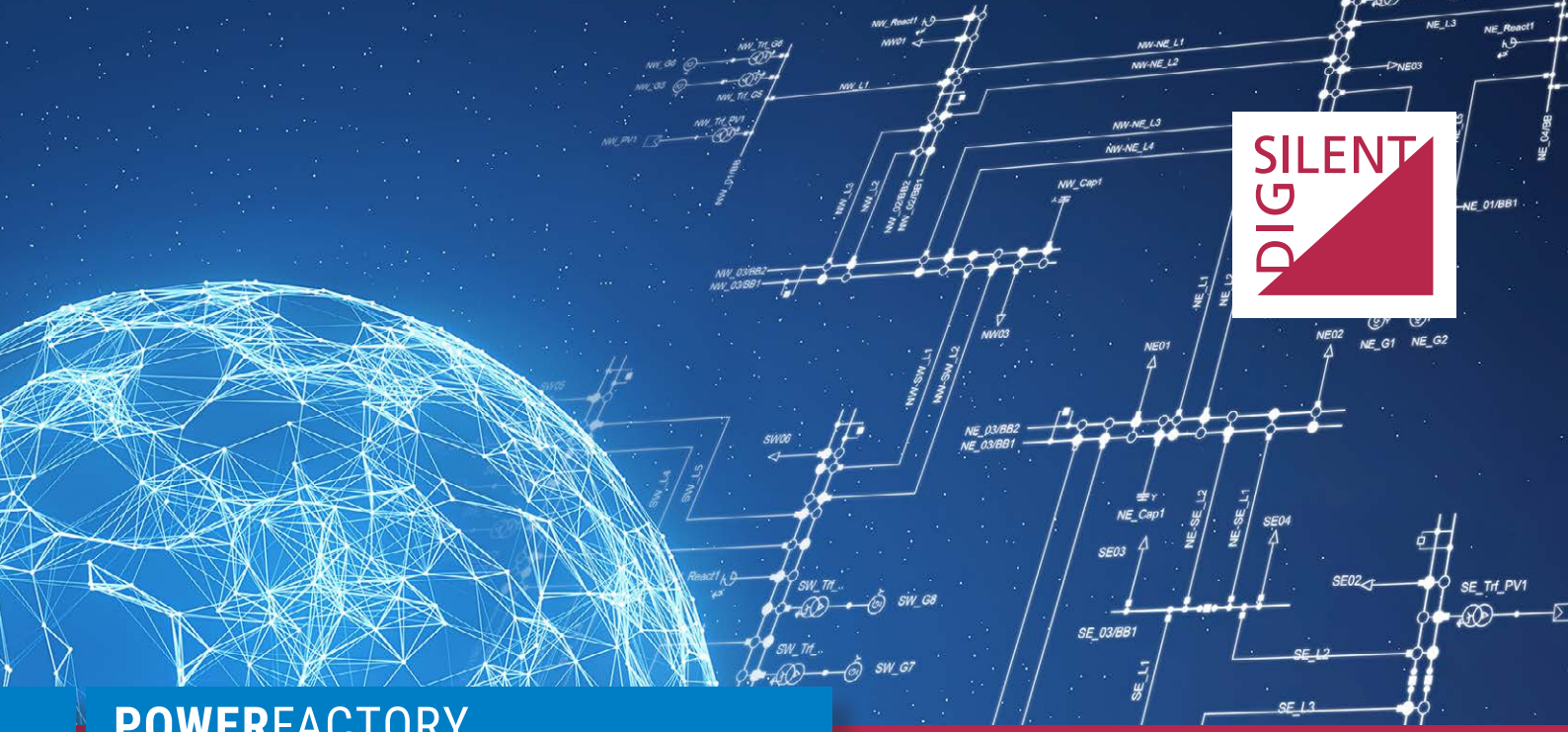

PowerFactory 2021

Technical Reference

ABB RAZOA

PF2021

POWER SYSTEM SOLUTIONS

MADE IN GERMANY

Publisher:
DIgSILENT GmbH
Heinrich-Hertz-Straße 9
72810 Gomaringen / Germany
Tel.: +49 (0) 7072-9168-0
Fax: +49 (0) 7072-9168-88
info@digsilent.de

Please visit our homepage at:
https://www.digsilent.de

November 15, 2019
PowerFactory 2021
Revision 924

Contents

1 Model information **1**

2 General description **1**

3 Supported features **1**

3.1 Measurement and acquisition 1

3.1.1 Available Units 1

3.1.2 Functionality 1

3.1.3 Data input 2

3.2 Starting elements 2

3.2.1 Available Units 2

3.2.2 Functionality 2

3.2.3 Data input 3

3.3 Protective elements 3

3.3.1 Available Units 3

3.3.2 Functionality 3

3.3.3 Data input 4

3.4 Output logic 5

3.4.1 Available Units 5

3.4.2 Functionality 5

3.4.3 Data input 5

4 Features not supported **6**

5 References **7**

1 Model information

Manufacturer ABB

Model RAZOA

Variants These PowerFactory relay models can be used to simulate the ABB RAZOA distance relays.

2 General description

The ABB RAZOA protection relays are old first generation microprocessor distance protections. They have a combined resistance and reactance measurement characteristic and each can be set independently. Thus the relay is suitable for the protection of grounded or ungrounded systems, overhead circuits with high X/R ratio, cables with low X/R ratio, short lines with high fault resistance ro long lines with heavy loading requirements.

The ABB RAZOA relays have been modeled using the *"RAZOA"* relay model.

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

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 the *"Ct"* current transformer which models the set of 3 phase current transformers; the voltages are converted by the *"Vt"* voltage transformer which again models a set of 3 voltage transformers. The secondary currents and voltages are then measured by one measurement element which simulates the analog filter of the relay.

3.1.1 Available Units

- One 3 phase current transformer (*"Ct"* block).
- One 3 phase voltage transformer (*"Vt"* block).
- One 3phase measurement element (*"Measurement"* block).

3.1.2 Functionality

The *"Ct"* represents an 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 block simulates a DFT filter operating with one cycle data.

3.1.3 Data input

The user must selects the input current secondary rated value (1 amp, 2 amp or 5 amp) and the relay rated voltage using the *Nominal Current* (*"Inom"* parameter) and the *Nominal Voltage* (*"Unom"* parameter) combo box in the *"Measurement"* block dialog.

3.2 Starting elements

The starting logic can be provided by an external device which must be referred by the *"Ancillary Starting element"* block or can be internal.
The external device can be any kind of device able to provide a generic trip signal (*yout*) and 3 phase trip signals (*y_A*, *y_B*, and *y_C*).
The internal starting logic consists of an underimpedance and an overcurrent starting (*RGZB/RGIC* block). The external starting device and the internal starting logic can coexist together.
The user can select which kind of internal starting is enabled. When the overcurrent starting is used, the starting is declared only when the phase or the ground currents are greater than a given threshold. Separated phase and earth starting thresholds are present.
When the underimpedance starting is used the system impedance must be smaller than a given impedance value and the phase current greater than a user defined threshold or the ground current greater than another user defined threshold. The impedance characteristic is a circle centered in the R-X axis origin. An additional an emergency phase overcurrent threshold set at $8I_n$ is active when the underimpedance starting is used. The user must enable the relevant block when the impedance starting is enabled in the *RGZB/RGIC* block. If the underimpedance starting is used and the current is greater than $8I_n$ the starting is declared.

3.2.1 Available Units

- A starting/fault detector element (*"RGZB/RGIC"* block).
- An additional phase overcurrent starting (*"Starting underimpedance 8In"* block).
- A reference to an external starting relay (*"Ancillary Starting element"* block).
- Two ancillary logic elements(*"LogicSt1"*, and *"LogicSt2 logic"* block).

3.2.2 Functionality

The impedance element trips when $|Z\bar{I}|$ is smaller than $\bar{V}$
The phase and the ground trip thresholds get the absolute value of the phase and of the ground current calculated by the measurement element.
The logic blocks combine the phase signals coming from the *"RGZB/RGIC"* and the *"Starting underimpedance 8In"* block.

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	Range	Note
	RGZB Impédance	RGZB/RGIC	impedance Z< (*"Z"*)	0.8-64 step 0.8 secΩ	
	RGZB min operating current	RGZB/RGIC	Current I> (*"ip1"*)	0.2 or 1.2 In	
	RGZB Réglage d'élément homopolaire	RGZB/RGIC	Current, 3*i0 (*"ie"*)	0.2-1.6 pu	
	RGIC Réglage par intensité	RGZB/RGIC	Current I>> (*"ip2"*)	1-4;0.2 In	
	RGIC Réglage relais homopolaire	RGZB/RGIC	Current, 3*i0 (*"ie"*)	0.2-1.6 pu	In the relay only 0.2 In and 0.5 In are available

3.3 Protective elements

The ABB RAZOA relay model simulates three impedance distance zones.

3.3.1 Available Units

- Three mho elements(*"MHOZ1"*, *"MHOZ2"*, and *"MHOZ3"* block).
- Three resistive blinders(*"R1"*, *"R2"*, and *"R3"* block).
- Three reactive blinders(*"X1"*, *"X2"*, and *"X3"* block).
- Three timers (*"T2"*, *"T3"* and *"T4"* block).
- Three logic elements(*"Upol calc - Z1"*, *"Z2"*, and *"Z3"* block).
- One Polarizing element (*"Polarizing"* block).
- Six logic blocks (*"And1"*, *"And2"*, *"And3"*,*"Or1"*, *"Or2"*, *"Or3"* block).

3.3.2 Functionality

Each impedance zone is modeled by a mho, which provide the directional behavior, by a set of blinder elements and logic elements.
The blinders provide graphical representation of the resistive and reactive limit in the R/X diagram and the user input interface, the relay model trip logic is not affected by their behavior . The vectorial calculation is performed by the logic elements.
The impedance zone trips only if relevant mho elements and the logic elements trips. More in detail for each impedance zone the mho must detect the fault element. Its tripping signal is combined by an *and* logic block with the trip signal coming from the logic elements.
For each zone the blinder elements are blocked both by the mho element and by the logic element; indeed they get the operating current and the operating current directly from the *"Polarizing"* block with a self polarizing scheme so their behavior could be not consistent with the relay behavior. The blocking from the logic elements avoids such problem.

The polarizing voltage for the mho (directional) elements is calculated by the *"Upol calc - Z1"* block.

The following operating currents and polarizing voltages are used by the mho (directional) elements:

Fault Type	Operating Current	Polarizing Voltage	Operating Voltage
Phase A - Grnd	$I_A + k_0 I_0$	U_{BC}	U_A
Phase B - Grnd	$I_B + k_0 I_0$	U_{CA}	U_B
Phase C - Grnd	$I_C + k_0 I_0$	U_{AB}	U_C
Phase A - Phase B	$I_A - I_B$	$-(U_C - U_0)$	U_{AB}
Phase B - Phase C	$I_B - I_A$	$-(U_A - U_0)$	U_{BC}
Phase C - Phase A	$I_C - I_A$	$-(U_B - U_0)$	U_{CA}

The following operating currents and operating voltages are used by the polygonal (reactive and resistive limits) elements:

Fault Type	Operating Current	Operating Voltage
Phase A - Grnd	$I_A + k_0 I_0$	U_A
Phase B - Grnd	$I_B + k_0 I_0$	U_B
Phase C - Grnd	$I_C + k_0 I_0$	U_C
Phase A - Phase B	$I_A - I_B$	U_{AB}
Phase B - Phase C	$I_B - I_A$	U_{BC}
Phase C - Phase A	$I_C - I_A$	U_{CA}

Timers The *"T2"* and the *"T3"* timer generate a user configurable trip delay associated to the zone 2 and to the zone 3 trip. The *"T4"* timer is associated to the relay starting *"RGZB/RGIC"* element.

3.3.3 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	Range	Note
	Reach Zone 1 R1 and X1	MHOZ1	Replica Impedance (*"Zm"*)	0.16-63 secΩ	$Zm = \sqrt{R1^2 + X1^2}$
			Relay Angle (*"phi"*)	40-80	Must be calculated manually taking care of the X1/R1 ratio $phi = \tan(X1/R1)$
	Portée Gradin 2	MHOZ2	Replica Impedance (*"Zm"*)	0.16-63 secΩ	
			Relay Angle (*"phi"*)	40-80	Equal to MHOZ1 *"phi"*
	Portée Gradin 3	MHOZ3	Replica Impedance (*"Zm"*)	0.16-63 secΩ	
			Relay Angle (*"phi"*)	40-80	Equal to MHOZ1 *"phi"*
	X1	X1	Reactance (*"X"*)	0.16-64 secΩ	
	R1	R1	Resistance (*"R"*)	0.16-64 secΩ	
	X2	X2	Reactance (*"X"*)	0.16-64 secΩ	

Address	Relay Setting	Model block	Model Parameter	Range	Note
	R2	R2	Resistance (*"R"*)	0.16-64 secΩ	$R = XR1/X1$ with X = reactance zone 2
	X3	X3	Reactance (*"X"*)	0.16-64 secΩ	
	R3	R3	Resistance (*"R"*)	0.16-64 secΩ	$R = XR1/X1$ with X = reactance zone 3
	K_N	Polarizing	K0 (*"k0"*)	0.1-1.5	
	T2	T2	Time Setting (*"Tdelay"*)	0.05-0.75 step 0.05 s	
	T3	T3	Time Setting (*"Tdelay"*)	0.2-3 step 0.2 s	
	T4	T4	Time Setting (*"Tdelay"*)	0.4-6 step 0.4 s	

3.4 Output logic

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

3.4.1 Available Units

- One output element (*"Output Logic"* block).

3.4.2 Functionality

The *"Output Logic"* block gets trip signals coming from the distance elements and from the *"T4"* backup trip timer; it operates the relay output contacts and the power breaker.

The relay output contacts are:

- yout
- Z1TRIP
- Z2TRIP
- Z3TRIP

The *yout* is a generic relay output signal which operates the breaker. The *Z1TRIP*, *Z2TRIP*, and *Z3TRIP* are associated to the first, second and third distance zone trip.

3.4.3 Data input

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

4 Features not supported

The following features are not supported:

- Oval Starting Characteristic (see 2.4 of [1])
- Relais d'antipompage (see 2.2.14 of [2])

5 References

[1] RTE Gestionnaire du Réseau du Transport Electricité RHÔNE ALPES AUVERGNE GROUPE EXPERTISE ET SERVICES EN CONTRÔLE COMMANDE, 15, RUE DES CUIRASSIERS - B.P. 3074 - 69399 LYON CEDEX 03 France. *ASEA RELAYS RK 614-300 F RFR , Février 1984, Edition 4 Relais de distance du type RAZOA*, 2007.

[2] RTE Gestionnaire du Réseau du Transport Electricité RHÔNE ALPES AUVERGNE GROUPE EXPERTISE ET SERVICES EN CONTRÔLE COMMANDE, 15, RUE DES CUIRASSIERS - B.P. 3074 - 69399 LYON CEDEX 03 France. *RAZOA GUIDE UTILISATEUR ABB ASEA BROWN BOVERI RAZOA-G.UTIL*, 2007.