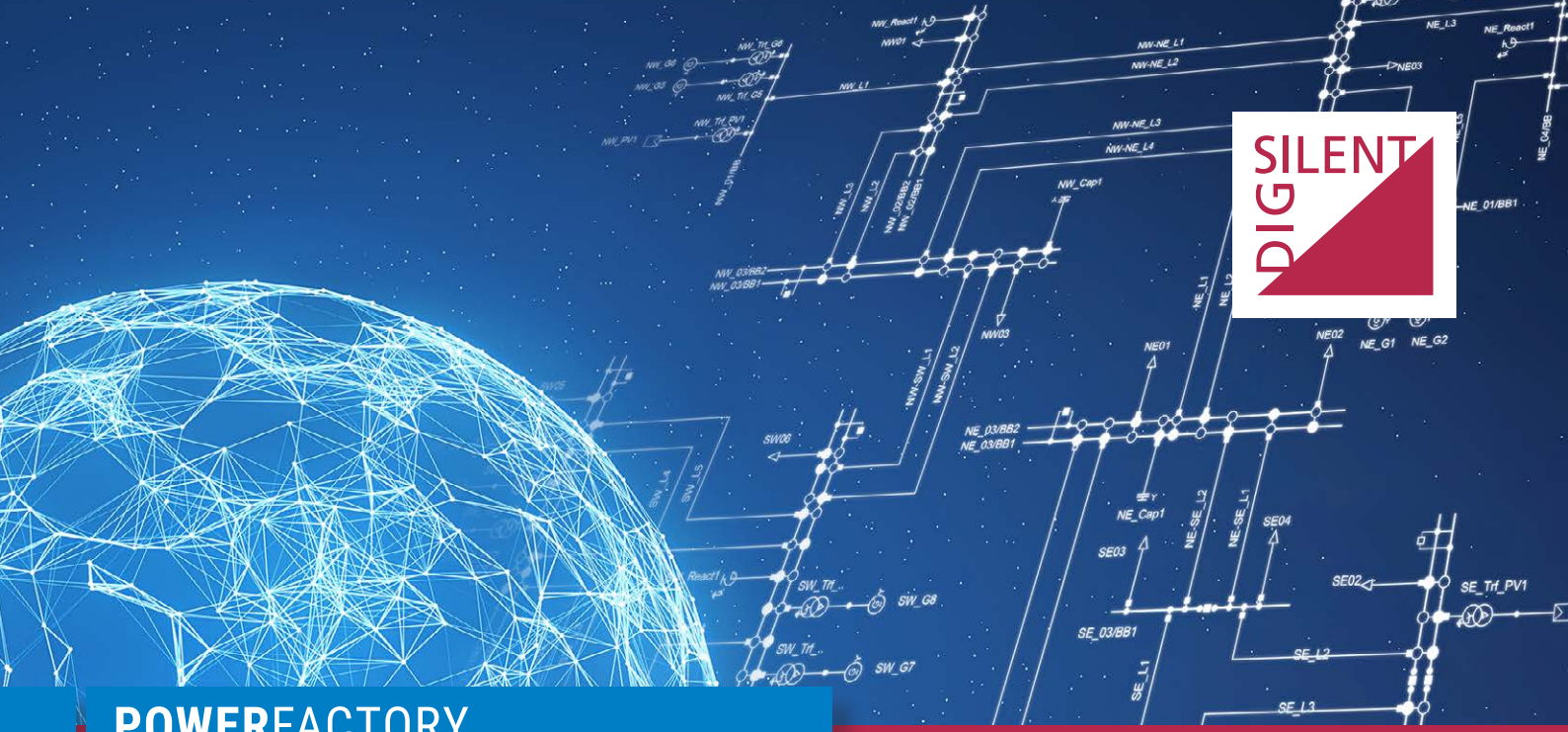

PowerFactory 2021

Technical Reference

Enertec RXAP

PF2021

POWER SYSTEM SOLUTIONS

MADE IN GERMANY

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Contents

1 Model information

Manufacturer Enertec

Model RXAP

Variants These PowerFactory relay models can be used to simulate the Alstom PXLC 3000-1 distance relays.

2 General description

The Enertec RXAP protection relays are old distance electromechanical protections, initially installed in the French network in the 50s, built up to 85 and still present in a large number. They protect high and extremely high voltage lines.

The Enertec RXAP relays have been modeled with the following relay models:

- RXAP 6xxx 1A
- RXAP 6xxx 5A
- RXAP 6x1x 1A
- RXAP 6x1x 5A

Please notice that the models listed above are identical except that for the measurement rated current and the impedance settings ranges.

The model implementation has been based on the information available in the relay documentation provided by RTE [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 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 1 amp or the 5 amp Enertec RXAP relay model accordingly with the relay version he is going to simulate. The relay rated voltage must be set using the *Rated Voltage* (*"Unom"* parameter) combo box in the *"Measurement"* block dialog.

3.2 Starting elements

The starting logic consists of a mho distance starting with minimum current starting (*Fault type detection* block).
The distance starting is enabled only when the phase or the ground currents are greater than a given threshold. Separated phase and earth starting thresholds are present.
A current biased earth fault starting element is also available.

3.2.1 Available Units

- A mho starting element (*"RMZ 100"* block).
- A phase and ground starting element (*"Fault type detection"* block).
- A biased overcurrent earth starting element (*"RBA 100"* block).
- Three ancillary logic elements(*"Const"*, *"And"*, and *"Eblock logic"* block).

3.2.2 Functionality

The mho element allows to insert separated reactance reaches for forward and reverse zone. It implements the distance starting which is inhibited by the minimum current starting logic present in the *"Fault type detection"* and in the *"Percent Fault detection Ground"* block.

The following operating currents and polarizing voltages are used by the mho:

Fault Type	Operating Current	Polarizing Voltage
Phase A - Grnd	$I_A + k_0 I_0$	U_{AN}
Phase B - Grnd	$I_B + k_0 I_0$	U_{BN}
Phase C - Grnd	$I_C + k_0 I_0$	U_{CN}
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}

Both the phase currents and zero sequence current are detected by the *"Fault type detection"* block which contains two separated current thresholds for the phase and the zero sequence. The *"Eblock logic"* inhibits the earth fault detection logic of the *"Fault type detection"* block if the earth current is greater than the biased earth trip characteristic (*"Eblock logic"* block). The *"RBA 100"* block models the following biased characteristic
$I_{biased} = 0.3 I_n + K * (I_A - I_B)$
with
$K = 25\% fault AB, 3ph$
$K = 15\% fault AN, BN, AC, BC$
$K = 0\% fault CN$

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
	Zr	RMZ 100	Replica Impedance (*"Zm"*)	10-30 Ω (1A)	
				2-6 Ω (5A)	
	Image	RMZ 100	Offset Impedance (*"Zoff"*)	0-15 step 0.75 Ω (1A)	6X1X only
				0-3 step 0.15 Ω (5A)	6X1X only

3.3 Protective elements

The Enertec RXAP relay models simulate two reactance blinders with directional characteristic distance protection. An out of step and power swing detection is also available.

3.3.1 Available Units

- Two reactance blinders to define zone 1 and zone 2(*"RMS X1"* and *"RMS X2"* block).
- One Distance directional element (*"RDW 173"* block).

- One Polarizing element (*"Polarizing"* block).
- Three timers (*"T2"*, *"T3"* and *"T4"* block)
- One distance mho element which defines the out of step/power swing external zone (*"RMZ 100 - Pompage"* block).
- One power swing and out of step element (*"Out of Step"* block).

3.3.2 Functionality

Reactance blinders For each blinder a vector is generated using the related impedance; the angle between such vector multiplied by the operating current vector and the operating voltage vector must be greater than 90° to declare the working point as internal to the shape.

Polarizing element The *"Polarizing"* block is connected to the mho, to the blinder elements and to the directional element and uses a self polarization. Special signal arrangements are used to provide the directional element the correct polarizing voltages. A three cycle voltage buffer is activated when the input voltage is smaller than 15% U_n.

Directional element The distance directional element (*"RDW 173"* block) uses the polarizing voltages and the operating currents calculated by the polarizing element (*"Polarizing"* block). The directional angle is not user configurable and is equal to 20°.

The following operating currents and polarizing voltages are used:

Fault Type	Operating Current	Polarizing Voltage
Phase A - Grnd	$I_A + k_0 I_0$	U_{BC}
Phase B - Grnd	$I_B + k_0 I_0$	U_{CA}
Phase C - Grnd	$I_C + k_0 I_0$	U_{AB}
Phase A - Phase B	$I_A - I_B$	U_{AC}
Phase B - Phase C	$I_B - I_A$	U_{BA}
Phase C - Phase A	$I_C - I_A$	U_{CB}
3 phase	$I_A - I_B$	U_{AB}

Timers The *"T2"* timer generates a user configurable trip delay associated to the *"RMX X2"* blinder. *"T3"* and the *"T4"* are associated to the distance starting *"RMZ 100"* element and are triggered by a fault detected by the directional element in the forward (*"T3"*) and in the reverse (*"T4"*) direction.

Out of step/Power Swing The *"Out of Step"* block operates as power swing and out of step detector. When a power swing condition has been detected it inhibits the *"RMX X1"* and the *"RMX X2"* block trip for 1.2 seconds. The power swing condition is declared if the system impedance remains between the mhos define by the *"RMZ 100"* block and the *"RMZ 100 - Pompage"* block more than 0.025 seconds.

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
	X1	RMX X1	Reactance (*"X"*)	1-32 step 0.001 Ω (1A)	
				0.2-6.4 step 0.001 Ω (5A)	
	X2	RMS X2	Reactance (*"X"*)	1-32 step 0.001 Ω (1A)	
				0.2-6.4 step 0.001 Ω (5A)	
	K	Polarizing	K0 (*"k0"*)	0.4-1	
	T2	T2	Time Setting (*"Tdelay"*)	0.5-1.5	
	T3	T3	Time Setting (*"Tdelay"*)	1-5	
	T4	T4	Time Setting (*"Tdelay"*)	1-5	
	Antipompage	RMZ 100 - Pompage	Replica Impedance (*"Zm"*)	20-40 Ω (1A)	
				4-8 Ω (5A)	
	Antipompage Image	RMZ 100 - Pompage	Offset Impedance (*"Zoff"*)	0-15 step 0.75 Ω (1A)	6X1X only
				0-3 step 0.15 Ω (5A)	6X1X only

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 the trip signal coming from the distance elements, and the Out of Step element; it operates the relay output contacts and the power breaker.

The relay output contact is *"yout"*.

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:

- Directional decaying memory voltage (see 6.3 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. *NOTE TECHNIQUE Déclinaison du guide de réglage à l'équipement RXAP 6000 D4183/71/ER/NTE/01.03*, 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. *RXAP GUI-CC-SF-05-03105*, 2007.