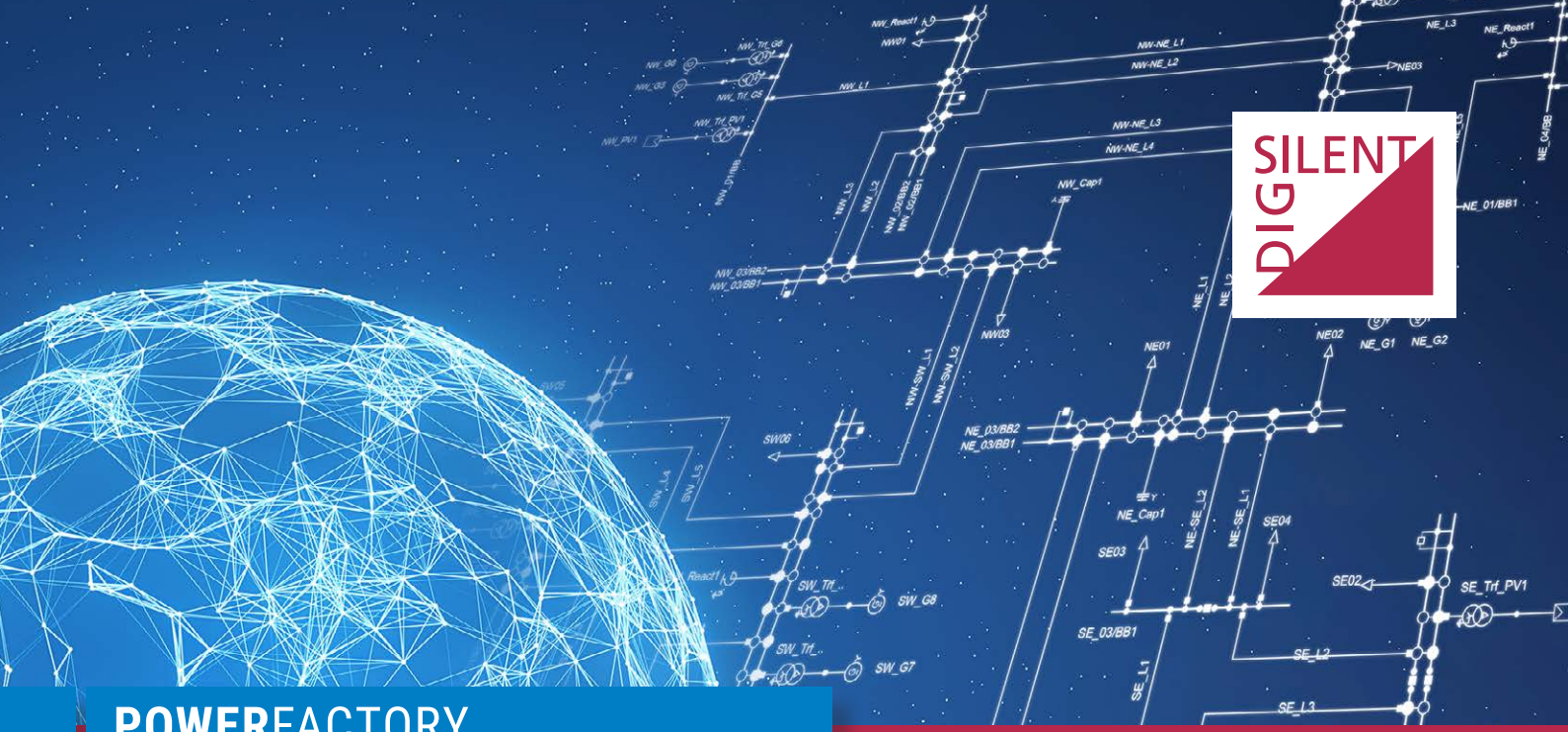

PowerFactory 2021

Technical Reference

Enertec PD3A

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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

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Contents

1 Model information

Manufacturer Enertec

Model PD3A

Variants These PowerFactory relay models can be used to simulate the Enertec PD3A distance relays.

2 General description

The Enertec PD3A protection relays are distance protections which protect medium and high voltage (up to 250 kV) lines. They can be equipped with a CT saturation detection element but the usual configuration does not include such feature.

The Enertec PD3A relays have been modeled with the following relay models:

- Enertec PD3A 1 amp
- Enertec PD3A 5 amp

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 [1] [2] [3] [4].

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 PD3A 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 quadrilateral distance starting.
The distance starting is controlled by some other multiple minimum current starting logics. Separated phase and earth starting thresholds are present.
An additional zero sequence overvoltage logic combined with the zero sequence current detection models the blown fuse detection logic.

3.2.1 Available Units

- A quadrilateral starting element (*"X3X4"* block).
- A phase and ground starting element (*"Fault type detection"* block).
- A biased overcurrent earth starting element (*"Percent Fault detection Ground"* block).
- A zero sequence overvoltage element (*"Ground voltage detector"* block).
- Two logic elements (*"FaultDetectionLogic"*, and *"BlownfuseLogic"* block).

3.2.2 Functionality

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 in the distance calculation:

Fault Type	Operating Current	Polarizing Voltage
Phase A - Grnd	I_A	U_A
Phase B - Grnd	I_B	U_B
Phase C - Grnd	I_C	U_C
Phase A - Phase B	I_A	U_{AB}
Phase B - Phase C	I_B	U_{BC}
Phase C - Phase A	I_C	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 *"Percent Fault detection Ground"* block models the following biased characteristic
$I_{biased} = 0.24I_n + 0.1 * (I_A - I_B)$
Additionally the quadrilateral element allows to insert separated reactance reaches for forward and reverse zone and implements the *X3* and the *X4* trip characteristic.
The Blown fuse Logic is based on the the measurement of the zero sequence voltage and current. The fuse is declared as blown when no zero sequence current has been detected and the zero sequence voltage is greater than 40% U_n.

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
	Ir	Fault type detection	Current, 3*i0 (*"ie"*)	0.24 In	No user input is required
	Rd	X3X4	+R Resistance (Rmax)	0-27.5 step 20.5 Ω (1A) 0-5.5 step 0.5 Ω (5A)	Rmax = Rd/2
	X3	X3X4	+ X reach (*"Xmax"*)	2.54-646.25 Ω (1A) 0.508-129.25 Ω (5A)	
	X4	X3X4	- X Reach (*"Xmin"*)	2.5-25 Ω (1A) 0.5-5 Ω (5A)	

3.3 Protective elements

The Enertec PD3A relay models simulate four 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(*"X1"* and *"X2"* block).
- One Distance directional element (*"Dir-Z"* block).
- One Polarizing element (*"Polarizing"* block).
- Four timers (*"T1"*, *"T2"*, *"T3"* and *"T4"* block).
- One distance quadrilateral element which defines the out of step/power swing external zone (*"DX"* 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.

The following operating currents and polarizing voltages are used:

Fault Type	Operating Current	Polarizing Voltage
Phase A - Grnd	$I_A + KI_0$	U_A
Phase B - Grnd	$I_B + KI_0$	U_B
Phase C - Grnd	$I_C + KI_0$	U_C
Phase A - Phase B	$I_A - I_B$	U_{AB}
Phase B - Phase C	$I_B - I_C$	U_{BC}
Phase C - Phase A	$I_C - I_A$	U_{CA}

Polarizing element A polarizing element calculates the polarizing voltage and the operating current for the directional element (*"Dir-Z"* block) and for the quadrilateral and for the blinder elements (*"X1"*, *"X2"*, *"X3X4"* and *"DX"* block). The *"Polarizing"* block is uses a self polarization.

Directional element The distance directional element (*"Dir-Z"* block) uses the polarizing voltages and the operating currents calculated by polarizing element (*"Polarizing"* block). The directional angle is not user configurable and is equal to 27°.

The following operating currents and polarizing voltages are used:

Fault Type	Operating Current	Polarizing Voltage
Phase A - Grnd	$I_A + KI_0$	U_A
Phase B - Grnd	$I_B + KI_0$	U_B
Phase C - Grnd	$I_C + KI_0$	U_C
Phase A - Phase B	$I_A - I_B$	U_{AB}
Phase B - Phase C	$I_B - I_C$	U_{BC}
Phase C - Phase A	$I_C - I_A$	U_{CA}

Timers The *"T1"* and the *"T2"* timer generate a user configurable trip delay to the *"X1"* and to the *"X2"* blinder. *"T3"* and the *"T4"* are associated to the distance starting *"X3X4"* 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 *"X1"* and the *"X2"* block trip for 1.2 seconds. The power swing condition is declared if the system impedance remains between the quadrilaterals define by the *"X3X4"* block and the *"DX"* 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 (M1, K1)	X1	Reactance (*"X"*)	0.2-100 step 0.01 Ω (1A) 0.04-20 step 0.01 Ω (5A)	

Address	Relay Setting	Model block	Model Parameter	Range	Note
	X2 (M2, K2)	X2	Reactance (*"X"*)	0.2-100 step 0.01 Ω (1A) 0.04-20 step 0.01 Ω (5A)	
	K0	Polarizing	K0 (*"k0"*)	0-3 step 0.1	
	T1	T1	Time Setting (*"Tdelay"*)	0.01-0.99 step 0.1 s	
	T2	T2	Time Setting (*"Tdelay"*)	0-0.99 step 0.01 s	
	T3	T3	Time Setting (*"Tdelay"*)	0-9.9 step 0.1 s	
	T4	T4	Time Setting (*"Tdelay"*)	0-9.9 step 0.1 s	
	ΔX	DX	dR (*"dR"*)	7.5 Ω (1A) 1.5 Ω (5A)	No user input is required
			dX (*"dX"*)	10 Ω (1A) 2 Ω (5A)	No user input is required

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:

- Accelerated trip schemes.

5 References

[1] RTE Gestionnaire du Réseau du Transport Electricité Nord Est, 62, RUE LOUIS DELOS - TSA 61011 - 59709 MARCQ EN BAROEUL CEDEX France. *PD3A RTE Guide MES 6062*, 1997.

[2] RTE Gestionnaire du Réseau du Transport Electricité Nord Est, 62, RUE LOUIS DELOS - TSA 61011 - 59709 MARCQ EN BAROEUL CEDEX France. *Déclinaison du Guide de Réglage à l'équipement PD3A 6xxx NT ING TENE-GESCC-EICE 03 0128*, 2003.

[3] RTE Gestionnaire du Réseau du Transport Electricité Nord Est, 62, RUE LOUIS DELOS - TSA 61011 - 59709 MARCQ EN BAROEUL CEDEX France. *Dépannage PD3A M6984-3*, 2003.

[4] RTE Gestionnaire du Réseau du Transport Electricité Nord Est, 62, RUE LOUIS DELOS - TSA 61011 - 59709 MARCQ EN BAROEUL CEDEX France. *Guide de mise en service d'une protection de distance PSC PD3A 6562*, 2007.