DIgSILENT

POWERFACTORY

PowerFactory 2021

Technical Reference

Alstom PXLC 3000

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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 Alstom

Model PXLC 3000

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

2 General description

The Alstom PXLC 3000 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 Alstom PXLC 3000 relays have been modeled with the following relay models:

- PXLC 3000 1 amp - 50 Hz
- PXLC 3000 5 amp - 50 Hz

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].

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 Alstom PXLC 3000 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 and of an independent overcurrent starting (*MTS* feature).
The distance starting is controlled by some other multiple minimum current starting logics. Separated phase and earth starting thresholds are present.
The independent overcurrent starting models the *MTS* features and consists of two ovecurrent elements checking the phase current values and the $|I_A| + |I_B| + |I_C|$ value.
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 mho starting element (*"X4X5"* 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 phase overcurrent elements for the MTS starting logic(*"MTS fault detection"*, and *"MTS fault detection (3ph)"* block).
- Two logic elements (*"FaultDetectionLogic"*, and *"BlownfuseLogic"* block).
- One calculation element (*"Icalc"* 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.
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 $I_{biased} = 0.2 I_n + 0.2 * I_{max}$ with $I_{max} = max(I_A, I_B, I_C)$
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.
The MTS starting logic which compares the phase currents with kI_n is modeled by the *"MTS fault detection (3ph)"* block. The $|I_A| + |I_B| + |I_C|$ value is calculated by the *"Icalc"* block, and the *"MTS fault detection"* block checks if it is greater than $1.5kI_n$ to declare the starting.

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"*)	0.2-3.2 step 0.2 In	
	K	MTS fault detection	Pickup Current (*"Ipset"*)	1.5;3;4.5;6;7.5	Relay internal switches
	X4	X4X5	+ Reactance (*"xpos"*)	5-500 step 0.1 Ω (1A)	
				1-100 step 0.02 Ω (5A)	
	K5	X4X5	- Reactance (*"xneg"*)	0.625-500 step 0.0125 Ω (1A)	$xneg = K5 * X4$
				0.125-100 step 0.025 Ω (5A)	

3.3 Protective elements

The Alstom PXLC 3000 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(*"X1"* and *"X2"* block).
- Two Distance directional elements (*"Dir-Z"*, and *"Dir-Z reverse"* block).
- One Polarizing element (*"Polarizing"* block).
- Two polarizing logic blocks (*"Deph120"* and *"Deph60"* block).
- Four timers (*"T1"*, *"T2"*, *"T3"* and *"T4"* block).
- One distance mho element which defines the out of step/power swing external zone (*"DX"* block).
- Three logic elements (*"Deph60"*, *"Deph120"*, and *"I logic 3ph"* 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 A polarizing element calculates the polarizing voltage and the operating current for the directional element (*"Dir-Z"* block) and for the mho and for the blinder elements (*"X1"*, *"X2"*, *"X4X5"* and *"DX"* block). The *"Polarizing"* block is uses a self polarization. The voltage rotations is done by the *"Deph120"* and the *"Deph60"* block.

Directional element The distance directional element (*"Dir-Z"*, and *"Dir-Z reverse"* block) use the polarizing voltages and the operating currents calculated by polarizing element (*"Polarizing"* block) and the *"Deph120"* and the *"Deph60"* block which rotate the polarizing voltages. Indeed the polarizing voltages used by the phase-ground loops are rotated by 60° and the voltages used by the phase-phase loops are rotated by 120°. The directional angle is not user configurable and is equal to 27°. The *"I logic 3ph"* element select the phase A current if a 3 phase fault has been detected.

The following operating currents and polarizing voltages are used:

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

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 *"X4X5"* 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 mhos define by the *"X4X5"* 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	X1	Reactance (*"X"*)	0.2-100 step 0.01 Ω (1A)	
				0.04-20 step 0.01 Ω (5A)	
	X2	X2	Reactance (*"X"*)	0.2-100 step 0.01 Ω (1A)	
				0.04-20 step 0.01 Ω (5A)	
	K0	Polarizing	K0 (*"k0"*)	0-1.5 step 0.01	
	ϕ	Polarizing	Angle (*"phik0"*)	45-86 step 2.7333°	
	T1	T1	Time Setting (*"Tdelay"*)	0-0.495 step 0.05 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	

Address	Relay Setting	Model block	Model Parameter	Range	Note
	ΔX	DX	+ Reactance (*"xpos"*)	5-500 step 0.1 Ω (1A) 1-100 step 0.02 Ω (5A)	ΔX = xpos-X4X5.xpos
			- Reactance (*"xneg"*)	0.625-500 step 0.0125 Ω (1A) 0.125-100 step 0.025 Ω (5A)	ΔX = xneg-X4X5.xneg

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:

- Distance measurement with MTS (see 2.3.4 of [1]).
- Accelerated trip schemes (see annex 3 of [1]).
- Directional memory voltage (see 2.3.5.2 of [1])

5 References

[1] Alstom T&D, GEC ALSTHOM T&D Protection & Controle Service Marketing HT Font de la Banquiére Avenue de Figuiéres 34975 LATTES CEDEX France. *PROTECTION DE DISTANCE PXLC 3000-1 Guide de Mise en Service et de Maintenance Version EDF 01/98 MS/M 6767-C*, 1998.