PowerFactory 2021

Technical Reference

AEG PD531

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PowerFactory 2021
Revision 924

Contents

1   Model information

Manufacturer   AEG

Model   PD531

Variants   The AEG PD531 PowerFactory relay model can be used to simulate the AEG PD531 - 301 - 403 - 602 relay versions. However please consider that the model has been implemented with a reduced set of the features available in the relays.

2   General description

The AEG PD531 distance protection devices are used for selective short-circuit protection in high-voltage systems. The systems can be operated as impedance grounded, resonant-grounded or isolated-neutral systems.

The AEG PD531 PowerFactory relay models consist of a main relay model and the "BUOC" sub relay:

The following model versions are available:

- PD531-1A
- PD531-5A

The AEG PD531 PowerFactory relay models have been implemented trying to simulate the most commonly used protective functions.

The main relay contains the measurement and acquisition units, the starting element, the polarizing elements, the directional element for the distance elements, the reclosing element, the circular impedance and the polygonal distance elements, a set of timers, the output logic and the sub relay.

The model implementation has been based on the information available in the relay manuals [1].

3   Supported features

3.1   Measurement and acquisition

The voltage and the current are measured by one three phase current transformer ("Ct" block) and one three phase voltage transformer ("Vt" block).

Three measurement units ("Measurement", "Delta Measurement" and "V seq Measurement" block) are fed by this CT and this VT.

3.1.1   Available Units and Input Signals

- One three phase current transformers ("Ct" block).

- One three phase voltage transformer ("Vt" block).

- One three phase measurement element calculating both the current and voltage values ("Measurement" block).

- One three phase measurement element calculating the phase to phase currents and the phase to phase voltages ("Delta Measurement" block).

- One three phase measurement element calculating the voltage sequence vectors ("V seq Measurement" block)

3.1.2   Functionality

The input current and voltage values are sampled at 24 samples/cycle. The average values are processed by a DFT filter, operating over a cycle, which then calculates the voltage and current values used by the protective elements.

The "Delta Measure" block calculates the current and voltage ph-ph values used by the phase-phase loop distance elements.

3.1.3   Data input

The nominal current and the nominal voltage values MUST be entered in all the measurement blocks.

3.2   Main Relay protective elements

The starting element, the polarizing element, the directional element, the circular impedance and the polygonal distance elements are working together to simulate the AEG PD531 distance functionalities. An additional over voltage element is simulating the *Displacement Voltage Time Protection* function.

3.2.1   Available Units

- One starting unit implementing the fault detection logic ("Starting" block).

- One directional element ("Dir-Z" block).

- One polarizing block ('Polarizing" block).

- Four circular impedance distance elements ("Z1Mho", "Z2Mho", "Z3Mho" and "Z4Mho" block).

- Four polygonal distance elements ("PPZ1", "PPZ2", "PPZ3" and "PPZ4" block)

- Six timers ("T1", "T2", "T3", "T4", "T5" and "T6" block)

- One reclosing element ("Reclosing" block)

- One overvoltage element ("VN>>" block)

3.2.2   Functionality

Starting element   The AEG PD531 relay model starting element ("Starting" block) simulates the relay fault detection functions; the following logics are supported:

- *Overcurrent*

- *Undervoltage*

- *Earth* (always active)

The "Fault loop settings" feature is also available. The *Overcurrent* and the *Undervoltage* starting logic can be enabled or disabled by the user.

Directional element   The directional element ("Dir-Z" block) is controlling both the phase-phase and the phase-ground loops. The directional angles are fixed and the element is modeling in detail the behavior of the relay directional function.

Polarizing element   The polarizing element is calculating the voltage vectors used by the directional element. The voltage memory is activated when the voltage RMS value drops below 15% Un, the memory lasts for 2 seconds.

Circular impedance elements   The circular impedance elements implement an impedance circle with the center in the axes origin;the *Arc compensation* additional area is also available. The elements get the phase-phase and the phase-ground loop impedance values from the *Polarizing* block and check that the impedance point is inside the circle and the arc extension area; in that case they activate the output signal after that time delay provided by the associated timer is expired.

Polygonal impedance elements   The polygonal impedance elements implement a quadrilateral shape with different resistance reach for the phase-phase and the phase-ground loops. The elements get the phase-phase and the phase-ground loop impedance values from the *Polarizing* block and check that the impedance point is inside the quadrilateral; in that case they activate the output signal after that time delay provided by the associated timer is expired.

Timers   The timers start counting the time as soon that a fault has been detected by the *Starting* element ("ystart" output signal). Four timers ("T1", "T2", "T3" and "T4") are associated to the circular impedance and polygonal elements. The remaining timers can be used to trigger a delayed backup trip:

- the "T5" output signal is evaluated by the output logic together with "ystart", output signal of the "Starting" block. When both are *on* a trip command is sent to the power breaker.

- the "T6" output signal is evaluated by the output logic alone. When the "T6" output signal is *on* a trip command is sent to the power breaker.

Recloser   The reclosing element can be set to trigger a variable number of reclosing attempts. Different dead times can be set for the first reclosing attempt (high speed reclosing) and for the following attempts. If the high speed reclosing is not used the dead times must be set identical and equal to time delay reclosing dead time. Only the 3 phase reclosing logic is supported.

Over voltage element   The over voltage element is a definite time residual over voltage element simulating the *Displacement Voltage Time Protection* relay function.

3.2.3   Data input

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

Starting element   :

Address	Relay Setting	Model block	Model setting	Note
	Neutral-point treat.	Starting	System Grounding (isysstar)	"Basic Data" tab page
	Transfer for 1p	Starting	Transfer for 1p (itransf1p)	"Fault Loop Settings" tab page
	I>>	Starting	I>> (IMM)	"Overcurrent" tab page
	Operate value I>	Starting	I> high range (IM1)	"Underimpedance" tab page
	Operating mode at V<	Starting	V Operation Mode (iVOpMode)	"Undervoltage" tab page
		Starting	Undervoltage (iopt_u)	"Basic Data" tab page uncheck the checkbox when the operation mode is "W/o V< starting"

Address	Relay Setting	Model block	Model setting	Note
	Operate value V<:<	Starting	U< (Um)	"Undervoltage" tab page
	Meas. Start. 1pG	Starting	Meas. start. 1pG (iStart1pG)	"Fault Loop Settings" tab page
	Meas. Start. 2pG	Starting	Meas. start. 2pG (iStart2pG)	"Fault Loop Settings" tab page
	Meas. Start. 3pG	Starting	Meas. start. 3pG (iStart3pG)	"Fault Loop Settings" tab page
	Operate value IN>	Starting	IN> sens. range (INM)	"Earth Fault Detection" tab page
	delay time tIN>	Starting	tIN> (tINM)	"Earth Fault Detection" tab page
	Operate value VN-G>	Starting	VNG> (VNGM)	"Earth Fault Detection" tab page

Directional element   :

No user input is required.

Polarizing element   :

Address	Relay Setting	Model block	Model setting	Note
	Abs. value kG	Polarizing	k0 (k0)	
	Angle kG [2]	Polarizing	Angle (phik0)	

Circular impedance elements   :

Address	Relay Setting	Model block	Model setting	Note
	Characteristic	Zy[1]Mho	Out of Service (outserv)	enable if "Characteristic" is "Circle"
	Measurement Direction Ny[1]	Zy[1]Mho	Tripping Direction (idir)	
	Impedance Zy[1]	Zy[1]Mho	Replica Impedance (Zm)	
	αy[1] (circle)	Zy[1]Mho	Alpha (arcalpha)	in the "Arc compensation" tab page
	Arc comp. circle	Zy[1]Mho	Enable (arcen)	in the "Arc compensation" tab page

Polygonal impedance elements   :

Address	Relay Setting	Model block	Model setting	Note
	Characteristic Ny[1]	PPZy[1]	Out of Service (outserv)	enable if "Characteristic" is "Polygon"
	Direction Ny[1]	PPZy[1]	Tripping Direction (idir)	
	Reactance Xy[1]	PPZy[1]	+X Reach (Xmax)	
	Resistance, phase-to-ground Ry[1]	PPZy[1]	+R Resistance (PH-E) (REmax)	
	Resistance, phase-to-phase Ry[1]	PPZy[1]	+R Resistance (Rmax)	
	αy[1]	PPZy[1]	Relay Angle (phi)	
	σy[1]	PPZy[1]	+X Angle (beta)	

[1]y = 1,2,3,4

Timers :

Address	Relay Setting	Model block	Model setting	Note
	t1	T1	Time Setting (Tdelay)	
	t2	T2	Time Setting (Tdelay)	
	t3	T3	Time Setting (Tdelay)	
	t4	T4	Time Setting (Tdelay)	
	t5	T5	Time Setting (Tdelay)	
	t6	T6	Time Setting (Tdelay)	

Recloser :

Address	Relay Setting	Model block	Model setting	Note
	Enable PSx[5]	Reclosing	No-reclosing (reclnotactive)	
	Dead time 1p PSx[5]	Reclosing	Reclosing Interval 1 (recltime1)	
	Dead time 3p PSx[5]	Reclosing	Reclosing Interval 1 (recltime1)	
	No. permit. TDR PSx[5]	Reclosing	Operations to lockout (oplockout)	Set oplockout = No. permit. TDR PSx[5] + 2 (if *HSR/TDR permitted*), oplockout = No. permit. TDR PSx[5] + 1 (if *TDR only permitted*)
	TDR dead time PS[5]	Reclosing	Reclosing Interval 1 (recltime1)	
	Reclaim time PS[5]	Reclosing	Reset Time (resettime)	

Displacement Voltage :

Address	Relay Setting	Model block	Model setting	Note
	Operate value VN-G>>	VN>>	Pickup Voltage (Uset)	
	Delay time tVN-G>>	VN>>	Time Delay (Tdel)	

3.3   BUOC sub relay

The "BUOC" sub relay implements a 3 phase over current element and a neutral current over current element used for back up purposes. The "BUOC" sub relay simulates the *Backup overcurrent protection (BUOC)* relay function.

3.3.1   Available Units

- Two three phase over current element ("I>" block).

- One single phase neutral over current element("IN>" block).

3.3.2   Functionality

Two define time over current elements are present.

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 setting	Note
	Operate value I>BUOC	I>	Pickup Current (Ipset)	
	Delay time tI>BUOC	tI>	Time Setting (Tset)	
	Operate value IN>BUOC	IN>	Pickup Current (Ipset)	
	Delay time tIN>,BUOC	tIN>	Time Setting (Tset)	

3.4   Output logic

The output logic is the interface between the relay and the power system. A set of relay output signals can be used to simulate the control logics.

3.4.1   Available Units

The trip logic is implemented by the "Logic" block located in the main relay. The "Closing Logic" block controlled by the reclosing feature ("Reclosing" block) has the purpose of generating a closing command for the power breaker when a reclosing attempt is triggered.

3.4.2   Functionality

The "Logic" block located in the main relay has the task to operate the power breaker when a trip command has been issued by any protective element.
The output signals which is used to operate the breaker is "yout". The following relay output signals and relevant logics are also available:

- Z1TRIP (connected to the 1st distance polygonal zone trip signal)

- Z2TRIP (connected to the 2nd distance polygonal zone trip signal)

- Z3TRIP (connected to the 3rd distance polygonal zone trip signal)

- Z4TRIP (connected to the 4th distance polygonal zone trip signal)

- Z5TRIP (connected to the "T5" timer output signal and to the starting element start signal)

- Z6TRIP (connected to the "T6" timer output signal)

- START (connected to the starting element start signal)

The "Logic" block implements a three phases trip logic.

3.4.3   Data input

Please disable the "Logic" block in the main relay to disable the relay model ability to open the power circuit.

The relay output signal logics can be modified inserting a custom logic in the "Logic" tab page of the "Logic" block.

4   Features not supported

4.1   Main features

The following features are not supported:

- Circuit Breaker Failure Protection.

- Switch Onto Fault Protection.

- Protective Signaling.

- Ground Fault Direction Determination by Steady-State Power Evaluation.

- Ground Fault Detection by Steady-State Current Evaluation.

- Measuring Circuit Monitoring

5 References

[1] AEG Energietechnik GmbH, System Protection and Control, Lyoner Straβe 44-48,D-60528 Frankfurt Postfach 71 01 07, D-60491 Frankfurt Germany. *PD 531 Distance Protection Device SLTS.06.04213/1295 EN - Gru - Lp.*