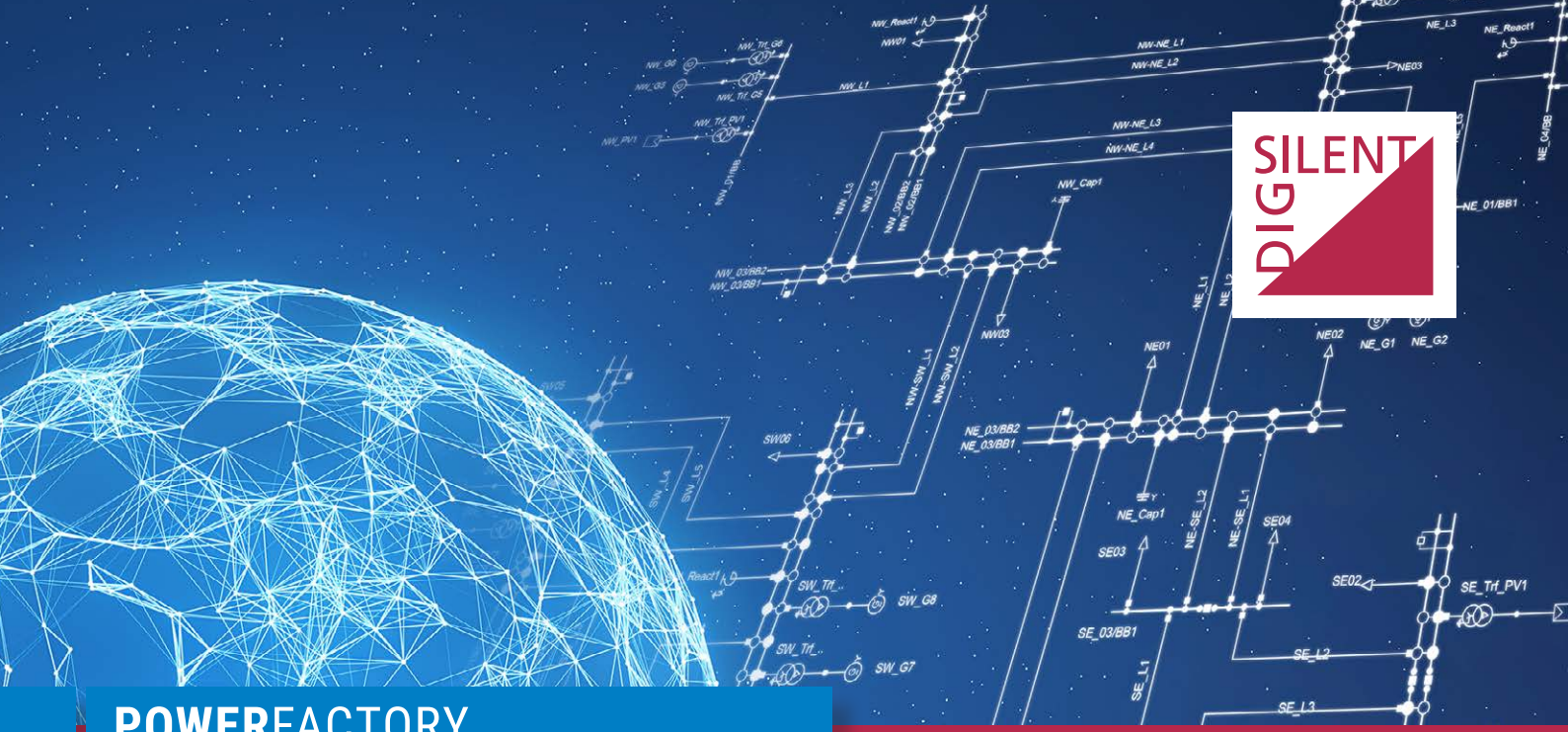

PowerFactory 2021

Technical Reference

AEG PD552

PF2021

POWER SYSTEM SOLUTIONS

MADE IN GERMANY

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Contents

1 Model information

Manufacturer AEG

Model PD552

Variants The AEG PD552 PowerFactory relay model can be used to simulate the AEG PD552 401 - 402 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 PD552 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 PD552 PowerFactory relay models consist of a main relay model and the following three sub relays:

- BUOC (backup overcurrent function)
- DTOC+IDMT (phase, ground and negative sequence overcurrent function)
- VmM (voltage function)

The following model versions are available:

- PD552-1A
- PD552-5A

The AEG PD552 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 PD552 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 PD552 relay model starting element (”Starting” block) simulates the relay fault detection functions; the following logics are supported:

- *Overcurrent*
- *Undervoltage*
- *Underimpedance*
- *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>> PSx[1]	Starting	I>> (IMM)	”Overcurrent” tab page
	Operate value I> PSx[1]	Starting	I> high range (IM1)	”Underimpedance” tab page
	Operating mode at V< PSx[1]	Starting	V Operation Mode (iVOpMode)	”Undervoltage” tab page

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

Address	Relay Setting	Model block	Model setting	Note
		Starting	Undervoltage (iopt_u)	”Basic Data” tab page uncheck the checkbox when the operation mode is ”W/o V< starting”
	Operate value V<:< PSx[2]	Starting	U< (Um)	”Undervoltage” tab page
	Operat. mode Z< PSx[2]	Starting	Z Operation Mode (iZOpMode)	”Underimpedance” tab page
		Starting	Underimpedance (iopt_z)	”Basic Data” tab page uncheck the checkbox when the operation mode is ”W/o Z< starting”
	Xfw PSx[2]	Starting	Forward Reactance (Xfw)	”Underimpedance” tab page
	Rfw,PG PSx[2]	Starting	Forward Resistance, Ph-E (RfPG)	”Underimpedance” tab page
	Rfw,PP PSx[2]	Starting	Forward Resistance, Ph-Ph (RfPP)	”Underimpedance” tab page
	Zfw,PG PSx[2]	Starting	Forward Impedance, Ph-E (ZfPG)	”Underimpedance” tab page
	Zfw,PP PSx[2]	Starting	Forward Impedance, Ph-Ph (ZfPP)	”Underimpedance” tab page
	Zbw/Zfw PSx[2]	Starting	Backward/Forward Impedance Ratio (ZbwZfw)	”Underimpedance” tab page
	Load Angle β PSx[2]	Starting	LoadAngle (Beta)	”Underimpedance” tab page
	Meas. Start. 1pG PSx[2]	Starting	Meas. start. 1pG (iStart1pG)	”Fault Loop Settings” tab page
	Meas. Start. 2pG PSx[2]	Starting	Meas. start. 2pG (iStart2pG)	”Fault Loop Settings” tab page
	Meas. Start. 3pG PSx[2]	Starting	Meas. start. 3pG (iStart3pG)	”Fault Loop Settings” tab page
	Operate value IN> PSx[2]	Starting	IN> sens. range (INM)	”Earth Fault Detection” tab page
	delay time tIN> PSx[2]	Starting	tIN> (tINM)	”Earth Fault Detection” tab page
	Operate value VN-G> PSx[2]	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 PSx[2]	Polarizing	k0 (k0)	
	Angle kG [2] PSx[2]	Polarizing	Angle (phik0)	

Circular impedance elements :

Address	Relay Setting	Model block	Model setting	Note
	Characteristic PSx[2]	Zy[3]Mho	Out of Service (outserv)	enable if ”Characteristic” is ”Circle”

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

Address	Relay Setting	Model block	Model setting	Note
	Measurement Direction Ny[3] PSx[2]	Zy[3] Mho	Tripping Direction (idir)	
	Impedance Zy[3] PSx[2]	Zy[3] Mho	Replica Impedance (Zm)	
	αy[3] (circle) PSx[2]	Zy[3] Mho	Alpha (arcalpha)	in the ”Arc compensation” tab page
	Arc comp. circle PSx[4]	Zy[5] Mho	Enable (arcen)	in the ”Arc compensation” tab page

Polygonal impedance elements :

Address	Relay Setting	Model block	Model setting	Note
	Characteristic Ny[5]PSx[4]	PPZy[5]	Out of Service (outserv)	enable if ”Characteristic” is ”Polygon”
	Direction Ny[5] PSx[4]	PPZy[5]	Tripping Direction (idir)	
	Reactance Xy[5] PSx[4]	PPZy[5]	+X Reach (Xmax)	
	Resistance, phase-to-ground Ry[5] PSx[4]	PPZy[5]	+R Resistance (PH-E) (REmax)	
	Resistance, phase-to-phase Ry[5] PSx[4]	PPZy[5]	+R Resistance (Rmax)	
	αy[5] PSx[4]	PPZy[5]	Relay Angle (phi)	
	σy[5] PSx[4]	PPZy[5]	+X Angle (beta)	

Timers :

Address	Relay Setting	Model block	Model setting	Note
	t1 PSx[4]	T1	Time Setting (Tdelay)	
	t2 PSx[4]	T2	Time Setting (Tdelay)	
	t3 PSx[4]	T3	Time Setting (Tdelay)	
	t4 PSx[4]	T4	Time Setting (Tdelay)	
	t5 PSx[4]	T5	Time Setting (Tdelay)	
	t6 PSx[4]	T6	Time Setting (Tdelay)	

Recloser :

Address	Relay Setting	Model block	Model setting	Note
	Enable PSx[4]	Reclosing	No-reclosing (reclnotactive)	
	Dead time 1p PSx[4]	Reclosing	Reclosing Interval 1 (recltime1)	
	Dead time 3p PSx[4]	Reclosing	Reclosing Interval 1 (recltime1)	
	No. permit. TDR PSx[4]	Reclosing	Operations to lockout (oplockout)	Set oplockout = No. permit. TDR PSx[5] + 2 (if *HSR/TDR permitted*), oplockout = No. permit. TDR PSx[4] + 1 (if *TDR only permitted*)
	TDR dead time PSx[4]	Reclosing	Reclosing Interval 1 (recltime1)	
	Reclaim time PSx[4]	Reclosing	Reset Time (resettime)	

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

Displacement Voltage :

Address	Relay Setting	Model block	Model setting	Note
	Operate value VN-G>> PSx[4]	VN>>	Pickup Voltage (Uset)	
	Delay time tVN-G>> PSx[4]	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 PSx[6]	I>	Pickup Current (Ipset)	
	Delay time tI>BUOC PSx[6]	tI>	Time Setting (Tset)	
	Operate value IN>BUOC PSx[6]	IN>	Pickup Current (Ipset)	
	Delay time tIN>,BUOC PSx[6]	tIN>	Time Setting (Tset)	

[6] x = 1,2,3,4

3.4 DTOC+IDMT sub relay

The ”DTOC+IDMT” sub relay protective functions operate on the basis of the phase current, of the residual current and of the negative sequence current. A set of inverse time and definite time phase, residual and negative sequence current elements can be used to clear overload and close-in faults and for fast back-up earth fault protection. The ”DTOC+IDMT” sub relay simulates the *Definite-time overcurrent protection (DTOC)* and the *Inverse-time overcurrent protection (IDMT)* relay function.

3.4.1 Available Units

- One inverse time 3 phase over current element (”Iph IDMT” block).
- Four define time 3 phase over current elements (”I>”, ”I>>”, ”I>>>” and ’I>>>>” block).
- One inverse time residual over current element (”IN IDMT” block).
- Four define time residual over current elements (”IN>”, ”IN>>”, ”IN>>>” and ’IN>>>>” block).
- One inverse time negative sequence over current element (”Ineg IDMT” block).
- Four define time negative sequence over current elements (”Ineg>”, ”Ineg>>”, ”Ineg>>>” and ’Ineg>>>>” block).

3.4.2 Functionality

The model is simulating the over current elements present in the relay protective functions.

The inverse time elements are supporting the following inverse time and definite time trip characteristics (the IEEE/ANSI characteristics are also associate to an inverse time reset characteristic):

- Definite Time
- Standard inverse
- Very inverse
- IEC Extremly inverse
- IEC Long time inverse
- IEEE Moderately inverse (associated to the ”IEEE Moderately inverse reset” reset characteristic)
- IEEE Very inverse (associated to the ”IEEE Very inverse reset” reset characteristic)
- IEEE Extremely inverse (associated to the ”IEEE Extremely inverse reset” reset characteristic)
- ANSI Long Time inverse (associated to the ”ANSI Long Time inverse reset” reset characteristic)
- ANSI Normally inverse (associated to the ” ANSI Normally inverse reset” reset characteristic)
- ANSI Short Time inverse (associated to the ”ANSI Short Time inverse reset” reset characteristic)

- RI-Type inverse
- RXIDG-Type inverse

The inverse time element trip characteristic equations comply with the IEC 60255-3 and the ANSI standards.

3.4.3 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
	Enable PSx[7]	DTOC+IDMT	Out of Service (outserv)	Subrelay setting
	Iref,P PSx[7]	Iph IDMT	Current Setting (Ipset)	
	Characteristic P PSx[7]	Iph IDMT	Characterstic (pcharac)	
	Factor kt,P PSx[7]	Iph IDMT	Time Dial (Tpset)	
	Reset P PSx[7]	Iph IDMT	Reset Characteristic (resetdis)	Set the check box when ”Delayed as per char”
	I > PSx[7]	I>	Pickup Current (Ipset)	
	tI > PSx[7]	I>	Time Setting (Tset)	
	I >> PSx[7]	I>>	Pickup Current (Ipset)	
	tI >> PSx[7]	I>>	Time Setting (Tset)	
	I >>> PSx[7]	I>>>	Pickup Current (Ipset)	
	tI >>> PSx[7]	I>>>	Time Setting (Tset)	
	I>>>> PSx[7]	I>>>	Pickup Current (Ipset)	
	tI>>>> PSx[7]	I>>>	Time Setting (Tset)	
	Iref,N PSx[7]	IN IDMT	Current Setting (Ipset)	
	Characteristic N PSx[7]	IN IDMT	Characterstic (pcharac)	
	Factor kt,N PSx[7]	IN IDMT	Time Dial (Tpset)	
	Reset N PSx[7]	IN IDMT	Reset Characteristic (resetdis)	Set the check box when ”Delayed as per char”
	IN > PSx[7]	IN>	Pickup Current (Ipset)	
	tIN > PSx[7]	IN>	Time Setting (Tset)	
	IN >> PSx[7]	IN>>	Pickup Current (Ipset)	
	tIN >> PSx[7]	IN>>	Time Setting (Tset)	
	IN >>> PSx[7]	IN>>>	Pickup Current (Ipset)	
	tIN >>> PSx[7]	IN>>>	Time Setting (Tset)	
	IN>>>> PSx[7]	IN>>>	Pickup Current (Ipset)	
	tIN>>>> PSx[7]	IN>>>	Time Setting (Tset)	
	Iref,neg PSx[7]	Ineg IDMT	Current Setting (Ipset)	
	Characteristic neg PSx[7]	Ineg IDMT	Characterstic (pcharac)	
	Factor kt,neg PSx[7]	Ineg IDMT	Time Dial (Tpset)	
	Reset neg PSx[7]	Ineg IDMT	Reset Characteristic (resetdis)	Set the check box when ”Delayed as per char”
	Ineg > PSx[7]	Ineg>	Pickup Current (Ipset)	
	tIneg > PSx[7]	Ineg>	Time Setting (Tset)	
	Ineg >> PSx[7]	Ineg>>	Pickup Current (Ipset)	
	tIneg >> PSx[7]	Ineg>>	Time Setting (Tset)	
	Ineg >>> PSx[7]	Ineg>>>	Pickup Current (Ipset)	
	tIneg >>> PSx[7]	Ineg>>>	Time Setting (Tset)	
	Ineg>>>> PSx[7]	Ineg>>>	Pickup Current (Ipset)	
	tIneg>>>> PSx[7]	Ineg>>>	Time Setting (Tset)	

[7] x = 1,2,3,4

3.5 VmM sub relay

The ”VmM” sub relay consists of a set of definite time phase, positive sequence, negative sequence and residual over voltage elements and of a set definite time phase and positive sequence under voltage elements. The sub relay simulates the *Over-/undervoltage protection (V<>)* relay function.

3.5.1 Available Units

- Two definite time 3 phase over voltage elements (”V>” and ”V>>” block).
- Two definite time residual over voltage elements (”VN>” and ”VN>>” block).
- Two definite time positive sequence over voltage elements (”Vpos>” and ”Vpos>>” block).
- Two definite time negative sequence over voltage elements (”Vneg>” and ”Vneg>>” block).
- Two definite time 3 phase under voltage elements (”V<” and ”V<< ” block).
- Two definite time positive sequence under voltage elements (”Vpos<” and ”Vpos<< ” block).

3.5.2 Functionality

This sub relay is providing the basic features of the relay voltage functions.

3.5.3 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
	Enable PSx[8]	VmM	Out of Service (outserv)	Subrelay object setting
	V> PSx[8]	V>	Pickup Voltage (Uset)	
	tV> PSx[8]	V>	Time Delay (Tdel)	
	V>> PSx[8]	V>>	Pickup Voltage (Uset)	
	tV>> PSx[8]	V>>	Time Delay (Tdel)	
	VNG> PSx[8]	VN>	Pickup Voltage (Uset)	
	tVNG> PSx[8]	VN>	Time Delay (Tdel)	
	VNG>> PSx[8]	VN>>	Pickup Voltage (Uset)	
	tVNG>> PSx[8]	VN>>	Time Delay (Tdel)	
	Vpos> PSx[8]	Vpos>	Pickup Voltage (Uset)	
	tVpos> PSx[8]	Vpos>	Time Delay (Tdel)	
	Vpos>> PSx[8]	Vpos>>	Pickup Voltage (Uset)	
	tVpos>> PSx[8]	Vpos>>	Time Delay (Tdel)	
	Vneg> PSx[8]	Vneg>	Pickup Voltage (Uset)	
	tVneg> PSx[8]	Vneg>	Time Delay (Tdel)	
	Vneg>> PSx[8]	Vneg>>	Pickup Voltage (Uset)	
	tVneg>> PSx[8]	Vneg>>	Time Delay (Tdel)	
	V< PSx[9]	V<	Pickup Voltage (Uset)	
	tV< PSx[9]	V<	Time Delay (Tdel)	

[8] x = 1,2,3,4

Address	Relay Setting	Model block	Model setting	Note
	V<< PSx[8]	V<<	Pickup Voltage (Uset)	
	tV<< PSx[8]	V<<	Time Delay (Tdel)	
	Vpso< PSx[8]	Vpos<	Pickup Voltage (Uset)	
	tVpos< PSx[8]	Vpos<	Time Delay (Tdel)	
	Vpos<< PSx[8]	Vpos<<	Pickup Voltage (Uset)	
	tVpos<< PSx[8]	Vpos<<	Time Delay (Tdel)	

3.6 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.

3.6.1 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.

3.6.2 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 1^{st} distance polygonal zone trip signal)
- Z2TRIP (connected to the 2^{nd} distance polygonal zone trip signal)
- Z3TRIP (connected to the 3^{rd} distance polygonal zone trip signal)
- Z4TRIP (connected to the 4^{th} 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.

3.6.3 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.
- Thermal overload protection.

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 532 PD552 Distance Protection Device AFSV.06.05781 /0499EN - Ti/PDF*.