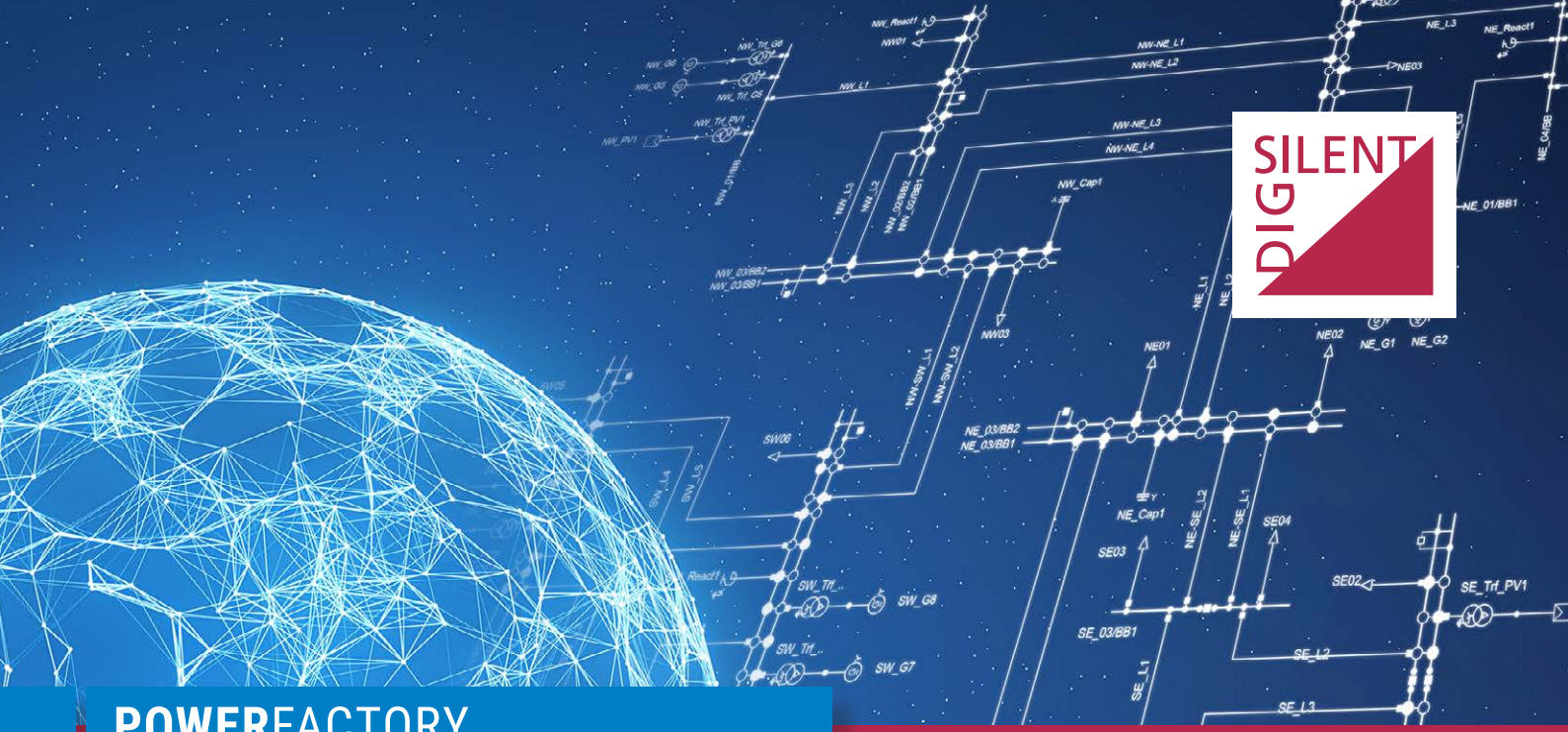

POWERFACTORY

PowerFactory 2021

Technical Reference

Areva P54x

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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 Areva

Model P54x

Variants The Areva P54x PowerFactory relay model can be used to simulate the Areva P541, P542, P543, P544, P545 and P546 relay. However please consider that the model has been implemented with a reduced set of the features available in the relays.

2 General description

The Areva P54x line distance protection device is a differential protective relay with additional distance protection elements designed to provide fast highly selective line protection. It can be applied in all kind of medium, high and extra high voltage systems. The wide range of protection functions covers all kind of applications in cable and overhead line protection.

The Areva P54x PowerFactory relay model consists of a main relay and four sub relays:

- Differential
- Overcurrent
- Polarizing
- Voltage

The Areva P54x PowerFactory relay model has been implemented trying to simulate the most commonly used protective functions.

The relay model contains the measurement and acquisition units, the starting elements, the reclosing element, the polygonal and the mho distance elements, a set of timers, the load encroachment element, the output logic and all other sub relays.

The model implementation has been based on the information available in the relay manual [1] [2] [3] .

3 Supported features

3.1 Measurement and acquisition

The voltage and the current are measured locally by one three phase current transformer (”Ct” block), one single phase current transformer (”CoreCt” block) and one three phase voltage transformer (”Vt” block). One additional three phase current transformer (”Remote Ct” block) represents the current transformer located at the other side of the line and feeding another relay connected via data link with the relay.

Five measurement units (”Measurement”, ”Delta Measurement”, ”Neutral Measurement”, ”Remote Measurement” and ”Seq Measurement” block) are fed by these CTs and this VT.

3.1.1 Available Units

- Two three phase current transformers (”Ct” and ”Remote Ct” block).
- One three phase voltage transformer (”Vt” block).
- One single phase current transformers (”CoreCt” block).
- One three phase measurement element calculating both the current and voltage values (”Measurement” block).
- One three phase measurement element calculating the current values at the remote location(”Remote 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 current and the voltage sequence vectors (”Seq Measurement” block).
- One single phase measurement element (”Neutral Measurement” block)

3.1.2 Functionality

The input current and voltage values are sampled at 48 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 Measurement” 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 load blinding element, the polygonal and the mho distance elements are working together to simulate the Areva P54x distance functionalities. The multiple polarizing elements and the directional elements are located in a subrelay. The ancillary overcurrent, voltage protective elements are located in two separated subrelays.

3.2.1 Available Units

- Five polygonal phase distance zones (”Z1P”, ”Z2P”, Z3P”, ”Z4P” and ”ZPP” block).
- Five polygonal ground distance zones (”Z1G”, ”Z2G”, Z3G”, ”Z4G” and ”ZPG” block).
- Five mho phase distance zones (”Z1PMho”, ”Z2PMho”, Z3PMho”, ”Z4PMho” and ”ZPPMho” block).
- Five mho ground distance zones (”Z1GMho”, ”Z2GMho”, Z3GMho”, ”Z4GMho”, ”ZPGMho” block).
- Five timers associated to the phase distance elements (”T1P”, ”T2P”, ”T3P”, ”T4P” and ”TZPP” block).
- Five timers associated to the ground distance elements (”T1G”, ”T2G”, ”T3G”, ”T4G” and ”TZPG” block).
- Five phase and ground overcurrent starting element (”Sensit. Iph> 1 Ignd> 1”, ”Sensit. Iph> 2 Ignd> 2”, ”Sensit. Iph> 3 Ignd> 3”,” Sensit. Iph> 4 Ignd> 4” and ”Sensit. Iph> P Ignd> G” block).
- One Auto-reclose function (”Reclosing” block).
- One Load blinders (”Load blinder” block).
- One starting unit implementing the fault detection logic minimum current threshold(”Starting” block).
- One directional element (”Dir-Z” block).
- Four polarizing blocks (”Polarizing Z1”, ”Polarizing Z2”, ”Polarizing Z3-Z4” and ”Polarizing ZP” block).
- Five phase minimum operating current elements (”Z1 Sensit Iph> 1” , ”Z2 Sensit Iph> 2”, ”Z3 Sensit Iph> 3”, ”ZP Sensit Iph> P” and ”Z4 Sensit Iph> 4” block)
- Six phase polygonal distance elements (”Z1 Ph”, ”Z2 Ph”, ”Z3 Ph”, ”Z4 Ph” , ”Z1X Ph” and ”ZP Ph” block).
- Six phase mho distance elements (”Z1 Ph Mho”, ”Z2 Ph Mho”, ”Z3 Ph Mho”, ”Z4 Ph Mho” , ”Z1X Ph Mho” and ”ZP Ph Mho” block).
- Five ground minimum operating current elements (”Z1 Sensit Igrnd> 1” , ”Z2 Sensit Igrnd> 2”, ”Z3 Sensit Igrnd> 3”, ”ZP Sensit Igrnd> P” and ”Z4 Sensit Igrnd> 4” block)
- Six ground polygonal distance elements (”Z1 Grnd”, ”Z2 Grnd”, ”Z3 Grnd”, ”Z4 Grnd” , ”Z1X Grnd” and ”ZP Grnd” block).
- Six ground mho distance elements (”Z1 Grnd Mho”, ”Z2 Grnd Mho”, ”Z3 Grnd Mho”, ”Z4 Grnd Mho” , ”Z1X Grnd Mho” and ”ZP Grnd Mho” block).
- Five timers associated to the phase distance elements(”T1P”, ”T2P”, ”T3P”, ”T4P” and ”TZPP” block).

- Five timers associated to the ground distance elements(”T1G”, ”T2G”, ”T3G”, ”T4G” and ”TZPP” block).
- One reclosing element (”Reclosing” block).
- Two definite time 3 phase overvoltage elements (”V> 1” and ”V> 2” block).
- Two definite time 3 phase undervoltage elements (”V< 1” and ”V< 2” block).
- Two inverse time 3 phase overcurrent elements (”I> 1” and ”I> 2” block).
- Two definite time 3 phase overcurrent elements (”I> 3” and ”I> 4” block).
- One directional definite time negative sequence overcurrent element (”I2>” block).
- One negative sequence directional element (”Neg seq Dir” block).
- Two directional inverse time residual overcurrent elements (”IN> 1” and ”IN> 2” block).
- One residual directional element (”Earth Dir” block).

3.2.2 Functionality

Polygonal impedance elements The polygonal impedance elements implement a quadrilateral shape with different impedance and resistance reaches 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 quadrilaterals; in that case they activate the output signal after that time delay provided by the associated timer is expired.

Mho elements The mho elements implement a mho shape which uses as polarizing voltage a user configurable combination of the self polarized voltage and of the memory self polarized voltage. Separated mho elements are monitoring the phase-ground and the phase-phase loops. The 3^{rd} zone mho can be configured as offset mho.

Load blinder The load blinder element (”Load Blinder” block) controls the phase-phase loops and inhibits the polygonal and the mho element trip when the calculated impedance is inside the load area.

Timers The timers start counting the time as soon that a fault has been detected by the *Starting* element (”ystart” output signal). Ten timers are associated to the polygonal and to the mho elements (”T1P”, ”T2P”, ”T3P”, ”T4P” and ”TZPP” to the phase elements, ”T1G”, ”T2G”, ”T3G”, ”T4G” and ”TZPP”to the ground elements).

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 each following attempt. A independent dead time after the trip can be set to be used when single phase ground fault has been detected. If the high speed reclosing is not used the dead times must be set identical and equal to time delay reclosing dead time. .

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):

Polygonal impedance elements :

Address	Relay Setting	Model block	Model setting	Note
3120	Z1 Ph Status	Z1P	Out of Service (outserv)	
3202	Z1 Ph. Reach	Z1P	Z Reach (Zmax)	
3203	Z1 Ph. Angle	Z1P	Relay Angle (phi)	
3207	R1 Ph. Resistive	Z1P	+R Resistance (Rmax)	
3208	Z1 Tilt Top Line	Z1P	+X Angle (beta)	
3209	Z1 Sensit. Iph> 1	Z1 Sensit Iph> 1	Pickup Current (Ipset)	
3130	Z2 Ph Status	Z2P	Out of Service (outserv)	
3210	Z2 Ph. Reach	Z2P	Z Reach (Zmax)	
3211	Z2 Ph. Angle	Z2P	Relay Angle (phi)	
3215	R2 Ph. Resistive	Z2P	+R Resistance (Rmax)	
3216	Z2 Tilt Top Line	Z2P	+X Angle (beta)	
3217	Z2 Sensit. Iph> 2	Z2 Sensit Iph> 2	Pickup Current (Ipset)	
3140	Z3 Ph Status	Z3P	Out of Service (outserv)	
3220	Z3 Ph. Reach	Z3P	Z Reach (Zmax)	
3225	Z3 Ph Rev Reach	Z3P	Z Reach (Zmax)	The Z fwd and rev reach are unique in the model
3221	Z3 Ph. Angle	Z3P	Relay Angle (phi)	
3222	Z3 Ph.Rev Reach	Z3P	-Z Reach (Zmaxrev)	
3225	R3 Ph. Res Fwd.	Z3P	+R Resistance (Rmax)	
3226	R3 Ph. Res Rev.	Z3P	-R Resistance (Rmin)	
3227	Z3 Tilt Top Line	Z3P	+X Angle (beta)	
3228	Z3 Sensit. Iph> 3	Z3 Sensit Iph> 3	Pickup Current (Ipset)	
3150	ZP Ph Status	ZPP	Out of Service (outserv)	
3151	ZP Ph. Dir.	ZPP	Tripping Direction (idir)	
3230	ZP Ph. Reach	ZPP	Z Reach (Zmax)	
3231	ZP Ph. Angle	ZPP	Relay Angle (phi)	
3235	RP Ph. Resistive	ZPP	+R Resistance (Rmax)	
3236	ZP Tilt Top Line	ZPP	+X Angle (beta)	
3237	ZP Sensit. Iph> P	ZP Sensit Iph> P	Pickup Current (Ipset)	
3160	Z4 Ph Status	Z4P	Out of Service (outserv)	
3240	Z4 Ph. Reach	Z4P	Z Reach (Zmax)	
3241	Z4 Ph. Angle	Z4P	Relay Angle (phi)	
3242	R4 Ph. Resistive	Z4P	+R Resistance (Rmax)	
3245	Z4 Tilt Top Line	Z4P	+X Angle (beta)	
3246	Z4 Sensit. Iph> 4	Z4 Sensit Iph> 2	Pickup Current (Ipset)	
3180	Z1 Gnd Status	Z1G	Out of Service (outserv)	
3251	Z1 Gnd. Reach	Z1G	Z Reach (Zmax)	
3252	Z1 Gnd. Angle	Z1G	Relay Angle (phi)	
3259	R1 Gnd. Resistive	Z1G	+R Resistance (Rmax)	
3254	Z1 Tilt Top Line	Z1G	+X Angle (beta)	
325B	Z1 Sensit. Ignd> 1	Z1 Sensit IGrnd> 1	Pickup Current (Ipset)	
3190	Z2 Gnd Status	Z2G	Out of Service (outserv)	

Address	Relay Setting	Model block	Model setting	Note
3260	Z2 Gnd. Reach	Z2G	Z Reach (Zmax)	
3261	Z2 Gnd. Angle	Z2G	Relay Angle (phi)	
3269	R2 Gnd. Resistive	Z2G	+R Resistance (Rmax)	
3264	Z2 Tilt Top Line	Z2G	+X Angle (beta)	
326B	Z2 Sensit. Ignd> 2	Z2 Sensit IGrnd> 2	Pickup Current (Ipset)	
31A0	Z3 Gnd Status	Z3G	Out of Service (outserv)	
3270	Z3 Gnd. Reach	Z3G	Z Reach (Zmax)	
3272	Z3 Gnd. Rev Reach	Z3G	-Z Reach (Zmaxrev)	
3271	Z3 Gnd. Angle	Z3G	Relay Angle (phi)	
3279	R3 Gnd. Res Fwd.	Z3G	+R Resistance (Rmax)	
327A	R3 Gnd. Res Rev.	Z3G	-R Resistance (Rmin)	
3274	Z3 Tilt Top Line	Z3G	+X Angle (beta)	
327C	Z3 Sensit. Iph> 3	Z3 Sensit Igrnd> 3	Pickup Current (Ipset)	
31B0	ZP Gnd Status	ZPG	Out of Service (outserv)	
31B1	ZP Gnd Dir.	ZPG	Tripping Direction (idir)	
3280	ZP Gnd. Reach	ZPG	Z Reach (Zmax)	
3281	ZP Gnd. Angle	ZPG	Relay Angle (phi)	
3289	RP Gnd. Resistive	ZPG	+R Resistance (Rmax)	
3284	ZP Tilt Top Line	ZPG	+X Angle (beta)	
328B	ZP Sensit. Ignd> P	ZP Sensit Igrnd> P	Pickup Current (Ipset)	
31C0	Z4 Gnd Status	Z4G	Out of Service (outserv)	
3290	Z4 Gnd. Reach	Z4G	Z Reach (Zmax)	
3291	Z4 Gnd. Angle	Z4G	Relay Angle (phi)	
3299	R4 Gnd. Resistive	Z4G	+R Resistance (Rmax)	
3294	Z4 Tilt Top Line	Z4G	+X Angle (beta)	
329B	Z4 Sensit. Ignd> 4	Z4 Sensit Igrnd> 2	Pickup Current (Ipset)	

Mho impedance elements :

Address	Relay Setting	Model block	Model setting	Note
3120	Z1 Ph Status	Z1PMho	Out of Service (outserv)	
3202	Z1 Phase Reach	Z1PMho	Z Replica Impedance (Zm)	
3203	Z1 Ph. Angle	Z1PMho	Relay Angle (phi)	
3130	Z2 Ph Status	Z2PMho	Out of Service (outserv)	
3210	Z2 Phase Reach	Z2PMho	Z Replica Impedance (Zm)	
3211	Z2 Ph. Angle	Z2PMho	Relay Angle (phi)	
3140	Z3 Ph Status	Z3PMho	Out of Service (outserv)	
3220	Z3 Phase Reach	Z3PMho	Z Replica Impedance (Zm)	
3221	Z3 Ph. Angle	Z3PMho	Relay Angle (phi)	
3150	ZP Ph Status	ZPPMho	Out of Service (outserv)	
3230	ZP Phase Reach	ZPPMho	Z Replica Impedance (Zm)	
3231	ZP Ph. Angle	ZPPMho	Relay Angle (phi)	
3160	Z4 Ph Status	Z4PMho	Out of Service (outserv)	
3240	Z4 Phase Reach	Z4PMho	Z Replica Impedance (Zm)	
3241	Z4 Ph. Angle	Z4PMho	Relay Angle (phi)	
3180	Z1 Gnd Status	Z1GMho	Out of Service (outserv)	
3251	Z1 Ground Reach	Z1GMho	Z Replica Impedance (Zm)	
3252	Z1 Gnd. Angle	Z1GMho	Relay Angle (phi)	
3190	Z2 Gnd Status	Z2GMho	Out of Service (outserv)	
3260	Z2 Ground Reach	Z2GMho	Z Replica Impedance (Zm)	
3261	Z2 Gnd. Angle	Z2GMho	Relay Angle (phi)	

Address	Relay Setting	Model block	Model setting	Note
31A0	Z3 Gnd Status	Z3GMho	Out of Service (outserv)	
3270	Z3 Ground Reach	Z3GMho	Z Replica Impedance (Zm)	
3271	Z3 Gnd. Angle	Z3GMho	Relay Angle (phi)	
31B0	ZP Gnd Status	ZPGMho	Out of Service (outserv)	
3280	ZP Ground Reach	ZPGMho	Z Replica Impedance (Zm)	
3281	ZP Gnd. Angle	ZPGMho	Relay Angle (phi)	
31C0	Z4 Gnd Status	Z4GMho	Out of Service (outserv)	
3290	Z4 Ground Reach	Z4GMho	Z Replica Impedance (Zm)	
3291	Z4 Gnd. Angle	Z4GMho	Relay Angle (phi)	

Load Blinder :

Address	Relay Setting	Model block	Model setting	Note
31D3	Load Blinders	Load Blinder	Out of Service (outserv)	
31D4	Load/B Impedance	Load Blinder	Reach(Reach)	
31D5	Load/B Angle	Load Blinder	Angle (Angle)	

Timers :

Address	Relay Setting	Model block	Model setting	Note
3409	Zone 1 Ph Delay	T1P	Time Setting (Tdelay)	
340A	Zone 1 Gnd Delay	T1G	Time Setting (Tdelay)	
3411	Zone 2 Ph Delay	T2P	Time Setting (Tdelay)	
3412	Zone 2 Gnd Delay	T2G	Time Setting (Tdelay)	
3419	Zone 3 Ph Delay	T3P	Time Setting (Tdelay)	
341A	Zone 3 Gnd Delay	T3G	Time Setting (Tdelay)	
3421	Zone P Ph Delay	TZPP	Time Setting (Tdelay)	
3422	Zone P Gnd Delay	TZP	Time Setting (Tdelay)	
3429	Zone 4 Ph Delay	T4P	Time Setting (Tdelay)	
342A	Zone 4 Gnd Delay	T4G	Time Setting (Tdelay)	

Recloser :

Address	Relay Setting	Model block	Model setting	Note
4905	Single Pole Shot	Reclosing	Operation mode	In the ”Operation Mode” tab page select ”1-pole auto reclosing for 1 phase and 3 pole auto reclosing for multi-phase faults” when the ”Trip Mode” is ”1 and 3 pole”, select ”3 pole auto reclosing for multi-phase faults” when the ”Trip Mode” is ”3 pole”
4906	3 Pole Shot	Reclosing	Operations to lockout (oplockout)	In the ”Basic Data” tab page
4907	1 Pole Dead Time	Reclosing	Reclosing int 1 1Ph-Grnd faults (recltime1 1ph)	In the ”Basic Data” tab page
4908	Dead Time 1	Reclosing	Reclosing Interval 1 (recltime1)	In the ”Basic Data” tab page
4909	Dead Time 2	Reclosing	Reclosing Interval 2 (recltime2)	In the ”Basic Data” tab page
490A	Dead Time 3	Reclosing	Reclosing Interval 3 (recltime3)	In the ”Basic Data” tab page
490B	Dead Time 4	Reclosing	Reclosing Interval 4 (recltime4)	In the ”Basic Data” tab page
490F	Reclaim Time	Reclosing	Reset Time (resettime)	In the ”Basic Data” tab page

3.3 Differential subrelay

3.3.1 Available Units

- Two CT ratio/connection compensation elements (”Wd_1 Adapt” and ”Wd_2 Adapt” block).
- One current differential element (”Differential” block).

3.3.2 Functionality

The *Differential* subrelay implements a differential elements with double slope bias restraint characteristic. Differences in the CT ratios and in the CT connections can be compensated by two additional compensation elements.

3.3.3 Data input

The relationships between the relay settings and the model parameters can be found in the following table:

Address	Relay Setting	Model block	Model setting	Note
3301	Phase Diff	Differential	Out of Service (outserv)	
3302	Phase Is1	Differential	Differential Current base threshold(Idiff)	
3303	Phase Is2	Differential	Restraint Current 2nd Threshold (Ipset2)	
3304	Phase k1	Differential	Restrain Percentage 1 (Irestrpercent1)	
3305	Phase k2	Differential	Restrain Percentage 1 (Irestrpercent1)	
3313	Id High Set	Differential	Unrestrained Differential Threshold	
3310	Compensation	Wd_1 Adapt	Current Transformer Ratio (CTratio)	
		Wd_2 Adapt	Current Transformer Ratio (CTratio)	
3315	Vectorial Comp	Wd_1 Adapt	Current Transformer Connection (icontype)	
		Wd_1 Adapt	Transformer Group (trasfgroup)	
		Wd_2 Adapt	Current Transformer Connection (icontype)	
		Wd_2 Adapt	Transformer Group (trasfgroup)	

3.4 Overcurrent subrelay

The *Overcurrent* sub relay simulates two phase overcurrent elements, two ground overcurrent elements, two sensitive ground overcurrent elements, one thermal image element with double time constant and one negative sequence overcurrent element. All elements, except the thermal image, have a directional feature.

3.4.1 Available Units

- Two directional inverse time phase overcurrent elements (”I> 1” and ”I> 2” block).
- Two directional definite time phase overcurrent element (”I> 3” and ”I> 4” block).
- One phase directional element (”Dir Ph” block).
- Two directional inverse time ground overcurrent elements (”IN> 1” and ”IN> 2” block).
- Two directional definite time ground overcurrent elements (”IN> 3” and ”IN> 4” block).
- Two ground directional elements (”Dir IN Io-Vo” and ”Dir IN Neg Seq” block)
- Two directional inverse time sensitive E/F overcurrent elements (”ISEF> 1” and ”ISEF> 2” block).
- Two directional definite time sensitive E/F overcurrent elements (”ISEF> 3” and ”ISEF> 4” block).
- One sensitive E/F directional element (”Dir ISEF” block).
- One thermal image element (”Thermal image 1” and ”Thermal image 2” block).
- One directional negative sequence overcurrent element (”I2> ” block).
- One directional negative sequence element (”Dir I2” block)

3.4.2 Functionality

The ground overcurrent elements can use as directional logic the zero sequence current and voltage phasor angle comparison (”Dir IN Io-Vo” block) or the negative sequence current and voltage phasor angle comparison (”Dir IN Neg Seq” block).

The relay thermal image element uses a double time constant which is modeled by two blocks, one for each time constant.

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 (associated to the ”Definite time reset” reset characteristic)
- IEC Standard inverse
- IEC Very inverse
- IEC Extremely 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)
- UK Long time inverse
- US CO-8 Inverse (associated to the ”US CO-8 Inverse reset” reset characteristic)
- US Short Time inverse (associated to the ”US Short time inverse reset” reset characteristic)

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:

Address	Relay Setting	Model block	Model setting	Note
3501	I> 1 Status	I> 1	Out of Service (outserv)	
3502	I> 1 Function	I> 1	Characteristic (pcharac)	
3503	I> 1 Directional	I> 1	Tripping Direction (idir)	
3504	I> 1 Current Set	I> 1	Current setting (Ipset)	
3505	I> 1 Time Delay	I> 1	Time Dial (Tpset)	Used in the relay by the DT characteristic
3506	I> 1 TMS	I> 1	Time Dial (Tpset)	Used in the relay by the IEC characteristics
3507	I> 1 Time Dial	I> 1	Time Dial (Tpset)	Used in the relay by the IEEE/US characteristic
3509	I> 1 tRESET	I> 1	Reset Delay (ResetT)	Activate the reset feature with the ”Reset Characteristic” check box
350A	I> 2 Status	I> 2	Out of Service (outserv)	
350B	I> 2 Function	I> 2	Characteristic (pcharac)	
350C	I> 2 Directional	I> 2	Tripping Direction (idir)	
350D	I> 2 Current Set	I> 2	Current setting (Ipset)	
350E	I> 2 Time Delay	I> 2	Time Dial (Tpset)	Used in the relay by the DT characteristic
350F	I> 2 TMS	I> 2	Time Dial (Tpset)	Used in the relay by the IEC characteristics
3510	I> 2 Time Dial	I> 2	Time Dial (Tpset)	Used in the relay by the IEEE/US characteristic
3512	I> 2 tRESET	I> 2	Reset Delay (ResetT)	Activate the reset feature with the ”Reset Characteristic” check box
3513	I> 3 Status	I> 3	Out of Service (outserv)	
3514	I> 3 Directional	I> 3	Tripping Direction (idir)	
3515	I> 3 Current Set	I> 3	Pickup Current (Ipset)	
3516	I> 3 Time Delay	I> 3	Time Setting (Tset)	
3518	I> 4 Status	I> 4	Out of Service (outserv)	
3519	I> 4 Directional	I> 4	Tripping Direction (idir)	
351A	I> 4 Current Set	I> 4	Pickup Current (Ipset)	
351B	I> 4 Time Delay	I> 4	Time Setting (Tset)	
351C	I> Char Angle	Dir Ph	Max. Torque Angle (mtau)	in the *Voltage Polarizing* tab page
3801	IN> 1 Status	IN> 1	Out of Service (outserv)	
3802	IN> 1 Function	IN> 1	Characteristic (pcharac)	
3803	IN> 1 Directional	IN> 1	Tripping Direction (idir)	
3829	IN> 1 Current Set	IN> 1	Current setting (Ipset)	

Address	Relay Setting	Model block	Model setting	Note
382C	IN> 1 Time Delay	IN> 1	Time Dial (Tpset)	Used in the relay by the DT characteristic
382D	IN> 1 TMS	IN> 1	Time Dial (Tpset)	Used in the relay by the IEC characteristics
382E	IN> 1 Time Dial	IN> 1	Time Dial (Tpset)	Used in the relay by the IEEE/US characteristic
3833	IN> 1 tRESET	IN> 1	Reset Delay (ResetT)	Activate the reset feature with the ”Reset Characteristic” check box
3835	IN> 2 Status	IN> 2	Out of Service (outserv)	
3836	IN> 2 Function	IN> 2	Characteristic (pcharac)	
3837	IN> 2 Directional	IN> 2	Tripping Direction (idir)	
383A	IN> 2 Current Set	IN> 2	Current setting (Ipset)	
383C	IN> 2 Time Delay	IN> 2	Time Dial (Tpset)	Used in the relay by the DT characteristic
383D	IN> 2 TMS	IN> 2	Time Dial (Tpset)	Used in the relay by the IEC characteristics
383E	IN> 2 Time Dial	IN> 2	Time Dial (Tpset)	Used in the relay by the IEEE/US characteristic
3844	IN> 2 tRESET	IN> 2	Reset Delay (ResetT)	Activate the reset feature with the ”Reset Characteristic” check box
3846	IN> 3 Status	IN> 3	Out of Service (outserv)	
3847	IN> 3 Directional	IN> 3	Tripping Direction (idir)	
384A	IN> 3 Current Set	IN> 3	Pickup Current (Ipset)	
384B	IN> 3 Time Delay	IN> 3	Time Setting (Tset)	
384D	IN> 4 Status	IN> 4	Out of Service (outserv)	
384E	IN> 4 Directional	IN> 4	Tripping Direction (idir)	
3851	IN> 4 Current Set	IN> 4	Pickup Current (Ipset)	
3852	IN> 4 Time Delay	IN> 4	Time Setting (Tset)	
3856	I> Char Angle	Dir IN Io-Vo	Max. Torque Angle (mtau)	in the *Voltage Polarizing* tab page
		Dir IN Neg Seq	Max. Torque Angle (mtau)	in the *Voltage Polarizing* tab page
3857	IN> Polarisation	Dir IN Io-Vo	Out of Service (outserv)	disable when the relay setting is ”negative sequence”
		Dir IN Neg Seq	Out of Service (outserv)	disable when the relay setting is ”zero sequence”
3859	IN> VNpol Set	Dir IN Io-Vo	Polarizing Voltage (upolur)	in the *Voltage Polarizing* tab page
385A	IN> V2pol Set	Dir IN Neg Seq	Polarizing Voltage (upolur)	in the *Voltage Polarizing* tab page
385B	IN> I2pol Set	Dir IN Neg Seq	Operating Current (curopu)	in the *Voltage Polarizing* tab page
3A01	Sens E/F Options	ISEF> 1	Out of Service (outserv)	
		ISEF> 2	Out of Service (outserv)	
3A02	ISEF> 1 Function	ISEF> 1	Characteristic (pcharac)	
3A2B	ISEF> 1 Direction	ISEF> 1	Tripping Direction (idir)	
3A2E	ISEF> 1 Current Set	ISEF> 1	Current setting (Ipset)	
3A31	ISEF> 1 Time Delay	ISEF> 1	Time Dial (Tpset)	Used in the relay by the DT characteristic
3A32	ISEF> 1 TMS	ISEF> 1	Time Dial (Tpset)	Used in the relay by the IEC characteristics
3A33	ISEF> 1 Time Dial	ISEF> 1	Time Dial (Tpset)	Used in the relay by the IEEE/US characteristic
3A37	ISEF> 1 tRESET	ISEF> 1	Reset Delay (ResetT)	Activate the reset feature with the ”Reset Characteristic” check box
3A3A	ISEF> 2 Function	ISEF> 2	Characteristic (pcharac)	
3A3B	ISEF> 2 Direction	ISEF> 2	Tripping Direction (idir)	
3A3E	ISEF> 2 Current Set	ISEF> 2	Current setting (Ipset)	
3A41	ISEF> 2 Time Delay	ISEF> 2	Time Dial (Tpset)	Used in the relay by the DT characteristic

Address	Relay Setting	Model block	Model setting	Note
3A42	ISEF> 2 TMS	ISEF> 2	Time Dial (Tpset)	Used in the relay by the IEC characteristics
3A43	ISEF> 2 Time Dial	ISEF> 2	Time Dial (Tpset)	Used in the relay by the IEEE/US characteristic
3A47	ISEF> 2 tRESET	ISEF> 2	Reset Delay (ResetT)	Activate the reset feature with the ”Reset Characteristic” check box
3A49	ISEF> 3 Status	ISEF> 3	Out of Service (outserv)	
3A4A	ISEF> 3 Direction	ISEF> 3	Tripping Direction (idir)	
3A4D	ISEF> 3 Current Set	ISEF> 3	Pickup Current (Ipset)	
3A4E	ISEF> 3 Time Delay	ISEF> 3	Time Setting (Tset)	
3A50	ISEF> 4 Status	ISEF> 4	Out of Service (outserv)	
3A51	ISEF> 4 Direction	ISEF> 4	Tripping Direction (idir)	
3A54	ISEF> 4 Current Set	ISEF> 4	Pickup Current (Ipset)	
3A55	ISEF> 4 Time Delay	ISEF> 4	Time Setting (Tset)	
3A59	ISEF> Char Angle	Dir ISEF	Max. Torque Angle (mtau)	in the *Voltage Polarizing* tab page
3A5B	ISEF> VN pol Set	Dir ISEF	Polarizing Voltage (upolur)	in the *Voltage Polarizing* tab page
3C01	Characteristic	Thermal Image 1	Out of Service (outserv)	
		Thermal Image 2	Out of Service (outserv)	
3C02	Thermal Trip	Thermal Image 1	Current setting (Ipset)	
		Thermal Image 2	Current setting (Ipset)	
3C04	Time Constant 1	Thermal Image 1	Time Dial (Tpset)	
3C05	Time Constant 2	Thermal Image 2	Time Dial (Tpset)	
3601	I2> Status	I2>	Out of Service (outserv)	
3602	I2> Directional	I2>	Tripping Direction (idir)	
3604	I2> Current Set	I2>	Pickup Current (Ipset)	
3605	I2> Time Delay	I2>	Time Setting (Tset)	
3606	I2> Char Angle	Dir I2	Max. Torque Angle (mtau)	in the *Voltage Polarizing* tab page
3607	I2> V2pol Set	Dir I2	Polarizing Voltage (upolur)	in the *Voltage Polarizing* tab page

Disable the ”Dir IN Io-Vo” block if the zero sequence current and voltage phasor angle comparison direction determination logic isn’t used; disable the ”Dir IN Neg Seq” block if the negative sequence current and voltage phasor angle comparison direction determination logic isn’t used.

3.5 Polarizing subrelay

3.5.1 Available Units

- Five polarizing elements (”Polarizing Z1 Self”, ”Polarizing Z2 Self”, ”Polarizing Z3 Self”, ”Polarizing Z4 Self” and ”Polarizing ZP Self” block).
- Five polarizing elements with delayed output (”Polarizing Z1 Memory”, ”Polarizing Z2 Memory”, ”Polarizing Z3 Memory”, ”Polarizing Z4 Memory” and ”Polarizing ZP Memory” block).
- Five adders (”Poladder Z1”, ”Poladder Z2”, ”Poladder Z3”, ”Poladder Z4” and ”Poladder ZP” block)
- Five directional elements (”Dir-Z1”, ”Dir-Z2”, ”Dir-Z3”, ”Dir-Z4” and ”Dir-ZP” block)

3.5.2 Functionality

The *Polarizing* subrelay simulate the composition of the self polarized voltages and the memorized voltages relay feature. The ratio between the two voltage components can be defined by the user. The polarizing voltages are used by the directional elements to figure out the fault direction. The fault direction is then provided to the distance elements. z

3.5.3 Data input

The relationships between the relay settings and the model parameters can be found in the following table:

Address	Relay Setting	Model block	Model setting	Note
3255	kZN1 Res. Comp.	Polarizing Z1 Self	k0 (k0)	
		Polarizing Z1 Memory	k0 (k0)	
3256	kZN1 Res. Angle	Polarizing Z1 Self	Angle (phik0)	
		Polarizing Z1 Memory	Angle (phik0)	
3265	kZN2 Res. Comp.	Polarizing Z2 Self	k0 (k0)	
		Polarizing Z2 Memory	k0 (k0)	
3266	kZN2 Res. Angle	Polarizing Z2 Self	Angle (phik0)	
		Polarizing Z2 Memory	Angle (phik0)	
3275	kZN3 Res. Comp.	Polarizing Z3 Self	k0 (k0)	
		Polarizing Z3 Memory	k0 (k0)	
3276	kZN3 Res. Angle	Polarizing Z3 Self	Angle (phik0)	
		Polarizing Z3 Memory	Angle (phik0)	
3285	kZNP Res. Comp.	Polarizing ZP Self	k0 (k0)	
	kZNP Res. Comp.	Polarizing ZP Memory	k0 (k0)	
3286	kZNP Res. Angle	Polarizing ZP Self	Angle (phik0)	
	kZNP Res. Angle	Polarizing ZP Memory	Angle (phik0)	
3295	kZN4 Res. Comp.	Polarizing Z4 Self	k0 (k0)	
		Polarizing Z4 Memory	k0 (k0)	
3296	kZN4 Res. Angle	Polarizing Z4 Self	Angle (phik0)	
		Polarizing Z4 Memory	Angle (phik0)	
31D7	Distance Polarizing	Poladder Z1	DistPolarizing	In the ”Logic” tab page
		Poladder Z2	DistPolarizing	In the ”Logic” tab page
		Poladder Z3	DistPolarizing	In the ”Logic” tab page
		Poladder ZP	DistPolarizing	In the ”Logic” tab page
		Poladder Z4	DistPolarizing	In the ”Logic” tab page

3.6 Voltage subrelay

3.6.1 Available Units

- One inverse time phase overvoltage elements (”V> 1”block).
- One definite time phase overvoltage elements (”V> 2” block).
- One inverse time phase undervoltage elements (”V< 1” block).
- One definite time phase undervoltage elements (”V< 2” block).
- One inverse time neutral voltage displacements elements (”VN> 1” block).
- One definite time neutral voltage displacements elements (”VN> 2” block).

3.6.2 Functionality

The *Voltage* subrelay simulates two phase overvoltage, two phase undervoltage and two neutral overvoltage elements. The inverse time elements can be configured to use an IDMT characteristic or a time defined characteristic.

3.6.3 Data input

The relationships between the relay settings and the model parameters can be found in the following table:

Address	Relay Setting	Model block	Model setting	Note
4203	V< Operate Mode	V< 1	Out of Service (outserv)	
4204	V< 1 Function	V< 1	Characteristic (pcharac)	
4205	V< 1 Voltage Set	V< 1	Input Setting (Ipsetr)	
4206	V< 1 Time Delay	V< 1	Time Dial (Tpset)	Active in the relay with the DT characteristic
4207	V< 1 TMS	V< 1	Time Dial (Tpset)	Active in the relay with the inverse characteristic
4209	V< 2 Status	V< 2	Out of Service (outserv)	
420A	V< 2 Voltage Set	V< 2	Pickup Voltage (Usetr)	
420B	V< 2 Time Delay	V< 2	Time Delay (tdel)	
420F	V> 2 Operate Mode	V> 1	Out of Service (outserv)	
4210	V> 1 Function	V> 1	Characteristic (pcharac)	
4211	V> 1 Voltage Set	V> 1	Input Setting (Ipsetr)	
4212	V> 1 Time Delay	V> 1	Time Dial (Tpset)	Active in the relay with the DT characteristic
4213	V> 1 TMS	V> 1	Time Dial (Tpset)	Active in the relay with the inverse characteristic
4214	V> 2 Status	V> 2	Out of Service (outserv)	
4215	V> 2 Voltage Set	V> 2	Pickup Voltage (Usetr)	
4216	V> 2 Time Delay	V> 2	Time Delay (tdel)	
3B01	VN> 1 Operate Mode	VN> 1	Out of Service (outserv)	
3B02	VN> 1 Function	VN> 1	Characteristic (pcharac)	
3B03	VN> 1 Voltage Set	VN> 1	Input Setting (Ipsetr)	
3B04	VN> 1 Time Delay	VN> 1	Time Dial (Tpset)	Active in the relay with the DT characteristic
3B05	VN> 1 TMS	VN> 1	Time Dial (Tpset)	Active in the relay with the inverse characteristic

Address	Relay Setting	Model block	Model setting	Note
3B07	VN> 2 Status	VN> 2	Out of Service (outserv)	
3B08	VN> 2 Voltage Set	VN> 2	Pickup Voltage (Usetr)	
3B09	VN> 2 Time Delay	VN> 2	Time Delay (tdel)	

3.7 Output logic

The output logic is the interface between the relay and the power system.

3.7.1 Available Units and Signals

The trip and reclosing logic is implemented by the following blocks located in the main relay.

- Logic
- Closing Logic

The relay output signal is ”yout”.

3.7.2 Functionality

The ”Logic” block operates the power breaker when a trip command has been issued by any protective element. A three phases trip logic is implemented.

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.

3.7.3 Data input

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

4 Features not supported

4.1 Main features

The following features are not supported:

- Mutual compensation.
- Fault detection superimposed current method
- Broken conductor detection.
- Channel aided DEF.
- Circuit breaker failure.
- SEF directional wattmetric logic.
- 2^{nd} harmonic restrain.
- Restricted earth fault.
- Voltage transformer supervision.
- Current transformer supervision.
- Frequency protection.
- Power swing detector.
- Out of step trip.
- Check synchronisation.
- Single phase tripping.

5 References

[1] Alstom T&D, Automation & Information Systems Business, Tour AREVA 1, place Jean Millier 92084 Paris - La Défense, 92084 France. *MiCOM P543/4/5/6 Current Differential Relay Software Versions 0410 and 0510 Hardware Suffix K Technical Data Sheet P54x/EN TDS/A22*, 2012.

[2] Areva T&D, Automation & Information Systems Business, Tour AREVA 1, place Jean Millier 92084 Paris - La Défense, 92084 France. *MiCOM P543, P544, P545, P546 Technical Manual Current Differential Protection Relays Platform Hardware Version: K Platform Software Version: 45 & 55 Publication Reference: P54xEN MLa4*, 2011.

[3] Areva T&D, Automation & Information Systems Business, Tour AREVA 1, place Jean Millier 92084 Paris - La Défense, 92084 France. *MICOM P54X Current Differential Protection Software Version 20 and 30 Operational Guide P54x / EN O /H53*, 2011.