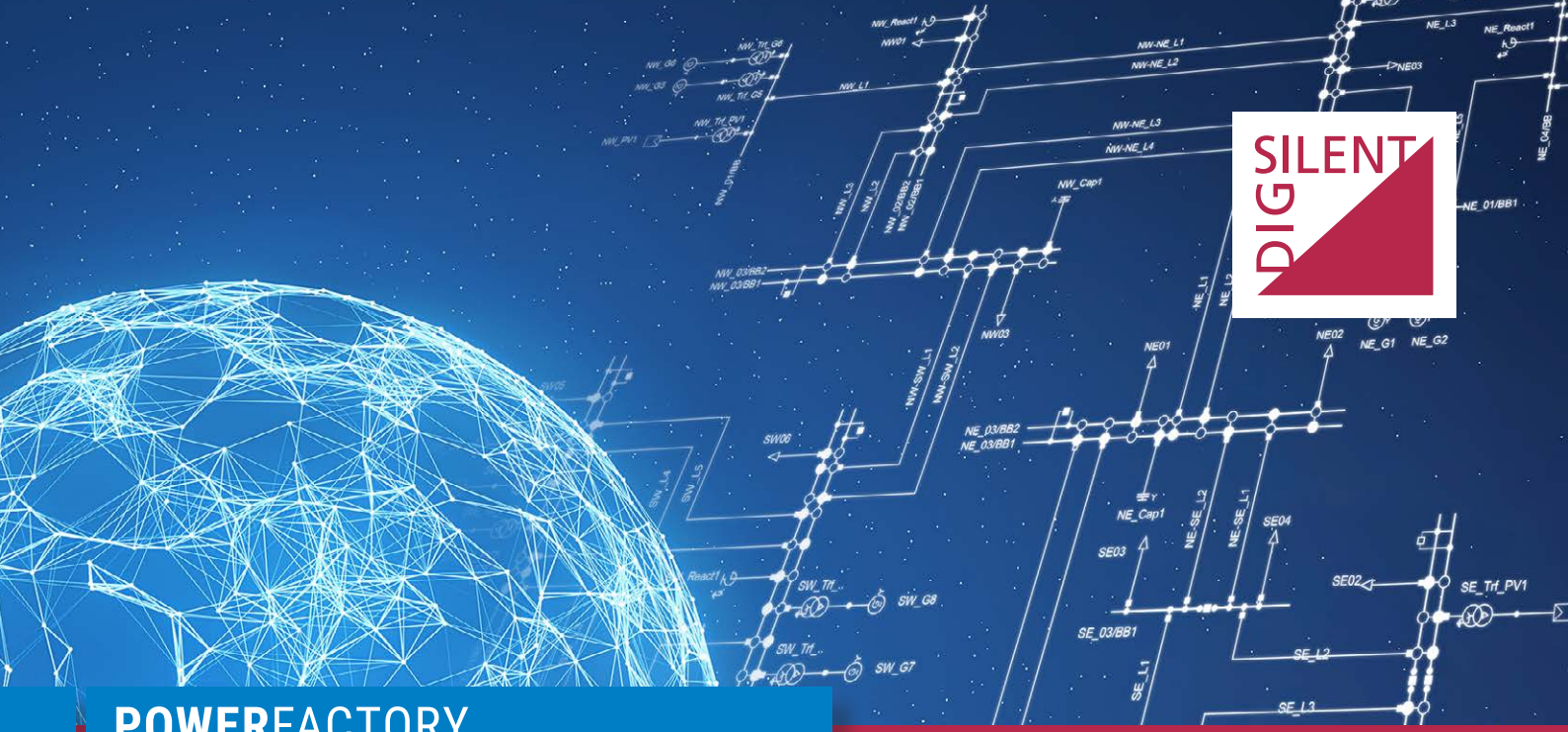

PowerFactory 2021

Technical Reference

VAMP 210

PF2021

POWER SYSTEM SOLUTIONS

MADE IN GERMANY

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Contents

1 Model information

Manufacturer VAMP

Model 210

Variants The VAMP 210 PowerFactory relay model can be used to simulate the VAMP 210 relay firmware version from 3.66 to 6.62. However please consider that the model has been implemented with a reduced set of the features available in the relays.

2 General description

The generator protection relay VAMP 210 is suitable for small and medium sized generators in solidly as well as high or low resistance grounded systems. The relay combines a selective ground fault protection, including back-up function, and a busbar earth fault protection. The selective directional earth fault protection is used in high resistance earthed systems. Low resistance or solidly earthed systems are using differential earth fault protection.

The VAMP 210 PowerFactory relay model consists of a main relay and five sub relays:

- Overcurrent elements (F50 - F51 - F46).
- Voltage elements (F27 - F59).
- Frequency elements (F81).
- Power & Q< 40 (F32-40).
- Distance elements (F21).

The main relay contains the measurement and acquisition units, the output logic, the *voltage measurement selector* and all sub relays.

The VAMP 210 PowerFactory relay model has been implemented trying to simulate the most commonly used protective functions.

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

3 Supported features

3.1 Measurement and acquisition

The voltage and the current are measured locally by one three phase current transformer (”Ct” block), two core current transformers (”Ct0 I01” and ”Ct0 I02” block), one three phase voltage transformer (”Vt” block), one open delta voltage transformer (”Vt0” block).

Eight measurement units (”Measurement”, ”Measurement DVoltage”, ”Measurement Seq”, ”Measurement Uo”, ”Measurement 2nd harmonic”, ”Meas Neutral I01”, ”Meas Neutral I02”and ”Measurement 3rd harm Uo” block) are fed by these CTs and these VTs.

3.1.1 Available Units

- One three phase current transformers (”Ct” block).
- One three phase voltage transformer (”Vt” block).
- Two core current transformers (”Ct0 I01” and ”Ct0 I02” block).
- One single voltage transformer (”Vt0” 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 voltage values(”Measurement DVoltage” block).
- One three phase measurement element calculating the current and voltage sequence values (”Measurement Seq” block).
- One single phase measurement element calculating the zero sequence voltage values (”Measurement Uo” block).
- Two single phase measurement elements calculating the zero sequence current in two separated locations (”Meas Neutral I01” and ”Meas Neutral I02” block).
- One three phase measurement element calculating the phase current 2^{nd} harmonic (”Measurement 2nd harmonic” block).
- One single phase measurement element calculating the zero sequence voltage values 3^{rd} harmonic (”Measurement 3rd harm Uo” block).

3.1.2 Functionality

The input current and voltage values are sampled at 32 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 ”Measurement DVoltage” block calculates the voltage ph-ph values used by the over voltage and under voltage elements.

”Ct0 I01” models the relay *(X1-7 & 8)* current inputs, ”Ct0 I02 ” models the *(X1-9 & 10)* current inputs.

3.1.3 Data input

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

3.2 Voltage measurement selector

The ”Voltage measurement mode” block, located in the main relay,allows the user to select *Voltage measurement mode* of the relay. The user can select in the ”Dip settings” tab page of the ”Voltage measurement mode” block dialog which zero sequence voltage input must be used by the zero sequence overvoltage elements (”Voltage” subrelay, ”U0>” and ”U0>>” block) and by the ground directional elements (”Overcurrent” subrelay, ”Earth Dir Iophi>” and ”Earth Dir Iophi>>” block).
The following zero sequence voltage source are available:

- A three phase voltage transformer (”Vt” block).
- A single voltage transformer (”Vt0” block).

When the ”2LL+Uo” relay ”Voltage measurement mode” is ”3LN” or is ”2LL+Uo” and no voltage transformer between neutral point and ground is present (three Yconnected voltage transformers are available) the ”TwoULLUo” dip must be ”off” and the ”ThreeULn” dip must be ”on”.
When the ”2LL+Uo” relay ”Voltage measurement mode” is ”2LL+Uo” and a voltage transformer between neutral point and ground is present the ”TwoULLUo” dip must be ”on” and the ”ThreeULn” dip must be ”off”.

3.3 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.

3.3.1 Available Units

- Three phase overcurrent elements 50/51(”I>” (with inverse characteristics), ”I>>” and ”I>>>” (time defined) block).
- Four phase directional overcurrent elements 67(”Dir Phase ” , ”Iphi>” (with inverse characteristics), ”Iphi>>”, ”Iphi>>>” and ”Iphi>>>>” (time defined) block).
- One unbalance protection element 46(”I2>” (with inverse characteristics) block).
- One voltage restraint/controlled overcurrent element 51V(”Iv>” and ”V restraint” block). Please set the ”Ux1”, ”Ux2”, ”Yy1” and ”IY2” value in the ”logic” tab page of the ”V restraint” block dialog.
- One thermal overload protection element 49 (”T>” block).
- Four ground overcurrent elements 50N/51N using input 4(”Io>” (with inverse characteristics) block, ”Io>>”, ”Io>>>” and ”Io>>>>” (time defined) block). Each element input can be connected to the zero sequence current calculated value (Holmgreen connection) or to the ”I01” or to the ”I02” ground current input. The configuration panel is available inside the

”Dip settings” tab page of the ”Io> Ground Switch”, ”Io>> Ground Switch” , ”Io>>> Ground Switch” and ”Io>>>> Ground Switch” dialog.

- Two directional ground overcurrent elements 67N (”Iophi>” and ”Iophi>>” (time defined) block, ”Earth dir (Io-Uo)” block implementing the directional logic). Each element input can be connected to the zero sequence current calculated value (Holmgreen connection) or to the ”I01” or to the ”I02” ground current input. The configuration panel is available inside the ”Dip settings” tab page of the ”Iophi> Ground Switch” and ”Iophi>> Ground Switch” dialog.
- One second harmonic blocking (”If2>” block).

3.3.2 Functionality

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

- DT (Definite Time).
- IEC EI (Extremely Inverse).
- IEC LTI (Long Time Inverse).
- IEC NI (Normal Inverse).
- IEC VI (Very Inverse).
- IEEE EI Extremly Inverse.
- IEEE LTEI Long time Extremly Inverse.
- IEEE LTI Long time Inverse.
- IEEE LTVI Long time Very Inverse.
- IEEE MI Moderately Inverse.
- IEEE STEI Short Time Extremely Inverse.
- IEEE STI Short Time Inverse.
- IEEE VI Very Inverse.
- IEEE2 EI Extremely Inverse.
- IEEE2 MI Moderately Inverse.
- IEEE2 NI Normaly Inverse.
- IEEE2 VI Very Inverse.
- RI/RI.
- RI/RXIDG.
- Thermal Overload.

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

Three additional user programmable curves (”Programmable curve 1”, ”Programmable curve 2”, and ”Programmable curve 3”) can be set inserting 16 points to create three user defined trip characteristics.

Any ground overcurrent element (”Io>”, ”Io>>”, ”Io>>>”, ”Io>>>>”, ”Iophi>”, and ”Iophi>>”)can be set independently from the other to get as input current one of the following inputs:

- Zero sequence current calculated by the three phase current transformer (”Ct” block).
- The current measured by the 1^{st} core current transformers (”Ct0 I01” block, X1-7 & 8 relay current inputs).
- The current measured by the 2^{nd} core current transformers (”Ct0 I02” block, X1-9 & 10 relay current inputs).

Please notice that such inputs are always a true RMS value of the current as calculated by the DFT filter.

The $2^{nd} harmonic$blocking logic is implemented inside the ”Overcurrent Output” block in the ”Logic” tab page. The current implementation is blocking the ”I>”, ”I>>”, ”I>>>”, ”T>” element.

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
	Overcurrent Protection (50/51) I> Status	I>	Out of Service (outserv)	
	Overcurrent Protection (50/51) I>> Status	I>>	Out of Service (outserv)	
	Overcurrent Protection (50/51) I>>> Status	I>>>	Out of Service (outserv)	
	Overcurrent Protection (50/51) I>	I>	Current Setting (Ipset)	
	Overcurrent Protection (50/51) I>>	I>>	Pickup Current (Ipset)	
	Overcurrent Protection (50/51) I>>>	I>>>	Pickup Current (Ipset)	
	Overcurrent Protection (50/51) Curve/Type	I>	Characteristic (pcharac)	
	Overcurrent Protection (50/51) t>	I>	Time Dial (tpset)	Relay setting active when the trip characteristic is DT
	Overcurrent Protection (50/51) t>>	I>>	Time Setting (Tset)	
	Overcurrent Protection (50/51) t>>>	I>>>	Time Setting (Tset)	
	Overcurrent Protection (50/51) k>	I>	Time Dial (tpset)	Relay setting active when the trip characteristic is inverse
	Directional overcurrent protection (67) Idir> Status	Iphi>	Out of Service (outserv)	
	Directional overcurrent protection (67) Idir>> Status	Iphi>>	Out of Service (outserv)	
	Directional overcurrent protection (67) Idir>	Iphi>	Current Setting (Ipset)	

Address	Relay Setting	Model block	Model setting	Note
	Directional overcurrent protection (67) Idir>>	Iophi>>	Current Setting (Ipset)	
	Directional overcurrent protection (67) Curve/Type Idir>	Iphi>	Characteristic (pcharac)	
	Directional overcurrent protection (67) Curve/Type Idir>>	Iphi>>	Characteristic (pcharac)	
	Directional overcurrent protection (67) t>	Iphi>	Time Dial (Tpset)	
	Directional overcurrent protection (67) t>>	Iphi>>	Time Dial (Tset)	
	Directional overcurrent protection (67) Idir> Mode	Iphi>	Tripping Direction (idir)	
	Directional overcurrent protection (67) Idir>> Mode	Iophi>>	Tripping Direction (idir)	
	Directional overcurrent protection (67) Idir> U1	Dir Phase	Polarizing Voltage (upolu)	In the *"Voltage Polarizing"* tab page
	Directional overcurrent protection (67) Idir>> U1	Dir Phase	Polarizing Voltage (upolu)	In the *"Voltage Polarizing"* tab page
	Directional overcurrent protection (67) Idir> Offset	Dir Phase	Max. Torque Angle (mtau)	in the *Voltage Polarizing* tab page
	Directional overcurrent protection (67) Idir>> Offset	Dir Phase	Max. Torque Angle (mtau)	in the *Voltage Polarizing* tab page
	Directional overcurrent protection (67) Idir>>> Status	Iphi>>>	Out of Service (outserv)	
	Directional overcurrent protection (67) Idir>>>> Status	Iphi>>>>	Out of Service (outserv)	
	Directional overcurrent protection (67) I φ >>>	Iphi>>>	Pickup Current (Ipset)	
	Directional overcurrent protection (67) I φ >>>>	Iphi>>>>	Pickup Current (Ipset)	
	Directional overcurrent protection (67) t>>>	Iphi>>>	Time Setting (Tset)	
	Directional overcurrent protection (67) t>>>>	Iphi>>>>	Time Setting (Tset)	
	Directional overcurrent protection (67) Idir>>> Mode	Iphi>	Tripping Direction (idir)	
	Directional overcurrent protection (67) Idir>>>> Mode	Iphi>>	Tripping Direction (idir)	
	Directional overcurrent protection (67) Idir>>> U1	Dir Phase	Polarizing Voltage (upolu)	In the *"Voltage Polarizing"* tab page
	Directional overcurrent protection (67) Idir>>>> U1	Dir Phase	Polarizing Voltage (upolu)	In the *"Voltage Polarizing"* tab page
	Directional overcurrent protection (67) Idir>>> Offset	Dir Phase	Max. Torque Angle (mtau)	in the *Voltage Polarizing* tab page
	Directional overcurrent protection (67) Idir>>>> Offset	Dir Phase	Max. Torque Angle (mtau)	in the *Voltage Polarizing* tab page
	Voltage restrained/controlled overcurrent function Iv> (51V) Status	Iv>	Out of Service (outserv)	
	Voltage restrained/controlled overcurrent function Iv> (51V) Iv>	Iv>	Pickup Current (Ipset)	
	Voltage restrained/controlled overcurrent function Iv> (51V) t>	Iv>	Time Setting (Tset)	
	Voltage restrained/controlled overcurrent function Iv> (51V) X1	V restraint	Ux1	*Logic* tab page
	Voltage restrained/controlled overcurrent function Iv> (51V) X2	V restraint	Ux2	*Logic* tab page

Address	Relay Setting	Model block	Model setting	Note
	Voltage restrained/controlled overcurrent function Iv> (51V) Y1	V restraint	Iy1	*Logic* tab page
	Voltage restrained/controlled overcurrent function Iv> (51V) Y2	V restraint	Iy2	*Logic* tab page
	Unbalance Protection (46) Ign	I2>	Current Setting (Ipset)	
	Unbalance Protection (46) K1	I2>	Time Dial (tpset)	
	Unbalance Protection (46) K2	I2>	Time shift (Tshift)	
	Unbalance Protection (46) Type	I2>	Characteristic (pcharac)	
	Overload protection (49) T>	T>	Current Setting (Ipset)	
	Overload protection (49) tau	T>	Time Dial (tpset)	
	Overload protection (49) ctau	T>	Reset Delay (ResetT)	
	Undirectional earth fault stage (50N/51N) Io> Status	Io>	Out of Service (outserv)	
	Undirectional earth fault stage (50N/51N) Io>> Status	Io>>	Out of Service (outserv)	
	Undirectional earth fault stage (50N/51N) Io>>> Status	Io>>>	Out of Service (outserv)	
	Undirectional earth fault stage (50N/51N) Io>>>> Status	Io>>>>	Out of Service (outserv)	
	Undirectional earth fault stage (50N/51N) Io>	Io>	Current Setting (Ipset)	
	Undirectional earth fault stage (50N/51N) Io>>	Io>>	Pickup Current (Ipset)	
	Undirectional earth fault stage (50N/51N) Io>>>	Io>>>	Pickup Current (Ipset)	
	Undirectional earth fault stage (50N/51N) Io>>>>	Io>>>>	Pickup Current (Ipset)	
	Undirectional earth fault stage (50N/51N) Curve/Type	Io>	Characteristic (pcharac)	
	Undirectional earth fault stage (50N/51N) t>	Io>	Time Dial (tpset)	Relay setting active when the trip characteristic is DT
	Undirectional earth fault stage (50N/51N) t>>	Io>>	Time Setting (Tset)	
	Undirectional earth fault stage (50N/51N) t>>>	Io>>>	Time Setting (Tset)	
	Undirectional earth fault stage (50N/51N) t>>>>	Io>>>>	Time Setting (Tset)	
	Undirectional earth fault stage (50N/51N) k>	Io>	Time Dial (tpset)	Relay setting active when the trip characteristic is inverse
	Directional earth fault protection (67N) Ioφ> Status	Iophi>	Out of Service (outserv)	
	Directional earth fault protection (67N) Ioφ>> Status	Iophi>>	Out of Service (outserv)	
	Directional earth fault protection (67N) Ioφ>	Iophi>	Current Setting (Ipset)	
	Directional earth fault protection (67N) Ioφ>>	Iophi>>	Current Setting (Ipset)	
	Directional earth fault protection (67N) Ioφ> Curve/Type	Iophi>	Characteristic (pcharac)	
	Directional earth fault protection (67N) Ioφ>> Curve/Type	Iophi>>	Characteristic (pcharac)	
	Directional earth fault protection (67N) Ioφ> t>	Iophi>	Time Dial (Tpset)	
	Directional earth fault protection (67N) Ioφ>> t>	Iophi>>	Time Dial (Tset)	
	Directional earth fault protection (67N) Ioφ> Mode	Iophi>	Tripping Direction (idir)	
	Directional earth fault protection (67N) Ioφ>> Mode	Iophi>>	Tripping Direction (idir)	

Address	Relay Setting	Model block	Model setting	Note
	Directional earth fault protection (67N) Ioφ> Uo>	Earth Dir Iophi>	Polarizing Voltage (upolu)	In the *"Voltage Polarizing"* tab page
	Directional earth fault protection (67N) Ioφ>> Uo>	Earth Dir Iophi>>	Polarizing Voltage (upolu)	In the *"Voltage Polarizing"* tab page
	Directional earth fault protection (67N) Ioφ> Offset	Earth Dir Iophi>	Max. Torque Angle (mtau)	in the *Voltage Polarizing* tab page
	Directional earth fault protection (67N) Ioφ>> Offset	Earth Dir Iophi>>	Max. Torque Angle (mtau)	in the *Voltage Polarizing* tab page
	Directional earth fault protection (67N) Io> Input	I> Ground Switch	Io_calc, Io1, Io1	In the *Dip Settings* tab page
	Directional earth fault protection (67N) Io>> Input	I>> Ground Switch	Io_calc, Io1, Io1	In the *Dip Settings* tab page
	Directional earth fault protection (67N) Io>>> Input	I>>> Ground Switch	Io_calc, Io1, Io1	In the *Dip Settings* tab page
	Directional earth fault protection (67N) Io>>>> Input	I>>>> Ground Switch	Io_calc, Io1, Io1	In the *Dip Settings* tab page
	Directional earth fault protection (67N) Ioφ> Input	Iophi> Ground Switch	Io_calc, Io1, Io1	In the *Dip Settings* tab page
	Directional earth fault protection (67N) Ioφ>> Input	Iophi>> Ground Switch	Io_calc, Io1, Io1	In the *Dip Settings* tab page
	Second harmonic O/C stage If2>(51F2) If2>	If2>	Pickup Current (Ipset)	
	Second harmonic O/C stage If2>(51F2) t_f2	If2>	Time Setting (Tset)	

3.4 Voltage subrelay

3.4.1 Available Units

- Three phase overvoltage elements 59 (”U>”, ”U>>”, ”U>>>” block)
- Three phase undervoltage elements 27 (”U<”, ”U<< ”, ”U<< <” block)
- Two residual voltage elements 59 N (”U0>” and ”U0>>” block).
- Two positive sequence undervoltage elements (”V1<” and ”V1<< ” block).
- One 3rd harmonic undervoltage element (”U0f3<” block).
- One inverse time over excitation element (”Uf>”, ”Meas Freq” and ”V/Hz calculator” block).

3.4.2 Functionality

The *Voltage* subrelay simulates three phase-phase overvoltage, three phase-phase undervoltage, three positive sequence undervoltage, one overfluxing, one 3^{rd} harmonic zero sequence overvoltage and two neutral overvoltage elements with definite time trip characteristic.
The over excitation element (”Uf>” block) can be configured to use an IDMT characteristic or a time defined characteristic. The frequency is calculated by the ”Meas Freq” block using an user selectable voltage, the flux (V/Hz) value is calculated by the ”V/Hz calculator” block.

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
	Overvoltage protection U> (59) Status	U>	Out of Service (outserv)	
	Overvoltage protection U>> (59) Status	U>>	Out of Service (outserv)	
	Overvoltage protection U>>> (59) Status	U>>>	Out of Service (outserv)	
	Overvoltage protection U> (59) U>	U>	Pickup Voltage (Uset)	
	Overvoltage protection U>> (59) U>>	U>>	Pickup Voltage (Uset)	
	Overvoltage protection U>>> (59) U>>>	U>>>	Pickup Voltage (Uset)	
	Overvoltage protection U> (59) t>	U>	Time Delay (Tdel)	
	Overvoltage protection U>> (59) t>>	U>>	Time Delay (Tdel)	
	Overvoltage protection U>>> (59) t>>>	U>>>	Time Delay (Tdel)	
	Overvoltage protection U< (27) Status	U<	Out of Service (outserv)	
	Overvoltage protection U<< (27) Status	U<<	Out of Service (outserv)	
	Overvoltage protection U<<< (27) Status	U<<<	Out of Service (outserv)	
	Overvoltage protection U< (27) U<	U<	Pickup Voltage (Uset)	
	Overvoltage protection U<< (27) U<<	U<<	Pickup Voltage (Uset)	
	Overvoltage protection U<<< (27) U<<<	U<<<	Pickup Voltage (Uset)	
	Overvoltage protection U< (27) t<	U<	Time Delay (Tdel)	
	Overvoltage protection U<< (27) t<<	U<<	Time Delay (Tdel)	
	Overvoltage protection U<<< (27) t<<<	U<<<	Time Delay (Tdel)	
	Zero sequence voltage protection Uo>(59N) Status	U0>	Out of Service (outserv)	
	Zero sequence voltage protection Uo>>(59N) Status	U0>>	Out of Service (outserv)	
	Zero sequence voltage protection Uo> (59N) Uo>	Uo>	Pickup Voltage (Uset)	
	Zero sequence voltage protection Uo>> (59N) Uo>>	Uo>>	Pickup Voltage (Uset)	
	Zero sequence voltage protection Uo>(59N) t>	Uo>	Time Delay (Tdel)	

Address	Relay Setting	Model block	Model setting	Note
	Zero sequence voltage protection Uo>>(59N) t>>	Uo>>	Time Delay (Tdel)	
	Undervoltage protection U1< (27P) Status	U1<	Out of Service (outserv)	
	Undervoltage protection U1<< (27P) Status	U1<<	Out of Service (outserv)	
	Undervoltage protection U1< (27P) U1<	U1<	Pickup Voltage (Uset)	
	Undervoltage protection U1<< (27P) U1<<	U1<<	Pickup Voltage (Uset)	
	Undervoltage protection U1< (27P) t<	U1<	Time Delay (Tdel)	
	Undervoltage protection U1<< (27P) t<<	U1<<	Time Delay (Tdel)	
	100% stator earth fault protection Uof3< (64F3) Status	U0f3<	Out of Service (outserv)	
	100% stator earth fault protection Uof3< (64F3) Uof3<	U0f3<	Pickup Voltage (Uset)	
	100% stator earth fault protection Uof3< (64F3) t<	U0f3<	Time Delay (Tdel)	
	Volts/hertz over-excitation protection Uf> (24) Status	Uf>	Out of Service (outserv)	
	Volts/hertz over-excitation protection Uf> (24) Uf>	Uf>	Input Setting (Ipset)	
	Volts/hertz over-excitation protection Uf> (24) t>	Uf>	Time Dial (Tpset)	

3.5 Frequency subrelay

3.5.1 Available Units

- Two over frequency / under frequency protection stages (”f><” , ”f>><<< ” block)
- Two under frequency stages (”f<” and ”f<< ” block)
- One rate of change of frequency df/dt protection stage (”df/dt>” block)
- One undervoltage self blocking element of under frequency stage (unique for all frequency elements, ”LVBlk” block)

3.5.2 Functionality

The *Frequency* subrelay implements four independent over frequency and under frequency elements with a common low voltage limit for self blocking and one rate of change of frequency element.

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
	Overfrequency and underfrequency protection f>, f< (81H/81L) f>< Status	f><	Out of Service (outserv)	
	Overfrequency and underfrequency protection f>, f< (81H/81L) f>><<< Status	f>><<<	Out of Service (outserv)	
	Overfrequency and underfrequency protection f>, f< (81H/81L) fX	f><	Frequency (Fset)	
	Overfrequency and underfrequency protection f>, f< (81H/81L) fXX	f>><<<	Frequency (Fset)	
	Overfrequency and underfrequency protection f>, f< (81H/81L) f<	f<	Frequency (Fset)	
	Overfrequency and underfrequency protection f>, f< (81H/81L) f<<	f<<	Frequency (Fset)	
	Overfrequency and underfrequency protection f>, f< (81H/81L) tX	f><	Time Delay (Tdel)	
	Overfrequency and underfrequency protection f>, f< (81H/81L) tXX	f>><<<	Time Delay (Tdel)	
	Overfrequency and underfrequency protection f>, f< (81H/81L) t<	f<	Time Delay (Tdel)	
	Overfrequency and underfrequency protection f>, f< (81H/81L) t<<	f<<	Time Delay (Tdel)	
	Overfrequency and underfrequency protection f>, f< (81H/81L) LVblck	LVBlk	Pickup Voltage (Uset)	
	Rate of change of frequency (ROCOF) protection df/dt (81R) Status	df/dt>	Out of Service (outserv)	
	Rate of change of frequency (ROCOF) protection df/dt (81R) df/dt>	df/dt>	Input Setting (Ipsetr)	
	Rate of change of frequency (ROCOF) protection df/dt (81R) t>	df/dt>	Time Dial (Tpset)	
	Rate of change of frequency (ROCOF) protection df/dt (81R) LVblk	LVBlk	Pickup Voltage (Uset)	

3.6 Power subrelay

3.6.1 Available Units

- Two under power elements (”P<” and ”P<< ” block).
- Two reverse power elements (”P< Reverse” and ”P<< Reverse” block).
- One under-excitation element Q < 40 (”Q< 40 Calc” and ”Q < 40” block).

3.6.2 Functionality

In the model only two power stages are available: each of them can be set to get as input the reverse power or the forward power. To simulate a power stage set to get the reverse power disable in the model the relevant under power element and enable the relevant reverse power element. As in the relay, in the model only two power elements must be active at the same time.

The active and the reactive power values are compared with the tripping area of the excitation stage in the ”Q < Calc” block, the trip delay is provided by the ”Q <” block.

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
	Reverse power and under-power protection P< (32) Status	P<	Out of Service (outserv)	
		P< Reverse	Out of Service (outserv)	
	Reverse power and under-power protection P<< (32) Status	P<<	Out of Service (outserv)	
		P<< Reverse	Out of Service (outserv)	
	Reverse power and under-power protection P< (32) P<	P<	Input Setting (Ipset)	
		P< Reverse	Input Setting (Ipset)	
	Reverse power and under-power protection P< (32) P<	P<<	Input Setting (Ipset)	
		P<< Reverse	Input Setting (Ipset)	
	Reverse power and under-power protection P< (32) t<	P<	Input Setting (Ipset)	
		P< Reverse	Input Setting (Ipset)	
	Reverse power and under-power protection P< (32) t<	P<<	Time Dial (Tpset)	
		P<< Reverse	Time Dial (Tpset)	
	Under-excitation protection Q< (40) Q@P0%	Q< Calc	Q1 (Q1)	In the *Logic* tab page
	Under-excitation protection Q< (40) Q@P80%	Q< Calc	Q2 (Q2)	In the *Logic* tab page
	Under-excitation protection Q< (40) t<	Q <	Time Setting (Tset)	

3.7 Distance subrelay

3.7.1 Available Units

- Two under impedance elements (”Z <” and ”Z << ” block).
- Two under reactance and loss of excitation elements (”X<” and ”X<< ” block).
- Two timers associated to the under impedance elements (”Z < delay” and ”Z << delay” block).
- Two timers associated to the under reactance elements (”X < delay” and ”X << delay” block).

3.7.2 Functionality

The *Distance* subrelay implements two circular impedance zones centered in the R-X axis origin which model the relay under impedance feature and two mho zones with user configurable offset from the R-X axis origin which model the relay under reactance & loss of excitation feature. Please notice that the reactance and the impedance settings are in secondary Ohms instead of % of Zn.

3.7.3 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
	Under-impedance protection Z< (21) Status	Z<	Out of Service (outserv)	
	Under-impedance protection Z<< (21) Status	Z<<	Out of Service (outserv)	
	Under-impedance protection Z< (21) Z<	Z<	Replica Impedance (Zm)	
	Under-impedance protection Z<< (21) Z<<	Z<<	Replica Impedance (Zm)	
	Under-impedance protection Z< (21) t<	Z < delay	Time Setting (Tdelay)	
	Under-impedance protection Z<< (21) t<<	Z << delay	Time Setting (Tdelay)	
	Under-reactance and loss of excitation protection X< (40) Status	X<	Out of Service (outserv)	
	Under-reactance and loss of excitation protection X<< (40) Status	X<<	Out of Service (outserv)	
	Under-reactance and loss of excitation protection X< (40) X<	X<	Replica Impedance (Zm)	
	Under-reactance and loss of excitation protection X<< (40) X<<	X<<	Replica Impedance (Zm)	
	Under-reactance and loss of excitation protection X< (40) t<	X < delay	Time Setting (Tdelay)	
	Under-reactance and loss of excitation protection X<< (40) t<	X << delay	Time Setting (Tdelay)	
	Under-reactance and loss of excitation protection X< (40) Ros	X<	Offset Impedance (Zoff)	Zoff = $\sqrt{Ros^2 + Xos^2}$-X>
			Relay Angle (phi)	phi=atan(Xos/Ros)
			Offset Angle (offang)	offang=atan(Xos/Ros)

Address	Relay Setting	Model block	Model setting	Note
	Under-reactance and loss of excitation protection X<< (40) Ros	X<<	Offset Impedance (Zoff)	Zoff = $\sqrt{Ros^2 + Xos^2}$-X>
			Relay Angle (phi)	phi=atan(Xos/Ros)
			Offset Angle (offang)	offang=atan(Xos/Ros)
	Under-reactance and loss of excitation protection X< (40) Xos	X<	Offset Impedance (Zoff)	Zoff = $\sqrt{Ros^2 + Xos^2}$-X>
	Under-reactance and loss of excitation protection X<< (40) Xos	X<<	Offset Impedance (Zoff)	Zoff = $\sqrt{Ros^2 + Xos^2}$-X>

3.8 Output logic

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

3.8.1 Available Units and Signals

The trip logic is implemented by the ”OutputLogic” block located in the main relay and by the following blocks located inside the subrelays:

- Overcurrent output.
- Voltage output.
- Frequency Output.
- Power & Q< Output.
- Distance output.

Please notice that only the ”OutputLogic” block is set to operate the power breaker.

The relay output signals are the following:

- T1.
- T2.
- A1.
- A2.
- A3.
- A4.
- A5.

The breaker trip signals are *T1* and *T2*. The other output signals can be used for signaling purposes.

3.8.2 Functionality

The ”OutputLogic” block located in the main relay operates the power breaker when a trip command has been issued by any protective element. The trip logic provided with the model is operating both the *T1* and the *T2* relay output signal but it can modified in the "Logic" tab page of the ”OutputLogic” block.

3.8.3 Data input

Please disable the ”OutputLogic” 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:

- Circuit breaker failure protection CBFP (50BF).
- Arc fault protection (50ARC/50NARC).
- Intermittent transient earth fault protection Iot> (67NT).
- Current transformer supervision.
- Voltage transformer supervision.
- Programmable stages (99).

4.1.1 Voltage subrelay

- U> element user configurable reset time.

4.1.2 Overcurrent subrelay

- Current peak value for any ground over current block.

5 References

[1] VAMP Ltd., Yrittajankatu 15 P.O.Box 810, FIN 65101 Vaasa, Finland. *VAMP 210 Generator protection relay Operation and configuration instructions Technical descriptionVM210.EN009*, 2005.