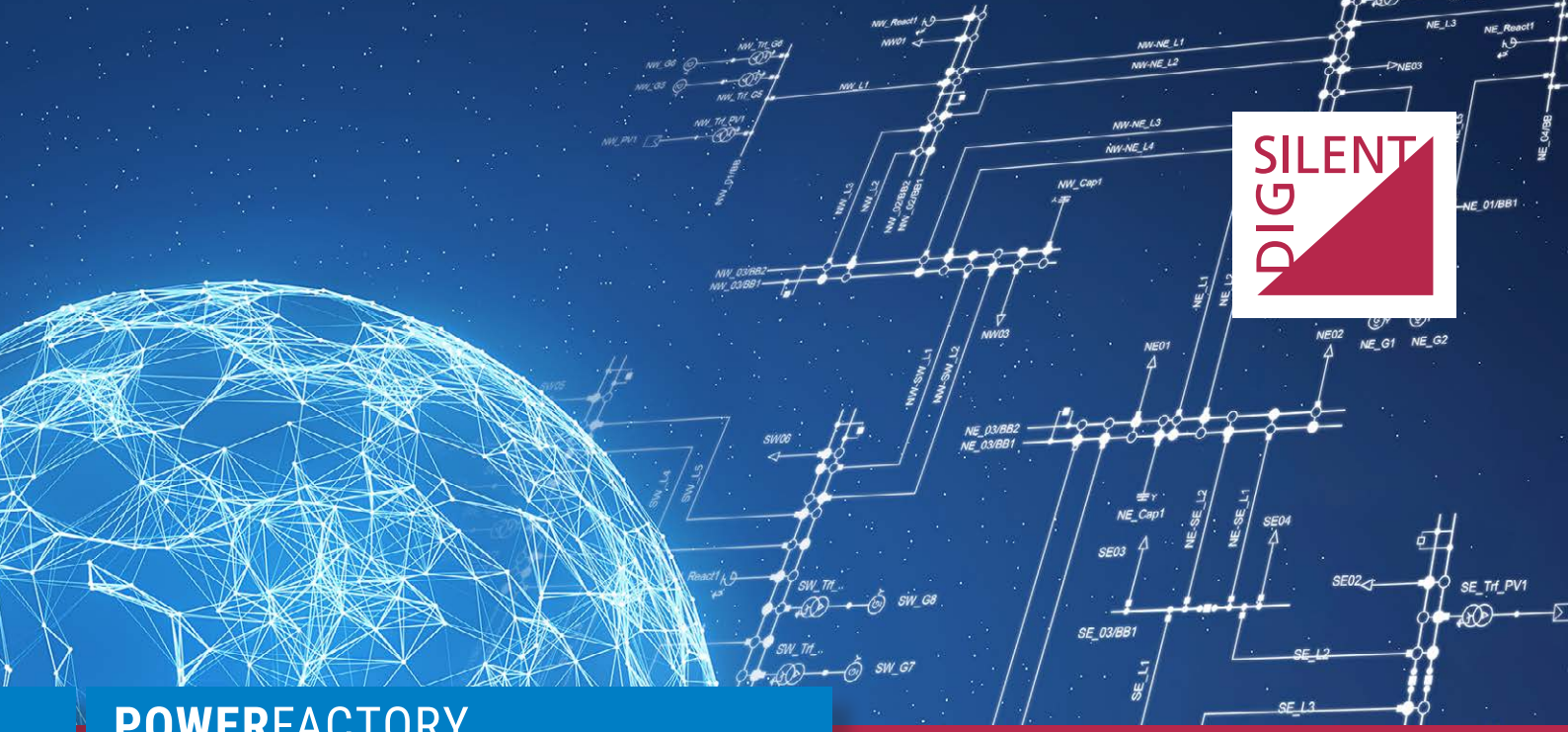

PowerFactory 2021

Technical Reference

VAMP 40

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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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1 Model information

Manufacturer VAMP

Model 40

Variants This PowerFactory relay model simulates the features present in the VAMP 40 protective relay.

2 General description

The numerical VAMP 40 feeder and motor protection relay includes all the essential protection functions needed to protect feeders and motors in distribution networks of utilities, industry, power plants and offshore applications. Further, the relay includes several programmable functions, such as arc(option), thermal, trip circuit supervision and circuit breaker protection and communication protocols for various protection and communication situations.

The PowerFactory VAMP 40 relay model is a monolithic model and simulates most of the protective features available in the relays.

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

3 Supported features

3.1 Measurement and acquisition

It represents the interface between the power system and the relay protective elements.

The phase currents flowing in the power system are converted by a block which simulates the 3 phase CT and by a block which models a single phase CT detecting the earth current; the system phase voltages are converted by a block which simulates a 3 phase VT; the secondary currents and voltages are then measured in the relay model by four elements which simulate the digital sampling of the relay.

3.1.1 Available elements and input signals

The *Measurement and acquisition* feature consists of the following elements:

- One 3 phase current transformer (”Ct-3P” block).
- One 3 phase voltage transformer (”Vt-3p” block).
- One neutral current transformer (”Ct-3I0” block).
- One 3 phase measurement element (”MeasPhase” block).

- One 3 phase sequence measurement element (”MeasSeq” block).
- One neutral current measurement element (”MeasEarth” block).
- One 3 phase current 2^{nd} harmonic measurement element (”Meas2nd Harmonic” block).

3.1.2 Functionality

The ”Ct-3P” and the ”Ct-3I0” block represent ideal CTs. Using the CT default configuration the current at the primary side are converted to the secondary side using the CT ratio. The CT saturation and/or its magnetizing characteristic are not considered. Please set the ”Detailed Model” check box in the ”Detailed Data” tab page of the CT dialog and insert the data regarding the CT burden, the CT secondary resistance and the CT excitation parameter if more accurate simulation results are required.

The input current and voltage values are sampled by the ”MeasPhase”, ”MeasEarth”, ”Meas2nd Harmonic” and the ”MeasSeq” block at 32 samples/cycle. The values are processed by a DFT filter, operating over a cycle, which then calculates the voltage and current RMS values used by the protective elements extracting the 1^{st} harmonic component. In the ”Meas2nd Harmonic” block the DFT filter is set to calculate the current 2^{nd} harmonic component.

3.1.3 Data input

The CT secondary rated current (1 or 5 A) value must be set in the ”MeasPhase”, ”MeasEarth”, ”Meas2nd Harmonic” and the ”MeasSeq” block.

If no core CT is available please select the 3 phases CT also in the ”Ct-3I0” slot: the earth current will be calculated assuming that an Holmgreen’s connection of the phases is used.

3.2 Protective elements

A set of inverse time and definite time overcurrent elements with two additional residual overvoltage elements is modeling the relay protective functions. All the inverse characteristics available in the relay are available in the inverse time model blocks.

3.2.1 Available Units

- One single phase inverse time overcurrent element 50/51(”I>” block).
- Two single phase definite time overcurrent elements 50/51(”I>>” and ”I>>>” block).
- One inverse time negative sequence protection element (”I2>” block).
- One definite time incorrect phase sequence 47 element (”I2>>” block).
- One unbalance / broken connector protection element (”I2/I1>” block).
- One inverse time ground overcurrent element 50N/51N monitoring the ”Ct-3I0” CT current (”Io>” block).
- One definite time ground overcurrent element 50N/51N monitoring the ”Ct-3I0” CT current (”Io>>” block).

- Two definite time ground overcurrent elements 50N/51N monitoring the ”Ct-3P” CT earth current(”I2o>” and ”I2o>>” block).
- One directional inverse time ground overcurrent element 67N(”Iophi>” block).
- One directional definite time ground overcurrent elements 67N(”Iophi>>” block).
- One ground directional element (”Earth dir (Io-Uo)” block).
- One definite time undercurrent element 37 (”I<” block).
- One overload element 49(”T>” block).
- Two definite time residual voltage elements 59 N (”Uo>” and ”Uo>>” block).
- Reclosing element (”Reclosing” block).
- Second harmonic blocking element(”If2>” block). .

3.2.2 Functionality

The inverse time overcurrent elements (”I>”, ”Io>”, ”Iophi>”, and ”I2>” block) support the following trip characteristics:

- DT (Definite Time Grnd).
- DT (Definite Time Ph).
- EI (Extremely Inverse).
- I2 Definite time.
- LTI (Long Time Inverse).
- NI (Normal Inverse).
- Thermal Overload.
- VI (Very Inverse).
- I2 Inverse. (”I2>” block only)

The relationship between current and time values for the ”EI (Extremely Inverse)”, the ”LTI (Long Time Inverse)”, the ” NI (Normal Inverse)”, and the ”VI (Very Inverse)” characteristic complies with the IEC 60255-3 standards.

The 2^{nd} harmonic blocking logic is implemented inside the ”Output logic” block in the ”Logic” tab page. The logic available by default is blocking the ”I>”, ”I>>”, ”I>>>”, ”T>” and ”I<” element.

The phase elements are single phase elements and get the greatest phase current. The ground directional elements (”Iophi>” and ”Iophi>>” block) are fed by the earth current measured by the ”Ct-3P” current transformer using an Holmgreen’s connection.

The ”Io>” and the ”Io>>” block monitor the earth current measured by the ”Ct-3I0” current transformer (current input 4 in the relay connection scheme). The ”Io2>” and the ”Io2>>” block monitor the earth current measured by the ”Ct-3P” current transformer using an Holmgreen’s connection (current input 5 in the relay connection scheme).

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):

Overcurrent :

Address	Relay Setting	Model block	Model setting	Note
	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) 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
	Broken Conductor Protection (46) I2/I1>	I2/I1>	Pickup Current (Ipset)	
	Broken Conductor Protection (46) t>	I2/I1>	Time Setting (Tset)	
	Unbalance Protection (46) IMOT	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)	
	Phase reversal /Incorrect phase sequence (47) I2/I1	I2>>	Pickup Current (Ipset)	Fixed at 80% no user input required
	Undercurrent protection (37) I<	I<	Pickup Current (Ipset)	
	Undercurrent protection (37) t<	I<	Time Setting (Tset)	
	Directional earth fault protection (67N) Type	Iophi>	Characteristic (pcharac)	
	Directional earth fault protection (67N) Ioφ>	Iophi>	Current Setting (Ipset)	
	Directional earth fault protection (67N) Ioφ>>	Iophi>>	Pickup Current (Ipset)	
	Directional earth fault protection (67N) t>	Iophi>	Time Dial (Tpset)	
	Directional earth fault protection (67N) t>>	Iophi>>	Time Setting (Tset)	
	Directional earth fault protection (67N) U0>	Earth Dir (I0-U0)	Polarizing Voltage (upolu)	In the *"Voltage Polarizing"* tab page
	Directional earth fault protection (67N) U0>>	Earth Dir (I0-U0)	Polarizing Voltage (upolu)	In the *"Voltage Polarizing"* tab page
	Directional earth fault protection (67N) Offset	Earth Dir (I0-U0)	Max. Torque Angle (mtau)	in the *Voltage Polarizing* tab page
	Earth Fault Protection (50N/51N) Io>	Io>	Current Setting (Ipset)	

Address	Relay Setting	Model block	Model setting	Note
	Earth Fault Protection (50N/51N) Io>>	Io>>	Pickup Current (Ipset)	
	Earth Fault Protection (50N/51N) Io2>	Io2>	Pickup Current (Ipset)	
	Earth Fault Protection (50N/51N) Io2>>	Io2>>	Pickup Current (Ipset)	
	Earth Fault Protection (50N/51N) Type	Io>	Characteristic (pcharac)	
	Earth Fault Protection (50N/51N) t> (Io>)	Io>	Time Dial (tpset)	Relay setting active when the trip characteristic is DT
	Earth Fault Protection (50N/51N) t> (Io>>)	Io>>	Time Setting (Tset)	
	Earth Fault Protection (50N/51N) t> (Io2>)	Io2>	Time Setting (Tset)	
	Earth Fault Protection (50N/51N) t> (Io2>>)	Io2>>	Time Setting (Tset)	
	Earth Fault Protection (50N/51N) k	Io>	Time Dial (tpset)	Relay setting active when the trip characteristic is inverse
	Overload protection (49) T>	T>	Current Setting (Ipset)	
	Overload protection (49) Tau	T>	Time Dial (tpset)	
	Overload protection (49) Tau2	T>	Reset Delay (ResetT)	
	Auto-reclose function (79) ARena	Reclosing	No-reclosing(reclnotactive)	
	Auto-reclose function (79) RecIT	Reclosing	Reset Time (resettime)	
	Auto-reclose function (79) AR matrix	Reclosing	Logic (ilogic)	In the *Logic* tab page
	Auto-reclose function (79) DeadT (shot 1)	Reclosing	Reclosing interval 1 (recltime1)	
	Auto-reclose function (79) DeadT (shot 2)	Reclosing	Reclosing interval 2 (recltime2)	
	Auto-reclose function (79) DeadT (shot 3)	Reclosing	Reclosing interval 3 (recltime3)	
	Auto-reclose function (79) DeadT (shot 4)	Reclosing	Reclosing interval 4 (recltime4)	
	Auto-reclose function (79) DeadT (shot 5)	Reclosing	Reclosing interval 5 (recltime5)	
	Second harmonic stage / inrush (68) If2>	If2>	Pickup Current (Ipset)	
	Second harmonic stage / inrush (68) t_f2	If2>	Time Setting (Tset)	

Voltage :

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
	Residual voltage protection (59N)Uo>	Uo>	Pickup Voltage (Uset)	
	Residual voltage protection (59N)t>	Uo>	Time Delay (Tdel)	
	Residual voltage protection (59N)Uo>>	Uo>>	Pickup Voltage (Uset)	
	Residual voltage protection (59N)t>>	Uo>>	Time Delay (Tdel)	

3.3 Output logic

It represents the output stage of the relay; it's the interface between the relay and the power breaker.

3.3.1 Available elements and relay output signals

The trip logic is implemented by the ”Output Logic” block. 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.

The relay trip output signal is ”T1”, the relay closing command output signal is ”yout”.

3.3.2 Functionality

The ”Output Logic” block collects the trip signals coming from the overcurrent protective elements and, when any protective element trips, operates the power breaker and the ”T1” relay output contact.

The *Output relay matrix* and the *Blocking matrix* relay setting can be set in the ”Logic” tab page of the ”Output Logic” block. The default trip logic blocks the phase overcurrent and undercurrent element trip (”I>”, ”I>>”, ”I>>>”, ”T>” and ”I<”) when the current 2^{nd} harmonic content exceeds the user configurable threshold set in the ”If2>” block.

The ”Closing Logic” block is controlled by the closing signal coming from the ”Reclosing” block and, when a reclosing attempt is initiated, triggers the closing command for the power breaker and operates the ”yout” relay output contact .

3.3.3 Data input

To disable the relay model ability to open the power circuit breaker simply disable the ”Output Logic” block.

To disable the relay model ability to close the power circuit breaker simply disable the ”Closing Logic” block.

4 Features not supported

The following features are not supported:

- Stall protection (48).
- Frequent start protection (66).
- Circuit breaker failure protection (50BF).
- Arc fault protection (50AR).
- Capacitor bank unbalance.
- Current transformer supervision.

5 References

[1] VAMP Ltd., Yrittajankatu 15 P.O.Box 810, FIN 65101 Vaasa, Finland. *VAMP 40 Feeder and motor protection relay Operation and configuration instructions Technical description VM40.EN001*, 2005.