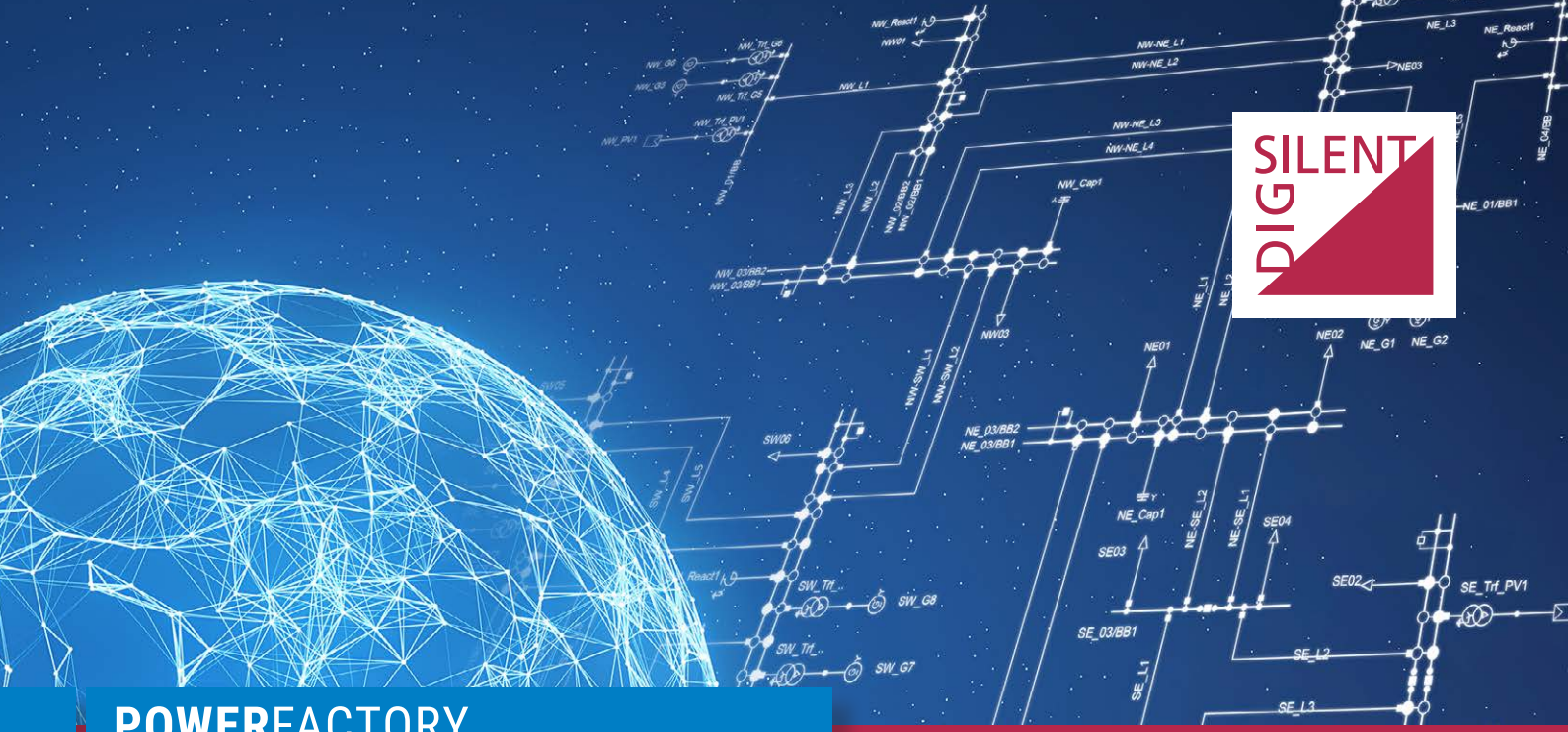

POWERFACTORY

PowerFactory 2021

Technical Reference

SEL 387

PF2021

POWER SYSTEM SOLUTIONS

MADE IN GERMANY

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Contents

1 Model information

Manufacturer SEL

Model 387

Variants The SEL 387 PowerFactory relay models can be used to simulate the different firmware versions of the SEL 387 protective relays. The reference firmware version used to implement the model is SEL-387-5-R602-V0-Z003003-D20020118. However please consider that the model has been implemented with a reduced set of the features available in the relays.

2 General description

The SEL-387 contains a variety of protective elements and control logic to protect two-, three-, or four- winding power transformers, reactors, generators, and other apparatus. It includes current differential elements with percentage restraint and harmonic blocking elements, sensitive restricted earth-fault (REF) elements, and overcurrent elements.

The SEL 387 PowerFactory relay models consist of a main model and a set of subrelays hosting the measurement and the overcurrent elements for each transformer winding.

The following model versions are available:

- SEL 387-1A
- SEL 387-5A

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

The relay models contain the measurement and acquisition units, eight subrelay (2 for each winding), and the output logic.

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

3 Supported features

3.1 Measurement and acquisition

The current are measured by four three phase current transformers (”Wd-1 Ct”, ”Wd-2 Ct”, ”Wd-3 Ct”, and ”Wd-4 Ct” block) and by four single phase current transformers (”Wd-1 Ct-3I0”, ”Wd-2 Ct-3I0”, ”Wd-3 Ct-3I0”, and ”Wd-4 Ct-3I0” block).

The measurement units are fed by these Cts and are hosted inside a set of subrelays. There is a subrelay for each windindg. Each *measurement* subrelay contains five measurement elements (”Measure”, ”Meas-2nd-H”, ”Meas-4th-H”, ”Meas-5th-H”, and ”Meas I2” block).

3.1.1 Available Units

- Four three phase current transformers measuring the phase currents in each winding(”Wd-1 Ct”, ”Wd-2 Ct”, ”Wd-3 Ct”, and ”Wd-4 Ct” block).
- Four single phase current transformers measuring the neutral current in each winding(”Wd-1 Ct-3I0”, ”Wd-2 Ct-3I0”, ”Wd-3 Ct-3I0”, and ”Wd-4 Ct-3I0” block).
- Four measurement subrelays (”Wd-1 Meas”, ”Wd-2 Meas”, ”Wd-3 Meas”, and”Wd-4 Meas” subrelay).

Each measurement subrelay contains the following measurement elements:

- One 3 phase measurement element (”Measure” block).
- One negative sequence measurement element (”Meas I2” block).
- One 2^{nd} harmonic measurement element (”Meas-2nd-H” block).
- One 4^{th} harmonic measurement element (”Meas-4th-H” block).
- One 5^{th} harmonic measurement element (”Meas-5th-H” block).

3.1.2 Functionality

The input current values are sampled at 20 samples/cycle. The values are processed by a cosine filter, operating over a cycle, which then calculates the current values used by the protective elements.

3.1.3 Data input

No manual data input is required but accordingly with the CT secondary rated current (1A or 5A) the correct SEL 387 relay model version must be selected.

3.2 Main Relay

The main relay scheme contains the current transformers, the measurement and the overcurrent subrelays the differential element and the output logic.

3.2.1 Available Units

- One 3 phase differential element (”Differential” block).
- Four measurement subrelays (”Wd-1 Meas”, ”Wd-2 Meas”, ”Wd-3 Meas” and ”Wd-4 Meas” block)
- Four overcurrent subrelays (”Wd-1 OC”, ”Wd-2 OC”, ”Wd-3 OC”, and ”Wd-4 OC” block).
- One output logic element (”Logic” block).
- Four measurement element ancillary to the differential element (”Diff RMS Meas”, ”Diff RMS Meas-2nd-H”, ”Diff RMS Meas-4th-H”, and ”Diff RMS Meas-5th-H” block).

3.2.2 Functionality

The relay differential logic is modeled by the ”Differential” element. The element defines a different *tap value* for each winding; the differential threshold values are expressed in terms of such *taps*. The differential element is harmonic blocked by the 2^{nd}, 3^{rd} and 4^{th} harmonic content. The differential characteristic has a double current biased slope; an additional unblocked constant threshold differential element is available.

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):

Address	Relay Setting	Model block	Model setting	Note
	TAP1	Differential	Tap 1 (tap1)	In the ”Tap” tab page
	TAP2	Differential	Tap 2 (tap2)	In the ”Tap” tab page
	TAP3	Differential	Tap 3 (tap3)	In the ”Tap” tab page
	TAP4	Differential	Tap 4 (tap4)	In the ”Tap” tab page
	MVA	Differential	Max rated power (maxpower)	In the ”Tap” tab page
	O87P	Differential	Differential Current threshold (Idiffr2)	
	SLP1	Differential	Restrain Percentage 1 (Irestrpercent1)	
	SLP2	Differential	Restrain Percentage 2 (Irestrpercent2)	
	IRS1	Differential	Restraint Current 2nd threshold (Ipset2r2)	
	U87P	Differential	Unrestrained Differential threshold (Idiffunrestr2)	
	PCT2	Differential	Blocking threshold (H2threshold)	In the ”2nd Harmonic” frame in the ”Harmonic blocking” tab page
	PCT4	Differential	Blocking threshold (H4threshold)	In the ”4th Harmonic” frame in the ”Harmonic blocking” tab page
	PCT5	Differential	Blocking threshold (H5threshold)	In the ”5th Harmonic” frame in the ”Harmonic blocking” tab page

Address	Relay Setting	Model block	Model setting	Note
	IHBL	Differential	Interblocking (h2interblock)	In the ”2nd Harmonic” frame in the ”Harmonic blocking” tab page
		Differential	Interblocking (h4interblock)	In the ”4th Harmonic” frame in the ”Harmonic blocking” tab page
		Differential	Interblocking (h5interblock)	In the ”5th Harmonic” frame in the ”Harmonic blocking” tab page

3.3 Measurement subrelays

Four *Measurement* subrelays are present in the SEL 387 main relay scheme. Each of them measure the currents converted to the CTs set along the wirings connected to a different winding.

3.3.1 Available Units

- Four 3 phase measurement elements (”Measure”, ”Meas I2”, ”Meas-2nd-H”, ”Meas-4th-H”, and ”Meas-5th-H” block).
- One current adaptor element (”Wd Adapter” block).

3.3.2 Functionality

The ”Measure” element calculates the fundamental frequency phase currents. The ”Meas I2” element calculates the phase currents negative sequence component. The ”Meas-2nd-H” element, the ”Meas-4th-H” element, and the ”Meas-5th-H” element calculate the 2^{nd}, the 4^{th} and the 5^{th} harmonic component of the phase currents.

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
	Wy[1]CT	Wd Adapter	Current Transformer Connection (icontype)	
	CTRy[1]	Wd Adapter	Current Transformer Ratio (CTratio)	
	Wy[1]CTC	Wd Adapter	Transformer Group (trasfgroup)	
	VWDGy[1]	Wd Adapter	Nominal Terminal Line-Line Voltage (LLVolt)	

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

3.4 Overcurrent subrelays

Four *Overcurrent* subrelays are present in the SEL 387 main relay scheme. Each of them evaluate the currents of a different winding.

3.4.1 Available Units

- One 3 phase inverse time overcurrent element (”51P” block).
- Four 3 phase definite time overcurrent elements (”50P1”, ”50P2”, ”50P3”, and ”50P4” block).
- One negative sequence inverse time overcurrent element (”51Q” block).
- Two negative sequence definite time overcurrent elements (”50Q1”, and ”50Q2” block).
- One neutral inverse time overcurrent element (”51N” block).
- Two neutral definite time overcurrent elements (”50N1”, and ”50N2” block).

3.4.2 Functionality

The inverse time elements (”51P”, ”51N” and ”51Q” block) support the following inverse time trip characteristics:

- C1 - IEC Class A (Standard Inverse)
- C2 - IEC Class B (Very Inverse)
- C3 - IEC Class C (Extremely Inverse)
- C4 - IEC Long Time Inverse
- U1 - U.S. Moderately Inverse
- U2 - U.S. Inverse
- U3 - U.S. Very Inverse
- U4 - U.S. Extremly Inverse

Each trip characteristic is associated to the relevant reset characteristic. The reset can set to be instantaneous or delayed accordingly to such reset characteristic.
The inverse time element trip characteristic equations comply with the IEC and ANSI standard equations.

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
	50Px[2]1P	50P1	Pickup Current (Ipsetr)	

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

Address	Relay Setting	Model block	Model setting	Note
	50Px^{2}1D	50P1	Time Setting (cTset)	
	50Px^{2}2P	50P2	Pickup Current (Ipsetr)	
	50Px^{2}3P	50P3	Pickup Current (Ipsetr)	
	50Px^{2}4P	50P4	Pickup Current (Ipsetr)	
	51Px^2 P	51P	Current Setting (Ipsetr)	
	51Px^2 C	51P	Characteristic(pcharac)	
	51Px^2 TD	51P	Time Dial (Tpset)	
	51Px^2 RS	51P	Reset Characteristic(resetdis)	
	50Qx^2 1P	50Q1	Pickup Current (Ipsetr)	
	50Qx^2 1D	50Q1	Time Setting (cTset)	
	50Qx^{2}2P	50Q2	Pickup Current (Ipsetr)	
	51Qx^2 P	51Q	Current Setting (Ipsetr)	
	51Qx^2 C	51Q	Characteristic(pcharac)	
	51Qx^2 TD	51Q	Time Dial (Tpset)	
	51Qx^2 RS	51Q	Reset Characteristic(resetdis)	
	50Nx^{2}1P	50N1	Pickup Current (Ipsetr)	
	50Nx^{2}1D	50N1	Time Setting (cTset)	
	50Nx^{2}2P	50N2	Pickup Current (Ipsetr)	
	51Nx^2 P	51N	Current Setting (Ipsetr)	
	51Nx^2 C	51N	Characteristic(pcharac)	
	51Nx^2 TD	51N	Time Dial (Tpset)	
	51Nx^2 RS	51N	Reset Characteristic(resetdis)	

3.5 Output logic

The output logic is the interface between the relay and the power system. A set of relay output signals is available and can be configured by the user to implement any control logic.

3.5.1 Available Units and Signals

The trip logic is implemented by the "Logic" block. Eleven relay output signals are available (”OUT1”, ”OUT2”, ”OUT3” . . . ”OUT11”)

By default the unique active relay output signal is ”OUT1”.

3.5.2 Functionality

The ”Logic” block operates the power breaker when a trip command has been issued by any protective element. The block output signal used to operate the breaker is ”OUT1”. The ”Logic” block gets from the definite time overcurrent elements both the trip signals and the starting signals. The trip logic provided with the default model considers also the status of the starting signals. The behavior of the other output signals and the trip logic can be configured in the "Logic" tab page of the "Logic" block dialog.

3.5.3 Data input

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

4 Features not supported

The following features are not supported:

- Harmonic restraint.
- DC ratio blocking
- Restricted earth fault
- Thermal element (387-6 only).

5 References

[1] SCHWEITZER ENGINEERING LABORATORIES, 2350 NE HOPKINS COURT PULLMAN, WA USA 99163-5603. *SEL-387 Current Differential and Overcurrent Protection Relay Versatile Solution for Power Apparatus Protection Data Sheet Date Code 20071214*, December 2007.

[2] SCHWEITZER ENGINEERING LABORATORIES, 2350 NE HOPKINS COURT PULLMAN, WA USA 99163-5603. *SEL-387-0, -5, -6 CURRENT DIFFERENTIAL RELAY OVERCURRENT RELAY DATA RECORDER INSTRUCTION MANUAL Date Code 20020118*, January 2002.