



POWERFACTORY

PowerFactory 2021

Technical Reference

SEL 311B

PF2021

POWER SYSTEM SOLUTIONS
MADE IN GERMANY

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1 Model information

Manufacturer SEL

Model 311B

Variants The SEL 311B PowerFactory relay models can be used to simulate the different firmware versions of the SEL 311B protective relays. The reference firmware version used to implement the models is SEL-311B-R105-V0-Z003002-D20020703. However please consider that the models have been implemented with a reduced set of the features available in the relays.

2 General description

The SEL 311B relay protects, controls, and monitors EHV, HV, and subtransmission lines. The relay contains all protective elements and control logic to protect any overhead transmission line.

The SEL 311B PowerFactory relay models consist of a monolithic scheme.

The following model versions are available:

- SEL 311B-1A
- SEL 311B-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, the polarizing elements, the directional element for the distance elements, the mho distance elements, a set of timers, the overcurrent elements, the overvoltage and undervoltage elements, the output logic.

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 by one three phase current transformer ("Ct" block) and one three phase voltage transformer ("Vt" block).

Three measurement units ("Measurement", "Mea Idelta" and "Measurement seq" block) are fed by this CT and this VT.

3.1.1 Available Units

- One three phase current transformers measuring the phase current ("Ct" block).
- One three phase voltage transformer measuring the phase voltages("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 ("Mea Idelta" block).
- One three phase measurement element calculating the current and the voltage sequence vectors ("Measurement seq" block).

3.1.2 Functionality

The input current and voltage values are sampled at 20 samples/cycle. The 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 "Mea Idelta" block calculates the phase-phase current values used by the phase-phase loop distance elements.

3.1.3 Data input

Please select the relay version accordingly with the input rated current value (1 A or 5 A).

3.2 Main Relay protective elements

The overcurrent starting elements, polarizing elements, the directional element, the mho distance elements are working together to simulate the SEL 311B distance functionalities. The ancillary overcurrent elements and the voltage protective elements are also modeled.

3.2.1 Available Units

- Three phase starting elements ("50PP1", "50PP2" and "50PP3" block).
- Three ground starting elements ("50G1/50L1", "50G2/50L2" and "50G3/50L3" block).
- Two polarizing elements ("Pol-Z" and "Pol-Z 2-3-4" block).
- One directional element ("Sel Dir" block).
- Three mho distance elements for the phase loops ("Ph-Ph 1", "Ph-Ph 2" and "Ph-Ph 3" block).
- Three timers associated to the phase mho elements ("Z1PD", "Z2PD" and "Z3PD" block).
- Three mho distance elements for the ground loops ("Ph-G1", "Ph-G2" and "Ph-G3" block).
- Three timers associated to the ground mho elements ("Z1GD", "Z2GD" and "Z3GD" block).
- One inverse time directional phase overcurrent element ("51P" block).
- Three definite time directional phase overcurrent elements ("67P1", "67P2" and "67P3" block).
- Three definite time phase overcurrent elements ("50P1", "50P2" and "50P3" block).
- One inverse time directional ground overcurrent element ("51G" block).
- Three definite time directional ground overcurrent elements ("67G1", "67G2" and "67G3" block).
- Three definite time ground overcurrent elements ("50G1", "50G2" and "50G3" block).
- One inverse time directional negative sequence overcurrent element ("51Q" block).
- Three definite time directional negative sequence overcurrent elements ("67Q1", "67Q2" and "67Q3" block).
- Three definite time negative sequence overcurrent elements ("50Q1", "50Q2" and "50Q3" block).
- One phase-phase definite time overvoltage element ("59PP" block).
- One phase-phase definite time undervoltage element ("27PP" block).
- One phase-ground definite time overvoltage element ("59L" block).
- One phase-ground definite time undervoltage element ("27L" block).

3.2.2 Functionality

Overcurrent starting elements Separated sets of overcurrent starting elements are available for the phase-phase and for the phase-ground loops. An overcurrent starting element is available for each distance zone. The phase-ground loop starting elements have both a ground and a phase current threshold.

Directional elements The directional element simulate in detail the SEL 311B negative sequence direction detection logic. The direction of the six mho elements and of the overcurrent elements must be set in the directional element dialog. For each inverse time overcurrent element the full set of available direction logics is present:

51P

- M2P (direction controlled by the Zone 2 phase distance element)
- N

51G

- 32QF
- 32QR
- Z2G (direction controlled by the Zone 2 ground distance elements)
- N

51Q

- 32QF
- 32QR
- M2P (direction controlled by the Zone 2 phase distance element)
- Z2G (direction controlled by the Zone 2 ground distance elements)
- N

The "Loss of potential" logic is also supported.

Polarizing element The polarizing elements are calculating the operating current and voltage and the polarizing voltage vectors used by the mho elements. Separated elements are available for the 1st zone ("Pol-Z" block) and for the other zones ("Pol-Z 2-3-4" block).

Mho elements Separated set of mho elements are monitoring the phase-ground and the phase-phase loops. The starting of the mho elements is controlled by the overcurrent starting elements.

Timers The timers are connected to the mho output signals. Separated timers are available for the phase and the ground loops.

Overcurrent The inverse time elements ("51P", "51G" and "51Q" block) are supporting 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. Extremely Inverse

The inverse time element trip characteristic equations comply with the IEC and ANSI standard equations.

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 elements :

Address	Relay Setting	Model block	Model setting	Note
	50PP1	50PP1	Current I>> (Ip2)	
	50PP2	50PP2	Current I>> (Ip2)	
	50PP3	50PP3	Current I>> (Ip2)	
	50L1	50G1/50L1	Current I>> (Ip2)	
	50L2	50G2/50L2	Current I>> (Ip2)	
	50L3	50G3/50L3	Current I>> (Ip2)	
	50GZ1	50G1/50L1	Current, 3*I0 (Ie)	
	50GZ2	50G2/50L2	Current, 3*I0 (Ie)	
	50GZ3	50G3/50L3	Current, 3*I0 (Ie)	

Polarizing element :

Address	Relay Setting	Model block	Model setting	Note
	k0M1	Polarizing	k0 (k0)	
	k0A1	Polarizing	Angle (phik0)	
	k0M	Polarizing 2-3-4	k0 (k0)	
	k0A	Polarizing 2-3-4	Angle (phik0)	

Mho impedance elements :

Address	Relay Setting	Model block	Model setting	Note
	E21P	Ph-Ph 1	Out of Service (outserv)	
		Ph-Ph 2	Out of Service (outserv)	
		Ph-Ph 3	Out of Service (outserv)	
	Z1P	Ph-Ph 1	Replica Impedance (Zm)	
	Z2P	Ph-Ph 2	Replica Impedance (Zm)	
	Z3P	Ph-Ph 3	Replica Impedance (Zm)	

3 Supported features

Address	Relay Setting	Model block	Model setting	Note
	E21MG	Ph-G1	Out of Service (outserv)	
		Ph-G2	Out of Service (outserv)	
		Ph-G3	Out of Service (outserv)	
	Z1MG	Ph-G1	Replica Impedance (Zm)	
	Z2MG	Ph-G2	Replica Impedance (Zm)	
	Z3MG	Ph-G3	Replica Impedance (Zm)	
	Positive-Seq.Line Impedance Angle	Ph-Ph 1	Relay angle (phi)	
		Ph-Ph 2	Relay angle (phi)	
		Ph-Ph 3	Relay angle (phi)	
	Zero-Seq.Line Impedance Angle	Ph-G1	Relay angle (phi)	
		Ph-G2	Relay angle (phi)	
		Ph-G3	Relay angle (phi)	

Timers :

Address	Relay Setting	Model block	Model setting	Note
	Z1PD	Z1PD	Time Setting (Tcdelay)	
	Z2PD	Z2PD	Time Setting (Tcdelay)	
	Z3PD	Z3PD	Time Setting (Tcdelay)	
	Z1GD	Z1GD	Time Setting (Tcdelay)	
	Z2GD	Z2GD	Time Setting (Tcdelay)	
	Z3GD	Z3GD	Time Setting (Tcdelay)	

Directional element ("Sel Dir") :

Address	Relay Setting	Model block	Model setting	Note
	ORDER	Sel Dir	Ground directional element priority(ORDER)	
	DIR1	Sel Dir	Level 1 direction (DIR1)	In the "Basic settings" tab page
	DIR2	Sel Dir	Level 2 direction (DIR2)	In the "Basic settings" tab page
	DIR3	Sel Dir	Level 3 direction (DIR3)	In the "Basic settings" tab page
	Z2F	Sel Dir	Forward directional Z2 threshold Z2F	In the "Negative sequence" tab page
	50QF	Sel Dir	Forward directional current threshold (s50QF)	In the "Negative sequence" tab page
	Z2R	Sel Dir	Reverse directional Z2 threshold Z2R	In the "Negative sequence" tab page
	50QR	Sel Dir	Reverse directional current threshold (s50QR)	In the "Negative sequence" tab page
	a2	Sel Dir	Positive sequence current restraint factor $a2=I2/I1$	In the "Negative sequence" tab page
	a0	Sel Dir	Zero sequence current restraint factor $a0=I0/I1$	In the "Ground" tab page
	k2	Sel Dir	Zero sequence current restraint factor $k2=I2/I0$	In the "Negative sequence" tab page
	ELOP	Sel Dir	Loss Of Potential enable setting (ELOP)	In the "Basic settings" tab page
	Z1MAG	Sel Dir	Positive sequence line impedance magnitude Z1MAG (Zm)	In the "Negative sequence" tab page
	Z1ANG	Sel Dir	Positive sequence line impedance angle Z1ANG (phi)	In the "Negative sequence" tab page

3 Supported features

Address	Relay Setting	Model block	Model setting	Note
	Z0MAG	Sel Dir	Zero sequence line impedance magnitude Z0MAG (Z0)	In the "Ground" tab page
	Z0ANG	Sel Dir	Zero sequence line impedance angle Z0ANG (phi0)	In the "Ground" tab page

Overcurrent :

Address	Relay Setting	Model block	Model setting	Note
	E51P	51P	Out of Service (outserv)	
	51PP	51P	Current Setting (Ipsetr)	
	51PC	51P	Characteristic(pcharac)	
	51PTD	51P	Time Dial (Tpset)	
	51PTC	Sel Dir	Phase(51P) Torque Control (s51PTC)	
	E51G	51G	Out of Service (outserv)	
	51GP	51G	Current Setting (Ipsetr)	
	51GC	51G	Characteristic(pcharac)	
	51GTD	51G	Time Dial (Tpset)	
	51GTC	Sel Dir	Residual(51N) Torque Control (s51PTC)	
	E51Q	51Q	Out of Service (outserv)	
	51QP	51Q	Current Setting (Ipsetr)	
	51QC	51Q	Characteristic(pcharac)	
	51QTD	51Q	Time Dial (Tpset)	
	51QTC	Sel Dir	Negative Sequence(51Q) Torque Control (s51PTC)	
	E50P	50P1	Out of Service (outserv)	
		50P2	Out of Service (outserv)	
		50P3	Out of Service (outserv)	
		67P1	Out of Service (outserv)	
		67P2	Out of Service (outserv)	
		67P3	Out of Service (outserv)	
	50P1	50P1	Pickup Current (Ipsetr)	
		67P1	Pickup Current (Ipsetr)	
	50P2	50P2	Pickup Current (Ipsetr)	
		67P2	Pickup Current (Ipsetr)	
	50P3	50P3	Pickup Current (Ipsetr)	
		67P3	Pickup Current (Ipsetr)	
	67P1D	67P1	Time Setting (cTset)	
	67P2D	67P2	Time Setting (cTset)	
	67P3D	67P3	Time Setting (cTset)	
	E50G	50G1	Out of Service (outserv)	
		50G2	Out of Service (outserv)	
		50G3	Out of Service (outserv)	
		67G1	Out of Service (outserv)	
		67G2	Out of Service (outserv)	
		67G3	Out of Service (outserv)	
	50G1	50G1	Pickup Current (Ipsetr)	
		67G1	Pickup Current (Ipsetr)	
	50G2	50G2	Pickup Current (Ipsetr)	
		67G2	Pickup Current (Ipsetr)	
	50G3	50G3	Pickup Current (Ipsetr)	
		67G3	Pickup Current (Ipsetr)	
	67G1D	67G1	Time Setting (cTset)	
	67G2D	67G2	Time Setting (cTset)	
	67G3D	67G3	Time Setting (cTset)	
	E50Q	50Q1	Out of Service (outserv)	
		50Q2	Out of Service (outserv)	
		50Q3	Out of Service (outserv)	
		67Q1	Out of Service (outserv)	
		67Q2	Out of Service (outserv)	
		67Q3	Out of Service (outserv)	
	50Q1	50Q1	Pickup Current (Ipsetr)	

3 Supported features

Address	Relay Setting	Model block	Model setting	Note
		67Q1	Pickup Current (Ipsetr)	
	50Q2	50Q2	Pickup Current (Ipsetr)	
		67Q2	Pickup Current (Ipsetr)	
	50Q3	50Q3	Pickup Current (Ipsetr)	
		67Q3	Pickup Current (Ipsetr)	
	67Q1D	67Q1	Time Setting (cTset)	
	67Q2D	67Q2	Time Setting (cTset)	
	67Q3D	67Q3	Time Setting (cTset)	

Voltage :

Address	Relay Setting	Model block	Model setting	Note
	EVOLT	59L	Out of Service (outserv)	
		59PP	Out of Service (outserv)	
		27L	Out of Service (outserv)	
		27PP	Out of Service (outserv)	
	59L	59L	Pickup Voltage (Usetr)	
	59PP	59PP	Pickup Voltage (Usetr)	
	27L	27L	Pickup Voltage (Usetr)	
	27PP	27PP	Pickup Voltage (Usetr)	

3.3 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.

3.3.1 Available Units and Signals

The trip logic is implemented by the "Logic" block. Twenty two relay output signals are available ("OUT1", "OUT2", "OUT3" ... "OUT22")

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

3.3.2 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 behavior of the other output signals, the trip logic and any special logic implemented in the relay by a SELOGIC control equation can be configured in the "Logic" tab page of the "Logic" block dialog.

3.3.3 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:

- Permissive Overreaching scheme.
- Directional Comparison Unblocking scheme.
- Directional Comparison Blocking scheme.
- Zone 1 extension.
- Remote End Just Opened.
- Switch Onto Fault.
- Positive Sequence Remote Bus Overvoltage element ("59PR" element).
- Polarization "Non-Homogeneous Correction Angle".
- Common Phase/Ground Distance Element Time Delay.
- Single Pole trip.
- Stub Protection.
- Pole Discordance.
- Out of step.
- Reclosing feature.
- Load encroachment feature.
- Synchro Check.

5 References

- [1] SCHWEITZER ENGINEERING LABORATORIES, 2350 NE HOPKINS COURT PULLMAN, WA USA 99163-5603. *SEL-311B PROTECTION AND AUTOMATION SYSTEM INSTRUCTION MANUAL 20020703*, July 2002.