



**POWERFACTORY**

# PowerFactory 2021

Technical Reference

SEL 421

PF2021

**POWER SYSTEM SOLUTIONS**  
MADE IN GERMANY

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November 15, 2019  
PowerFactory 2021  
Revision 924

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## 1 Model information

**Manufacturer** SEL

**Model** 421

**Variants** The SEL 421 PowerFactory relay models can be used to simulate the different firmware versions of the SEL 421 protective relays. The reference firmware version used to implement the model is SEL-421-R108-V0-Z002003-D20021216 and SEL-421-1-R108-V0-Z002003-D20021216. 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 421 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 421 PowerFactory relay models consist of a main model and a subrelay hosting the out of step logic.

The following model versions are available:

- SEL 421-1A
- SEL 421-5A

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 elements for the distance elements, the mho and the polygonal distance elements, a set of timers, the overcurrent elements, the undervoltage and the overvoltage element, 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 ("M-I/U", "M-lab/lbc/lca" and "Meas RMS 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 ("M-I/U" block).
- One three phase measurement element calculating the phase to phase currents ("M-lab/lbc/lca" block).
- One three phase measurement element calculating the current and the voltage sequence vectors ("Meas RMS 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 "M-lab/lbc/lca" block calculates the phase-phase current 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 overcurrent starting elements, polarizing elements, the directional element, the load encroachment element, the polygonal and the mho distance elements are working together to simulate the SEL 421 distance functionalities. The ancillary overcurrent elements and two voltage protective elements are also modeled.

### 3.2.1 Available Units

- One phase starting element ("50PP Starting" block).
- One ground starting element ("50G/50L" block)
- Two polarizing elements ("Polarizing" and "Polarizing Z1" block).
- One load encroachment element ("Load Encroachment" block).
- One directional element ("Sel Dir" block).
- Five mho distance elements for the phase loops ("Z1MP", "Z2MP", "Z3MP", "Z4MP" and "Z5MP" block).
- Five polygonal distance elements for the phase loops ("Z1QP", "Z2QP", "Z3QP", "Z4QP" and "Z5QP" block).
- Five timers associated to the phase polygonal and mho elements ("Z1PD", "Z2PD", "Z3PD", "Z4PD", and "Z5PD" block).
- Five mho distance elements for the ground loops ("Z1MG", "Z2MG", "Z3MG", "Z4MG" and "Z5MG" block).
- Five polygonal distance elements for the ground loops ("Z1QG", "Z2QG", "Z3QG", "Z4QG" and "Z5QG" block).
- Five timers associated to the ground polygonal and mho elements ("Z1GD", "Z2GD", "Z3GD", "Z4GD" and "Z5GD" block).
- Three inverse time directional phase overcurrent elements ("51S1P", "51S2P" and "51S3P" block).
- Three inverse time directional ground (residual) overcurrent elements ("51S1N", "51S2N" and "51S3N" block).
- Three inverse time directional positive sequence overcurrent element ("51S1I1", "51S2I1" and "51S3I1" block).
- Three inverse time directional negative sequence overcurrent elements ("51S1Q", "51S2Q" and "51S3Q" block).
- Four definite time directional phase overcurrent element ("50P1", "50P2", "50P3" and "50P4" block).
- Four definite time directional ground overcurrent element ("50/67N1", "50/67N2", "50/67N3" and "50/67N4" block).
- Four definite time directional negative sequence overcurrent element ("50/67Q1", "50/67Q2", "50/67Q3" and "50/67Q4" block).
- One definite time phase-phase overvoltage element ("59L" block).
- One definite time phase-phase undervoltage element ("27L" block).

### 3.2.2 Functionality

**Overcurrent starting elements** Separated overcurrent starting elements are available for the phase-phase and for the phase-ground loops. An unique overcurrent starting element is available for the phase-phase distance zones and an unique overcurrent starting element is available for the phase-ground distance zones. The phase-ground loop starting element has both a ground and a phase current threshold.

**Directional elements** The directional element simulate in detail the SEL 421 negative sequence direction detection logic. The direction of the four distance 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:

*51Sx<sup>1</sup> when 51Sx<sup>1</sup> O = IAn or IBn or ICn or IMAXn*

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

*51Sx<sup>1</sup> when 51Sx<sup>1</sup> O = 3I0*

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

*51Sx<sup>1</sup> when 51Sx<sup>1</sup> O = 3I2*

- 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 polygonal and the mho elements. Separated elements are available for the 1<sup>st</sup> zone ("Polarizing Z1" block) and for the other zones ("Polarizing" 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.

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<sup>1</sup>x = 1,2,3

**Polygonal elements** A set of polygonal elements can be used to monitor the phase-ground loops. The starting of the ground polygonal elements is controlled by the overcurrent starting elements.

**Load encroachment element** The model load encroachment element simulates exactly the shape of the relay feature. When a load encroachment condition is detected it blocks the phase mho elements.

**Timers** The timers are connected to the mho and to the polygonal output signals. Separated timers are available for the phase and the ground loops. The ground mho and the ground polygonal elements share the same timers.

**Overcurrent** The *Selectable Operating Quantity Inverse Time Overcurrent Elements* are modeled using the following four sets of inverse time overcurrent elements:

- Phase ("51S1P", "51S2P" and "51S3P" block).
- Positive sequence ("51S1I1", "51S2I1" and "51S3I1" block).
- Negative Sequence ("51S1Q", "51S2Q" and "51S3Q" block).
- Ground(residual) ("51S1N", "51S2N" and "51S3N" block).

In the relay 3 *Selectable Operating Quantity Inverse Time Overcurrent Elements* are present so in the model the elements listed above must be considered as part of the following 3 sets:

- 51S1 ("51S1P", "51S1I1", "51S1Q" and "51S1N" block).
- 51S2 ("51S2P", "51S2I1", "51S2Q" and "51S2N" block)
- 51S3 ("51S3P", "51S3I1", "51S3Q" and "51S3N" block)

Only one element for each set must be active.

The inverse time elements 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
- C5 - IEC Short Time Inverse
- U1 - U.S. Moderately Inverse
- U2 - U.S. Inverse
- U3 - U.S. Very Inverse
- U4 - U.S. Extremely Inverse
- U5 - U.S. Short Time Inverse



### 3 Supported features

Each tripping characteristic includes also a reset feature which can be enabled by the user. 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
	50PP	50PP Starting	Current $I_{>>}$ ( $I_{p2}$ )	
	50L	50G/50L	Current $I_{>>}$ ( $I_{p2}$ )	
	50G	50G/50L	Current, $3 \cdot I_0$ ( $I_e$ )	

##### Polarizing element :

Address	Relay Setting	Model block	Model setting	Note
	k01M	Polarizing Z1	k0 ( $k_0$ )	
	k01A	Polarizing Z1	Angle ( $\phi_{ik0}$ )	
	k0M	Polarizing	k0 ( $k_0$ )	
	k0A	Polarizing	Angle ( $\phi_{ik0}$ )	

##### Mho impedance elements :

Address	Relay Setting	Model block	Model setting	Note
	E21MP	Z1MP	Out of Service (outserv)	
		Z2MP	Out of Service (outserv)	
		Z3MP	Out of Service (outserv)	
		Z4MP	Out of Service (outserv)	
		Z5MP	Out of Service (outserv)	
	Z1MP	Z1MP	Replica Impedance ( $Z_m$ )	
	Z2MP	Z2MP	Replica Impedance ( $Z_m$ )	
	Z3MP	Z3MP	Replica Impedance ( $Z_m$ )	
	Z4MP	Z4MP	Replica Impedance ( $Z_m$ )	
	Z5MP	Z5MP	Replica Impedance ( $Z_m$ )	
	E21MG	Z1MG	Out of Service (outserv)	
		Z2MG	Out of Service (outserv)	
		Z3MG	Out of Service (outserv)	
		Z4MG	Out of Service (outserv)	
		Z5MG	Out of Service (outserv)	
	Z1MG	Z1MG	Replica Impedance ( $Z_m$ )	
	Z2MG	Z2MG	Replica Impedance ( $Z_m$ )	
	Z3MG	Z3MG	Replica Impedance ( $Z_m$ )	
	Z4MG	Z4MG	Replica Impedance ( $Z_m$ )	
	Z5MG	Z5MG	Replica Impedance ( $Z_m$ )	
	Positive-Seq.Line Impedance Angle	Z1MP	Relay angle ( $\phi$ )	
		Z2MP	Relay angle ( $\phi$ )	
		Z3MP	Relay angle ( $\phi$ )	

### 3 Supported features

Address	Relay Setting	Model block	Model setting	Note
	Zero-Seq.Line Impedance Angle	Z4MP Z5MP Z1MG  Z2MG Z3MG Z4MG Z5MG	Relay angle (phi) Relay angle (phi) Relay angle (phi)  Relay angle (phi) Relay angle (phi) Relay angle (phi) Relay angle (phi)	

#### Polygonal impedance elements :

Address	Relay Setting	Model block	Model setting	Note
	E21XP	Z1QP Z2QP Z3QP Z4QP Z5QP	Out of Service (outserv) Out of Service (outserv) Out of Service (outserv) Out of Service (outserv) Out of Service (outserv)	
	XP1	Z1QP	+X Reach (Xmax)	
	XP2	Z2QP	+X Reach (Xmax)	
	XP3	Z3QP	+X Reach (Xmax)	
	XP4	Z4QP	+X Reach (Xmax)	
	XP5	Z5QP	+X Reach (Xmax)	
	RP1	Z1QP	+R Resistance (Rmax)	
	RP2	Z2QP	+R Resistance (Rmax)	
	RP3	Z3QP	+R Resistance (Rmax)	
	RP4	Z4QP	+R Resistance (Rmax)	
	RP5	Z5QP	+R Resistance (Rmax)	
	Positive-Seq.Line Impedance Angle	Z1QP	Relay angle (phi)	
		Z2QP	Relay angle (phi)	
		Z3QP	Relay angle (phi)	
		Z4QP	Relay angle (phi)	
		Z5QP	Relay angle (phi)	
	E21XG	Z1QG Z2QG Z3QG Z4QG Z5QG	Out of Service (outserv) Out of Service (outserv) Out of Service (outserv) Out of Service (outserv) Out of Service (outserv)	
	XG1	Z1QG	+X Reach (Xmax)	
	XG2	Z2QG	+X Reach (Xmax)	
	XG3	Z3QG	+X Reach (Xmax)	
	XG4	Z4QG	+X Reach (Xmax)	
	XG5	Z5QG	+X Reach (Xmax)	
	RG1	Z1QG	+R Resistance (Rmax)	
	RG2	Z2QG	+R Resistance (Rmax)	
	RG3	Z3QG	+R Resistance (Rmax)	
	RG4	Z4QG	+R Resistance (Rmax)	
	RG5	Z5QG	+R Resistance (Rmax)	
	Zero-Seq.Line Impedance Angle	Z1QG	Relay angle (phi)	
		Z2QG	Relay angle (phi)	
		Z3QG	Relay angle (phi)	
		Z4QG	Relay angle (phi)	
		Z5QG	Relay angle (phi)	

### 3 Supported features

#### Timers :

Address	Relay Setting	Model block	Model setting	Note
	Z1PD	Z1PD	Time Setting (Tcdelay)	
	Z2PD	Z2PD	Time Setting (Tcdelay)	
	Z3PD	Z3PD	Time Setting (Tcdelay)	
	Z4PD	Z4PD	Time Setting (Tcdelay)	
	Z5PD	Z5PD	Time Setting (Tcdelay)	
	Z1GD	Z1GD	Time Setting (Tcdelay)	
	Z2GD	Z2GD	Time Setting (Tcdelay)	
	Z3GD	Z3GD	Time Setting (Tcdelay)	
	Z4GD	Z4GD	Time Setting (Tcdelay)	
	Z5GD	Z5GD	Time Setting (Tcdelay)	

#### Load Encroachment :

Address	Relay Setting	Model block	Model setting	Note
	ELE	Load Encroachment	Out of Service (outserv)	
	ZLF	Load Encroachment	ZLF	
	ZLR	Load Encroachment	ZLR	
	PLAF	Load Encroachment	PLAF	
	NLAF	Load Encroachment	NLAF	
	PLAR	Load Encroachment	PLAR	
	NLAR	Load Encroachment	NLAR	

#### Directional element ("Sel Dir") :

Address	Relay Setting	Model block	Model setting	Note
	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
	DIR4	Sel Dir	Level 4 direction (DIR4)	In the "Basic settings" tab page
	DIR5	Sel Dir	Level 5 direction (DIR5)	In the "Basic settings" tab page
	Z2F	Sel Dir	Forward directional Z2 threshold Z2F (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 (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
	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
	E32IV	Sel Dir	Ground directional element enabling flag E32IV (E32IV)	In the "Ground" tab page
	50GFP	Sel Dir	Forward directional residual ground pickup 50GFP (s50GFP)	In the "Ground" tab page
	50GRP	Sel Dir	Reverse directional residual ground pickup 50GRP (s50GRP)	In the "Ground" tab page
	Z0F	Sel Dir	Forward directional Z0 threshold Z0F	In the "Ground" tab page
	Z0R	Sel Dir	Reverse directional Z0 threshold Z0R	In the "Ground" tab page
	50LP	Sel Dir	Load Detection phase pickup 50LP (s50LP)	In the "Ground" tab page
	a0	Sel Dir	Zero sequence current restraint factor a0=I0/I1	In the "Ground" tab page
	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
	51S1O	51S1P	Out of Service (outserv)	Enable if IAn or IBn or ICn or IMAXn
		51S1I1	Out of Service (outserv)	Enable if I1L
		51S1Q	Out of Service (outserv)	Enable if 3I2L
		51S1N	Out of Service (outserv)	Enable if 3I0L
	51S1P	51S1P	Current Setting (Ipsetr)	Enable if IAn or IBn or ICn or IMAXn
		51S1I1	Current Setting (Ipsetr)	Enable if I1L
		51S1Q	Current Setting (Ipsetr)	Enable if 3I2L
		51S1N	Current Setting (Ipsetr)	Enable if 3I0L
	51S1C	51S1P	Characteristic(pcharac)	Enable if IAn or IBn or ICn or IMAXn
		51S1I1	Characteristic(pcharac)	Enable if I1L
		51S1Q	Characteristic(pcharac)	Enable if 3I2L
		51S1N	Characteristic(pcharac)	Enable if 3I0L
	51S1TD	51S1P	Time Dial (Tpset)	Enable if IAn or IBn or ICn or IMAXn
		51S1I1	Time Dial (Tpset)	Enable if I1L
		51S1Q	Time Dial (Tpset)	Enable if 3I2L
		51S1N	Time Dial (Tpset)	Enable if 3I0L
	51S1RS	51S1P	Reset Characteristic (resetdis)	Enable if IAn or IBn or ICn or IMAXn
		51S1I1	Reset Characteristic (resetdis)	Enable if I1L
		51S1Q	Reset Characteristic (resetdis)	Enable if 3I2L
		51S1N	Reset Characteristic (resetdis)	Enable if 3I0L
	51S1TC	Sel Dir	Phase(51P) Torque Control (s51PTC)	Set if IAn or IBn or ICn or IMAXn
		Sel Dir	Phase(51P) Torque Control (s51PTC)	Set if I1L
		Sel Dir	Negative Sequence(51Q) Torque Control (s51PTC)	Set if 3I2L
		Sel Dir	Residual(51N) Torque Control (s51PTC)	Set if 3I0L
	51S2O	51S2P	Out of Service (outserv)	Enable if IAn or IBn or ICn or IMAXn

### 3 Supported features

Address	Relay Setting	Model block	Model setting	Note
	51S2P	51S2I1	Out of Service (outserv)	Enable if I1L
		51S2Q	Out of Service (outserv)	Enable if 3I2L
		51S2N	Out of Service (outserv)	Enable if 3I0L
		51S2P	Current Setting (Ipsetr)	Enable if IAn or IBn or ICn or IMAXn
	51S2C	51S2I1	Current Setting (Ipsetr)	Enable if I1L
		51S2Q	Current Setting (Ipsetr)	Enable if 3I2L
		51S2N	Current Setting (Ipsetr)	Enable if 3I0L
		51S2P	Characteristic(pcharac)	Enable if IAn or IBn or ICn or IMAXn
	51S2TD	51S2I1	Characteristic(pcharac)	Enable if I1L
		51S2Q	Characteristic(pcharac)	Enable if 3I2L
		51S2N	Characteristic(pcharac)	Enable if 3I0L
		51S2P	Time Dial (Tpset)	Enable if IAn or IBn or ICn or IMAXn
	51S2RS	51S2I1	Time Dial (Tpset)	Enable if I1L
		51S2Q	Time Dial (Tpset)	Enable if 3I2L
		51S2N	Time Dial (Tpset)	Enable if 3I0L
		51S2P	Reset Characteristic (resetdis)	Enable if IAn or IBn or ICn or IMAXn
	51S2TC	51S2I1	Reset Characteristic (resetdis)	Enable if I1L
		51S2Q	Reset Characteristic (resetdis)	Enable if 3I2L
		51S2N	Reset Characteristic (resetdis)	Enable if 3I0L
		Sel Dir	Phase(51P) Torque Control (s51PTC)	Set if IAn or IBn or ICn or IMAXn
	51S3O	Sel Dir	Phase(51P) Torque Control (s51PTC)	Set if I1L
		Sel Dir	Negative Sequence(51Q) Torque Control (s51PTC)	Set if 3I2L
		Sel Dir	Residual(51N) Torque Control (s51PTC)	Set if 3I0L
		51S3P	Out of Service (outserv)	Enable if IAn or IBn or ICn or IMAXn
	51S3P	51S3I1	Out of Service (outserv)	Enable if I1L
		51S3Q	Out of Service (outserv)	Enable if 3I2L
		51S3N	Out of Service (outserv)	Enable if 3I0L
		51S3P	Current Setting (Ipsetr)	Enable if IAn or IBn or ICn or IMAXn
	51S3C	51S3I1	Current Setting (Ipsetr)	Enable if I1L
		51S3Q	Current Setting (Ipsetr)	Enable if 3I2L
		51S3N	Current Setting (Ipsetr)	Enable if 3I0L
		51S3P	Characteristic(pcharac)	Enable if IAn or IBn or ICn or IMAXn
	51S3TD	51S3I1	Characteristic(pcharac)	Enable if I1L
		51S3Q	Characteristic(pcharac)	Enable if 3I2L
		51S3N	Characteristic(pcharac)	Enable if 3I0L
		51S3P	Time Dial (Tpset)	Enable if IAn or IBn or ICn or IMAXn
	51S3RS	51S3I1	Time Dial (Tpset)	Enable if I1L
		51S3Q	Time Dial (Tpset)	Enable if 3I2L
		51S3N	Time Dial (Tpset)	Enable if 3I0L
		51S3P	Reset Characteristic (resetdis)	Enable if IAn or IBn or ICn or IMAXn
	51S3TC	51S3I1	Reset Characteristic (resetdis)	Enable if I1L
		51S3Q	Reset Characteristic (resetdis)	Enable if 3I2L
		51S3N	Reset Characteristic (resetdis)	Enable if 3I0L
		Sel Dir	Phase(51P) Torque Control (s51PTC)	Set if IAn or IBn or ICn or IMAXn
		Sel Dir	Phase(51P) Torque Control (s51PTC)	Set if I1L

### 3 Supported features

Address	Relay Setting	Model block	Model setting	Note
		Sel Dir	Negative Sequence(51Q) Torque Control (s51PTC)	Set if 3I2L
		Sel Dir	Residual(51N) Torque Control (s51PTC)	Set if 3I0L
	50P1P	50P1	Pickup Current (Ipsetr)	
	50P2P	50P2	Pickup Current (Ipsetr)	
	50P3P	50P3	Pickup Current (Ipsetr)	
	50P4P	50P4	Pickup Current (Ipsetr)	
	E50N	50/67N1	Out of Service (outserv)	
		50/67N2	Out of Service (outserv)	
		50/67N3	Out of Service (outserv)	
		50/67N4	Out of Service (outserv)	
	50N1	50/67N1	Pickup Current (Ipsetr)	
	50N2	50/67N2	Pickup Current (Ipsetr)	
	50N3	50/67N3	Pickup Current (Ipsetr)	
	50N4	50/67N4	Pickup Current (Ipsetr)	
	E50Q	50/67Q1	Out of Service (outserv)	
		50/67Q2	Out of Service (outserv)	
		50/67Q3	Out of Service (outserv)	
		50/67Q4	Out of Service (outserv)	
	50Q1	50/67Q1	Pickup Current (Ipsetr)	
	50Q2	50/67Q2	Pickup Current (Ipsetr)	
	50Q3	50/67Q3	Pickup Current (Ipsetr)	
	50Q4	50/67Q4	Pickup Current (Ipsetr)	
	67NL1D	50/67N1	Time Setting (cTset)	
	67NL2D	50/67N2	Time Setting (cTset)	
	67NL3D	50/67N3	Time Setting (cTset)	
	67NL4D	50/67N4	Time Setting (cTset)	
	67Q1D	50/67Q1	Time Setting (cTset)	
	67Q2D	50/67Q2	Time Setting (cTset)	
	67Q3D	50/67Q3	Time Setting (cTset)	
	67Q4D	50/67Q4	Time Setting (cTset)	

#### Voltage :

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

### 3.3 Out of Step subrelay

The *Out of Step* subrelay implements the out of step and the power swing detection logic.

#### 3.3.1 Available Units

- Two polygonal zones defining the power swing detection area ("Zone 5" and "Zone 6" block).
- One minimum current activation threshold ("I supervision" block).
- One power swing and out of step detection element ("Out Of Step" block).
- One timer associated to the out of step trip signal ("OS Time Delay" block).

#### 3.3.2 Functionality

The power swing detection area is defined by two polygonal zones: please notice that one zone ("Zone 6") contains the second one ("Zone 5") and no intersection is present between the zones. The power swing condition is declared when the system impedance point is in the area defined between the two polygonal zones for a time greater than an user definable setting ("tP1" in the "Timers" tab of the "OS Time Delay" element dialog). The power swing block is disabled after 2 seconds. The number of the distance zones blocked by the power swing detector can be configured by the user. The out of step condition is declared when the system impedance point intersects in sequence both the internal and the external polygonal zone. The out of step trip signal can be delayed by an additional timer ("OS Time Delay").

#### 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
	EOOS	Out Of Step	Out of Step (ioos)	Select "All zones Blocking Configuration" or "Z1 Blocking Configuration" or "Z1 & Z2 Blocking Configuration" Select "All zones Blocking Configuration" or "Z1 & Z2 Blocking Configuration" or "Z2=> Blocking Configuration" Select "All zones Blocking Configuration" or "Z2=> Blocking Configuration" Select "All zones Blocking Configuration" or "Z2=> Blocking Configuration" In the "Timer" tab page
	OOSB1	Out Of Step	Blocking Configuration (iblockconf)	
	OOSB2	Out Of Step	Blocking Configuration (iblockconf)	
	OOSB3	Out Of Step	Blocking Configuration (iblockconf)	
	OOSB4	Out Of Step	Blocking Configuration (iblockconf)	
	OSBD	Out Of Step	tP1 (TtP1)	
	OSTD	OS Time Delay	Time Setting (Tcdelay)	
	X1T5	Zone 5	+X Reach (Xmax)	
	X1B5	Zone 5	-X Reach (Xmin)	
	R1R5	Zone 5	+R Resistance (Rmax)	
	R1L5	Zone 5	-R Resistance (Rmin)	
	X1T6	Zone 6	+X Reach (Xmax)	
	X1B6	Zone 6	-X Reach (Xmin)	
	R1R6	Zone 6	+R Resistance (Rmax)	

### 3 Supported features

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Address	Relay Setting	Model block	Model setting	Note
	R1L6 50ABC	Zone 6 I supervision	-R Resistance (Rmin) Pickup Current (Ipsetr)	



### 3.4 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.

#### 3.4.1 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".

#### 3.4.2 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 and the trip logic can be configured in the "Logic" tab page of the "Logic" block dialog.

#### 3.4.3 Data input

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

## 4 Features not supported

### 4.1 Main Relay

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 scheme.
- Positive Sequence Remote Bus Overvoltage element ("59PR" element).
- Polarization "Non-Homogeneous Correction Angle".
- Single Pole trip.
- Stub Protection.
- Pole Discordance.
- Breaker Failure.
- Series Compensation.
- Overcurrent element instantaneous not directional pickup.
- Pole Open detection.
- Synchronism check.
- Reclosing feature.

### 4.2 Out of Step Subrelay

- Negative sequence current unblock.

## 5 References

- [1] Schweitzer Engineering Laboratories, 2350 NE Hopkins Court Pullman, WA USA 99163-5603.  
*SEL-421 Relay SEL 421-1 Relay Protection Automation Control 20021216*, December 2002.