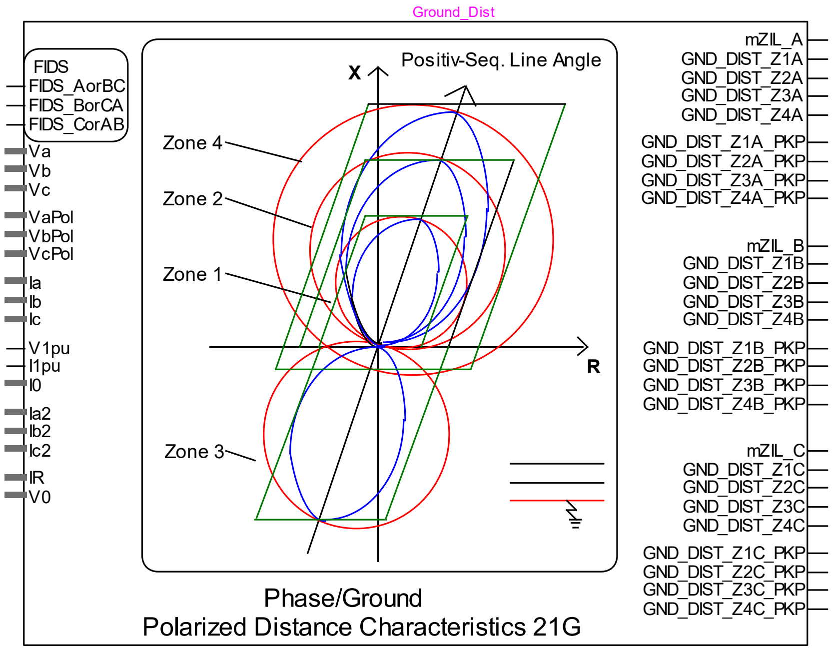
Protection: Distance relay functions



Henry Gras, Jean Mahseredjian, 2017-09-26 4:36:00 PM

1 Introduction

There are two distance relay functions for the ANSI standards 21P (phase) and 21G (ground).

The inputs are the phasors of the phase currents and voltages, the calculated residual current from I_0, the measured residual current (from the ground), the negative sequence current, the memory (polarization) voltages (see Section 3) and the sequence voltages.

21G (respectively 21P) detects when the impedance phase-to-ground (respectively phase-to-phase) seen by the relay enters in the protection zone which can be a Mho, lens or quadrilateral locus. The zone can be forward or reverse directional or non-directional. Each zone has its own pickup and reset delays plus overcurrent, directional and reactance characteristic supervisors.
In the case of the ground distance, zero-sequence and negative-sequence supervisors are also modelled and so is the zero sequence compensation.
The distance elements can be self-polarized or polarized. In this latter case, the memory voltage depends on the manufacturer (see Section 3).

2 Input data: “Phase-to-ground distance” and “Phase-to-phase distance”

- **Enable ground (phase) distance relay**: enable the distance function. If unchecked, the functions are disabled and replaced by an empty subcircuit whose outputs are zeros.
- **Phase-to-ground (to-phase) zone *i***: If this box is checked, the level is enabled.

Distance functions have 4 levels. See Figure 2-1 and Figure 2-2 for identifying various input variables. Each distance function has the following settings:

- **Direction**: Forward, reverse, non-directional. This is the orientation of the zone.
- **Shape**: Mho/Lens or Quad. If Mho/Lens is selected, the **Comparator limit angle** input will determine if the shape is Mho (**Comparator limit angle** equal to 90º) or lens (**Comparator limit angle smaller** than 90º).
- **Polarizing current** (for 21G only): type of polarizing current for the quad element. Choice between Zero-sequence or Negative-sequence.
- **Reach** and **Reach rev:** Reach setting in %, ohms at the secondary of the current transformer (CT) and voltage transformer (VT) or ohms at the primary.
- **RCA or RCA rev:** Characteristic angle of the zone in degrees. For reverse directional characteristics or **RCA rev**, the angle is automatically shifted by 180º.
- **Comparator limit angle** (Mho or Lens shapes**,** see Figure 2-2):
    - if 90º the shape is Mho
    - if smaller than 90º the shape is Lens
    - if bigger than 90º the shape is Apple (see Section 4).
- **Left blinder** and **Right blinder** (Quad shape)**:** Intersection point of the blinder on the R-axis of the R-X plan in %, ohms at the secondary of the current transformer (CT) and voltage transformer (VT) or ohms at the primary (selection option). See L-blinder and R-blinder in Figure 2-1.
- **Left** and **Right blinder angle:** Angle in degrees between the R-axis and the blinder.
- **Comparator limit angle** (Quad shape, see Figure 2-1, “Comp limit”): angle in degrees between the reactance limit and the reach vector.
- **Delay**: Pickup delay for the tripping request of the function to become true after all the conditions (zone detection, supervisors, …) are true.
- **Z0/Z1 mag**: (for 21G only) ratio of the magnitudes of the zero- and positive-sequence impedances. Used for the zero-sequence compensation.
- **Z0/Z1 ang**: (for 21G only) angle difference between the zero- and positive-sequence impedances. Used for the zero-sequence compensation.
- **Z0M/Z1 mag**: (for 21G only) ratio of the magnitudes of the mutual zero-sequence and the positive-sequence impedances. Used for the zero sequence compensation.
- **Z0M/Z1 ang**: (for 21G only) angle difference between the mutual zero-sequence and the positive-sequence impedances. Used for the zero sequence compensation of parallel lines. The zero sequence current of the parallel line has to be an input of the ground CT.
- **I_{0min}:** (for 21G only) Minimum zero sequence current magnitude to enable the element.
- **I_{min}:** (for 21P only) Minimum phase current magnitude to enable the element of this phase.

- ❑ **Non-homogeneous angle:** (for 21G only, Quad) Modifies the angle of the polarizing current of the reactance comparator (degrees). See Figure 2-1, “Non-homogenous” angle.

The following settings are used to enable various extra supervisors (see Section 4). If a supervisor is disabled, it is excluded and its outputs are set to 1.

- ❑ **Enable the negative-sequence polarized directional characteristic supervision (**for 21G**)**
- ❑ **Enable the neutral polarized directional characteristic supervision** (21G)
- ❑ **Enable the polarized directional characteristic supervision** (21P)

When the above settings are enabled, the following inputs are also enabled:

- ❑ **DIR RCA**: Angle in degrees of the directional supervisor axis.
- ❑ **DIR Comparator limit angle**: “DIR comp limit” angle on Figure 2-1, in degrees.

The directional supervisor option is

- ❑ **Enable the reactance characteristic supervision:** Add a reactance supervision. The angle between the reactance limit and the reach vector is Comparator limit angle (the same as for Quad shape, see Figure 2-1).

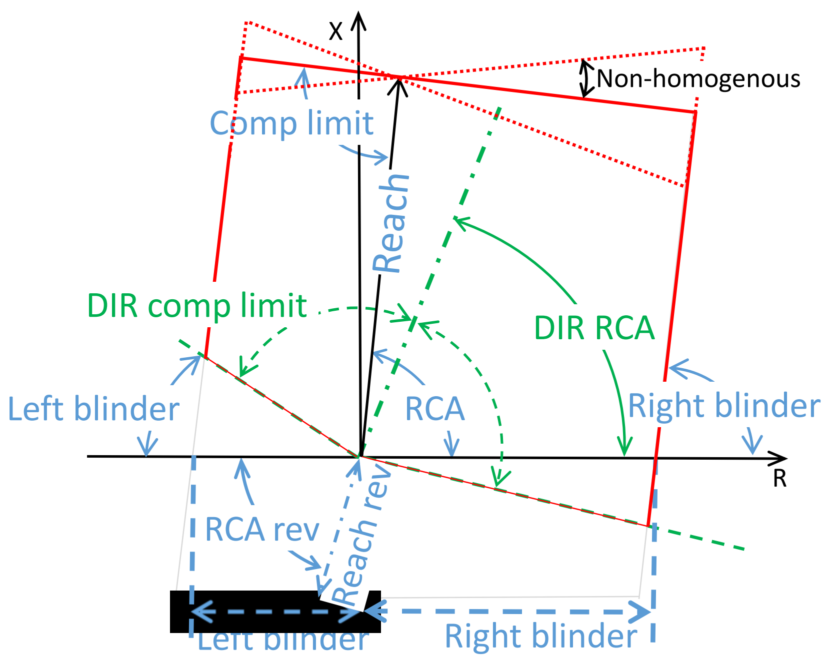


Figure 2-1 Quadrilateral characteristic (Quad shape).

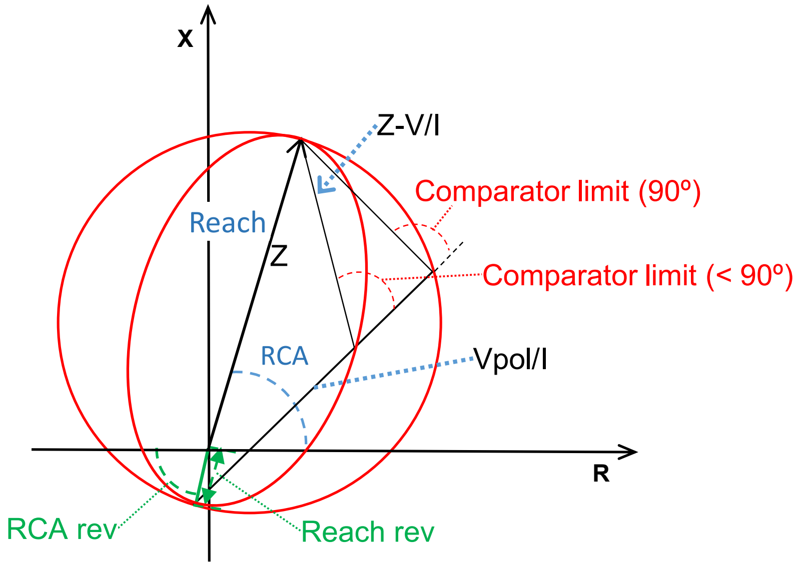


Figure 2-2 Mho or Lens characteristics.

3 Input data: Line characteristics tab

- **Positive-sequence** (and **Zero-sequence) magnitude**: positive- and zero-sequence impedance magnitudes of the line in ohms seen at the primary or secondary (selection) of the CT/VT.
- **angle**: angles for the above.
- **Voltage memory polarization type**: Self-polarized, Crossed-Polarized or Manufacturer.

The memory voltage data is related to the manufacturer as presented below.

3.1 Voltage memory polarization: Self-polarized

For the ground distance function, the memorized voltages are the phase-to-ground voltages. If **Use Positive sequence** is checked they are the positive sequence voltages. For example, for the distance element of phase-A:

$$\mathbf{V}_{\mathbf{MEM\_A}} = \mathbf{V}_{\mathbf{A}} \text{ or } \mathbf{V}_{\mathbf{A1}} \tag{1}$$

For the phase distance function, they are the phase-to-phase voltages. If **Use Positive sequence** is checked they are the positive sequence phase-to-phase voltages. For example: $\mathbf{V}_{\mathbf{AB1}} = \mathbf{V}_{\mathbf{A1}} - \mathbf{V}_{\mathbf{B1}}$

For example, for the distance element of phase A to phase B:

$$\mathbf{V}_{\mathbf{MEM\_AB}} = \mathbf{V}_{\mathbf{AB}} \text{ or } \mathbf{V}_{\mathbf{AB1}} \tag{2}$$

3.2 Voltage memory polarization: Crossed-polarized

For the ground distance function, the memorized voltages are the phase-to-phase voltages shifted by 90º. For example, for the distance element of phase A:

$$\mathbf{V}_{\mathbf{MEM\_A}} = j\mathbf{V}_{\mathbf{BC}} \text{ or } j\mathbf{V}_{\mathbf{BC}} \tag{3}$$

For the phase distance function, they are the phase-to-ground voltages shifted by –90º. For example, for the distance element of phase A to phase B:

$$\mathbf{V}_{\mathbf{MEM\_AB}} = -j\mathbf{V}_{\mathbf{C}} \text{ or } -j\mathbf{V}_{\mathbf{C1}} \tag{4}$$

3.3 Voltage memory polarization: Manufacturer

3.3.1 General Electric

If the manufacturer General Electric, the memory voltage manager defined in [1] is implemented.

- **Memory duration**: for General Electric only, length of memory in cycles (see also the tooltip).

3.3.2 Siemens

If the manufacturer is Siemens, the memory voltage manager defined in [3] is implemented.

- k_{Pre} Phase loop: Pre-fault factor for phase loop.
- k_{Pre} Earth loop: Pre-fault factor for earth loop.

3.3.3 SEL

If the manufacturer is SEL, the memory voltages are polarized with the positive sequence voltages. An infinite impulse response filter is also applied and defined as follows:

$$\mathbf{V_{MEM}} = \frac{1}{16}\mathbf{V_{1,k}} + \frac{15}{16}\mathbf{V_{1,k\text{-}2}} \qquad (5)$$

where $\mathbf{V_{1,k}}$ is the positive sequence voltage at the sample k and $\mathbf{V_{1,k-2}}$ the positive sequence voltage two samples before. The sample rate is 4 samples per cycle.

4 Angle comparators

The following tabs summarize the angle monitors (supervisors).

Table 4-1: Forward/Reverse Mho/Lens (Figure 2-2)

Phase	Vector 1	Vector 2	Limit angle setting
AB	$Z(I_A-I_B)-(V_A-V_B)$	$(V_{A,MEM}-V_{B,MEM})$	Comparator limit angle 21P
BC	$Z(I_B-I_C)-(V_B-V_C)$	$(V_{B,MEM}-V_{C,MEM})$	Comparator limit angle 21P
CA	$Z(I_C-I_A)-(V_C-V_A)$	$(V_{C,MEM}-V_{A,MEM})$	Comparator limit angle 21P
A	$Z(I_A+I_0K_0+I_GK_{0M})-V_A$	$V_{A,MEM}$	Comparator limit angle 21G
B	$Z(I_B+I_0K_0+I_GK_{0M})-V_A$	$V_{B,MEM}$	Comparator limit angle 21G
C	$Z(I_C+I_0K_0+I_GK_{0M})-V_A$	$V_{C,MEM}$	Comparator limit angle 21G

Where $V_{A,MEM}$, $V_{B,MEM}$, $V_{C,MEM}$ are the memory voltages of phases A, B and C, respectively, I_G is the measured ground current, Z is the reach impedance defined by Reach and RCA (see Figure 2-2), K_0 and K_{0M} are defined by the data inputs Z0/Z1 mag, Z0/Z1 angle, Z0M/Z1 mag and Z0M/Z1 angle.
The current I_0 is the calculated zero-sequence current.

Table 4-2: Non-directional Mho/Lens (Figure 2-2)

Phase	Vector 1	Vector 2	Limit angle setting
AB	$Z(I_A-I_B)-(V_A-V_B)$	$(V_{A,MEM}-V_{B,MEM})- Z_{rev}(I_A-I_B)$	Comparator limit angle 21P
BC	$Z(I_B-I_C)-(V_B-V_C)$	$(V_{B,MEM}-V_{C,MEM}) - Z_{rev}(I_B-I_C)$	Comparator limit angle 21P
CA	$Z(I_C-I_A)-(V_C-V_A)$	$(V_{C,MEM}-V_{A,MEM}) - Z_{rev}(I_C-I_A)$	Comparator limit angle 21P
A	$Z(I_A+I_0K_0+I_GK_{0M})-V_A$	$V_{A,MEM} - Z_{rev}(I_A+I_0K_0+I_GK_{0M})$	Comparator limit angle 21G
B	$Z(I_B+I_0K_0+I_GK_{0M})-V_A$	$V_{B,MEM} - Z_{rev}(I_B+I_0K_0+I_GK_{0M})$	Comparator limit angle 21G
C	$Z(I_C+I_0K_0+I_GK_{0M})-V_A$	$V_{C,MEM} - Z_{rev}(I_C+I_0K_0+I_GK_{0M})$	Comparator limit angle 21G

Z_{rev} is the reverse reach impedance defined by Reach rev and RCA rev data inputs shown in Figure 2-2.

Table 4-3: Quad reactance (see Figure 2-1)

Phase	Vector 1	Vector 2	Limit angle setting
AB	$Z(I_A-I_B)-(V_A-V_B)$	$Z(I_A-I_B)$	Comparator limit angle 21P
BC	$Z(I_B-I_C)-(V_B-V_C)$	$Z(I_B-I_C)$	Comparator limit angle 21P
CA	$Z(I_C-I_A)-(V_C-V_A)$	$Z(I_C-I_A)$	Comparator limit angle 21P
A	$Z(I_A+I_0K_0+I_GK_{0M})-V_A$	$I_0\angle\text{Non-homogenous} + 90°$	Comparator limit angle 21G
B	$Z(I_B+I_0K_0+I_GK_{0M})-V_A$	$I_0\angle\text{Non-homogenous} + 90°$	Comparator limit angle 21G
C	$Z(I_C+I_0K_0+I_GK_{0M})-V_A$	$I_0\angle\text{Non-homogenous} + 90°$	Comparator limit angle 21G

The impedance Z is found from Reach and RCA data inputs (see also Figure 2-1). The Non-homogenous angle is zero for phase elements. For 21G Mho/Lens application the Non-homogenous angle is also zero.

Table 4-4: Reverse Quad reactance

Phase	Vector 1	Vector 2	Limit angle setting
AB	$Z(I_A-I_B)-(V_A-V_B)$	$Z_{rev}\ (I_A-I_B)$	Comparator limit angle 21P
BC	$Z(I_B-I_C)-(V_B-V_C)$	$Z_{rev}\ (I_B-I_C)$	Comparator limit angle 21P
CA	$Z(I_C-I_A)-(V_C-V_A)$	$Z_{rev}\ (I_C-I_A)$	Comparator limit angle 21P
A	$ZI_A+ Z_{rev}\ (I_0K_0+I_GK_{OM})-V_A$	$I_0\angle\text{Non-homogenous} + 90°\ 1\angle 180°$	Comparator limit angle 21G
B	$ZI_B+ Z_{rev}\ (I_0K_0+I_GK_{OM})-V_A$	$I_0\angle\text{Non-homogenous} + 90°\ 1\angle 180°$	Comparator limit angle 21G
C	$ZI_C+ Z_{rev}\ (I_0K_0+I_GK_{OM})-V_A$	$I_0\angle\text{Non-homogenous} + 90°\ 1\angle 180°$	Comparator limit angle 21G

The Non-homogenous angle is zero for phase elements.

Table 4-5: Directional

Phase	Vector 1	Vector 2	Limit angle setting
A	$Z_{DIR}(I_A-I_B)$	$(V_{A,MEM}-V_{B,MEM})$	DIR Comparator limit angle
B	$Z_{DIR}\ (I_B-I_C)$	$(V_{B,MEM}-V_{C,MEM})$	DIR Comparator limit angle
C	$Z_{DIR}\ (I_C-I_A)$	$(V_{C,MEM}-V_{A,MEM})$	DIR Comparator limit angle
AB	$Z_{DIR}\ (I_0 \text{ or } I_2)$	$V_{A,MEM}$	DIR Comparator limit angle
BC	$Z_{DIR}\ (I_0 \text{ or } I_2)$	$V_{B,MEM}$	DIR Comparator limit angle
CA	$Z_{DIR}\ (I_0 \text{ or } I_2)$	$V_{C,MEM}$	DIR Comparator limit angle

Z_{DIR} is the directional supervisor impedance oriented by DIR RCA (see Figure 2-1).

Table 4-6: Quad characteristic blinder

Phase	Vector 1	Vector 2	Limit angle setting
A	$Z_{BL}\ (I_A-I_B)-(V_A-V_B)$	$Z_{Bl}\ (I_A-I_B)$	90º
B	$Z_{BL}\ (I_B-I_C)-(V_B-V_C)$	$Z_{Bl}\ (I_B-I_C)$	90º
C	$Z_{BL}\ (I_C-I_A)-(V_C-V_A)$	$Z_{Bl}\ (I_C-I_A)$	90º
AB	$Z_{BL}\ (I_A+I_0K_0+I_GK_{0M})-V_A$	$Z_{Bl}\ (I_A+I_0K_0+I_GK_{0M})$	90º
BC	$Z_{BL}\ (I_B+I_0K_0+I_GK_{0M})-V_A$	$Z_{Bl}\ (I_B+I_0K_0+I_GK_{0M})$	90º
CA	$Z_{BL}\ (I_C+I_0K_0+I_GK_{0M})-V_A$	$Z_{Bl}\ (I_C+I_0K_0+I_GK_{0M})$	90º

In this table Z_{BL} is the blinder vector defined by Left blinder and Right blinder length and angle parameters shown in Figure 2-1.

Table 4-7: Zero-sequence directional

Phase	Vector 1	Vector 2	Limit angle setting
A, B, C	Z_{DIR} I_0	$-V_0$	Comparator limit angle 21G

The current I_0 is the calculated zero-sequence current. The voltage V_0 is the calculated zero-sequence voltage.

5 Flags available in the tripping function of the relay

- 21_PA_1: Phase distance (zone1 detection + supervisors + delay) on phase A
- 21_PA_2: Phase distance (zone2 detection + supervisors + delay) on phase A
- 21_PA_3: Phase distance (zone3 detection + supervisors + delay) on phase A
- 21_PA_4: Phase distance (zone4 detection + supervisors + delay) on phase A
- 21_PB_1: Phase distance (zone1 detection + supervisors + delay) on phase B
- 21_PB_2: Phase distance (zone2 detection + supervisors + delay) on phase B
- 21_PB_3: Phase distance (zone3 detection + supervisors + delay) on phase B
- 21_PB_4: Phase distance (zone4 detection + supervisors + delay) on phase B
- 21_PC_1: Phase distance (zone1 detection + supervisors + delay) on phase C
- 21_PC_2: Phase distance (zone2 detection + supervisors + delay) on phase C
- 21_PC_3: Phase distance (zone3 detection + supervisors + delay) on phase C
- 21_PC_4: Phase distance (zone4 detection + supervisors + delay) on phase C
- 21_GA_1: Ground distance (zone1 detection + supervisors + delay) on phase A
- 21_GA_2: Ground distance (zone2 detection + supervisors + delay) on phase A
- 21_GA_3: Ground distance (zone3 detection + supervisors + delay) on phase A
- 21_GA_4: Ground distance (zone4 detection + supervisors + delay) on phase A
- 21_GB_1: Ground distance (zone1 detection + supervisors + delay) on phase B
- 21_GB_2: Ground distance (zone2 detection + supervisors + delay) on phase B
- 21_GB_3: Ground distance (zone3 detection + supervisors + delay) on phase B
- 21_GB_4: Ground distance (zone4 detection + supervisors + delay) on phase B
- 21_GC_1: Ground distance (zone1 detection + supervisors + delay) on phase C
- 21_GC_2: Ground distance (zone2 detection + supervisors + delay) on phase C
- 21_GC_3: Ground distance (zone3 detection + supervisors + delay) on phase C
- 21_GC_4: Ground distance (zone4 detection + supervisors + delay) on phase C

The following flags are available only in the output bundle.

- 21P_Z1A_PKP: Phase distance (zone1 detection + supervisors) pickup on phase A
- 21P_Z2A_PKP: Phase distance (zone2 detection + supervisors) pickup on phase A
- 21P_Z3A_PKP: Phase distance (zone3 detection + supervisors) pickup on phase A
- 21P_Z4A_PKP: Phase distance (zone4 detection + supervisors) pickup on phase A
- 21P_Z1B_PKP: Phase distance (zone1 detection + supervisors) pickup on phase B
- 21P_Z2B_PKP: Phase distance (zone2 detection + supervisors) pickup on phase B
- 21P_Z3B_PKP: Phase distance (zone3 detection + supervisors) pickup on phase B
- 21P_Z4B_PKP: Phase distance (zone4 detection + supervisors) pickup on phase B
- 21P_Z1C_PKP: Phase distance (zone1 detection + supervisors) pickup on phase C
- 21P_Z2C_PKP: Phase distance (zone2 detection + supervisors) pickup on phase C
- 21P_Z3C_PKP: Phase distance (zone3 detection + supervisors) pickup on phase C
- 21P_Z4C_PKP: Phase distance (zone4 detection + supervisors) pickup on phase C
- 21G_Z1A_PKP: Ground distance (zone1 detection + supervisors) pickup on phase A
- 21G_Z2A_PKP: Ground distance (zone2 detection + supervisors) pickup on phase A
- 21G_Z3A_PKP: Ground distance (zone3 detection + supervisors) pickup on phase A
- 21G_Z4A_PKP: Ground distance (zone4 detection + supervisors) pickup on phase A
- 21G_Z1B_PKP: Ground distance (zone1 detection + supervisors) pickup on phase B
- 21G_Z2B_PKP: Ground distance (zone2 detection + supervisors) pickup on phase B

- 21G_Z3B_PKP: Ground distance (zone3 detection + supervisors) pickup on phase B
- 21G_Z4B_PKP: Ground distance (zone4 detection + supervisors) pickup on phase B
- 21G_Z1C_PKP: Ground distance (zone1 detection + supervisors) pickup on phase C
- 21G_Z2C_PKP: Ground distance (zone2 detection + supervisors) pickup on phase C
- 21G_Z3C_PKP: Ground distance (zone3 detection + supervisors) pickup on phase C
- 21G_Z4C_PKP: Ground distance (zone4 detection + supervisors) pickup on phase C

6 Scopes

The following scopes are avalaible in the subcircuit: *RelayName/Control/Console*

- Vab_1MEM: Memory voltage phasor magnitude phase A to phase B
- Vab_1MEM_ang: Memory voltage phasor angle phase A to phase B
- Vbc_1MEM: Memory voltage phasor magnitude phase B to phase C
- Vbc_1MEM_ang: Memory voltage phasor angle phase B to phase C
- Vca_1MEM: Memory voltage phasor magnitude phase C to phase A
- Vca_1MEM_ang: Memory voltage phasor angle phase C to phase A
- 21P_Z1A: Phase distance (zone1 detection + supervisors + delay) on phase A
- 21P_Z2A: Phase distance (zone2 detection + supervisors + delay) on phase A
- 21P_Z3A: Phase distance (zone3 detection + supervisors + delay) on phase A
- 21P_Z4A: Phase distance (zone4 detection + supervisors + delay) on phase A
- 21P_Z1B: Phase distance (zone1 detection + supervisors + delay) on phase B
- 21P_Z2B: Phase distance (zone2 detection + supervisors + delay) on phase B
- 21P_Z3B: Phase distance (zone3 detection + supervisors + delay) on phase B
- 21P_Z4B: Phase distance (zone4 detection + supervisors + delay) on phase B
- 21P_Z1C: Phase distance (zone1 detection + supervisors + delay) on phase C
- 21P_Z2C: Phase distance (zone2 detection + supervisors + delay) on phase C
- 21P_Z3C: Phase distance (zone3 detection + supervisors + delay) on phase C
- 21P_Z4C: Phase distance (zone4 detection + supervisors + delay) on phase C
- 21G_Z1A: Ground distance (zone1 detection + supervisors + delay) on phase A
- 21G_Z2A: Ground distance (zone2 detection + supervisors + delay) on phase A
- 21G_Z3A: Ground distance (zone3 detection + supervisors + delay) on phase A
- 21G_Z4A: Ground distance (zone4 detection + supervisors + delay) on phase A
- 21G_Z1B: Ground distance (zone1 detection + supervisors + delay) on phase B
- 21G_Z2B: Ground distance (zone2 detection + supervisors + delay) on phase B
- 21G_Z3B: Ground distance (zone3 detection + supervisors + delay) on phase B
- 21G_Z4B: Ground distance (zone4 detection + supervisors + delay) on phase B
- 21G_Z1C: Ground distance (zone1 detection + supervisors + delay) on phase C
- 21G_Z2C: Ground distance (zone2 detection + supervisors + delay) on phase C
- 21G_Z3C: Ground distance (zone3 detection + supervisors + delay) on phase C
- 21G_Z4C: Ground distance (zone4 detection + supervisors + delay) on phase C
- mZIL_A: Distance in ohms at the secondary of the CT/VT or the fault phase A-to-ground
- mZIL_B: Distance in ohms at the secondary of the CT/VT or the fault phase B-to-ground
- mZIL_C: Distance in ohms at the secondary of the CT/VT or the fault phase C-to-ground
- mZIL_AB: Distance in ohms at the secondary of the CT/VT or the fault phase A-to-phase B
- mZIL_BC: Distance in ohms at the secondary of the CT/VT or the fault phase B-to-phase C
- mZIL_CA: Distance in ohms at the secondary of the CT/VT or the fault phase C-to-phase C
- Locus zones: see Section 7.

7 Impedance locus drawing (R-X graph)

- **Locus *k*-zones GND**: Draw the impedance locus and the characteristics of the 4 zones, for phase *k* of the ground distance element. This option is selectable in the Function Scopes tab.
- **Expansion time**: time in seconds for the locus to reach its maximum value. When the locus does not move in the R-X graph, its size increases until a maximum. The aim is to help the user to differentiate a transient position of the locus with a quasi-steady state one. The size of it can them give an idea on the time the locus stays at this position.

- **Refresh period**: A given characteristic is polarized and its size changes during the simulation. To avoid a messy superimposition of the characteristic, the drawing is refreshed at this period.

The above options are also applicable to the phase-to-phase distance element (replace GND by PHS).
Examples are shown in Figure 7-1 and Figure 7-2.

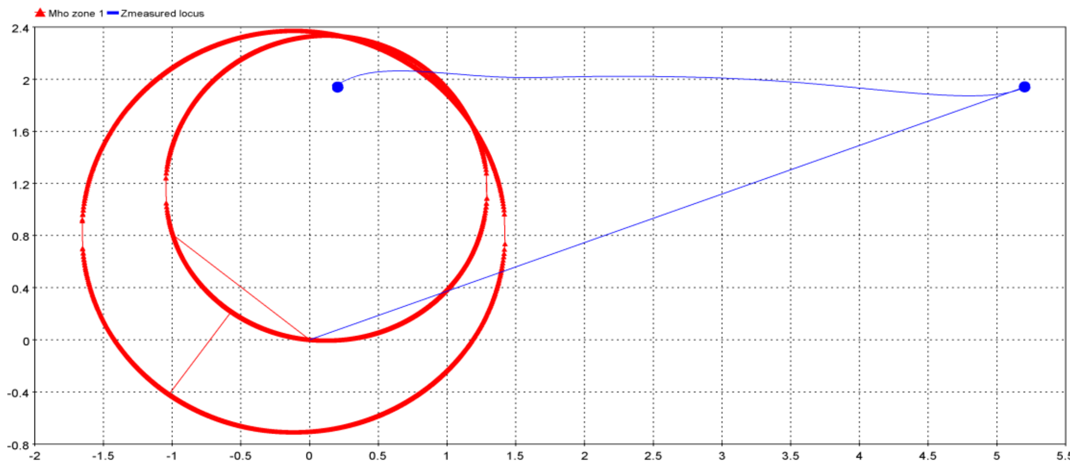


Figure 7-1 Impedance locus and Mho characteristic, Expansion time of 0.5 s, Refresh period of 1 s.

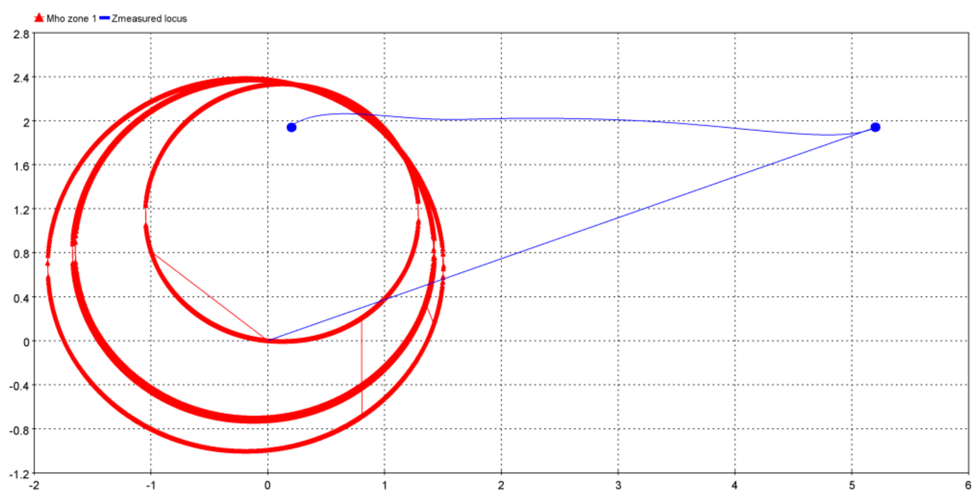


Figure 7-2 Impedance locus and Mho characteristic, Expansion time of 0.5 s, Refresh period of 0.3 s.

7.1 Showing the locus graphs

See the documentation of the “R-X graph plotter” device shown in Figure 7-3.

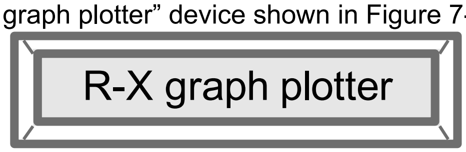


Figure 7-3: R-X graph plotter

8 Modifications

The protection functions are updated automatically. For example, for memory usage and computational speed considerations, if an entire element is disabled, the subcircuits associated to its functions are replaced by

empty subcircuits with the same inputs and outputs. The outputs will be forced to zero or one. When enabled, the subcircuits can take different architectures considering the user choices. Some elements can be excluded if not enabled in the mask.
The updates are performed immediately after entering the parameters and clicking the OK button. The user should wait for the completion of tasks.
If the user wants to modify the subcircuit manually (for example, when adding new scopes), using in the GUI, and avoid the automatic updates of contents, the attribute DeviceVersion has to be set to "none" as shown below. To access to this attribute, right click on the desired device, then go to Attributes and select DeviceVersion (see Figure below).
To allow the automatic updates again, just remove the "none" string.

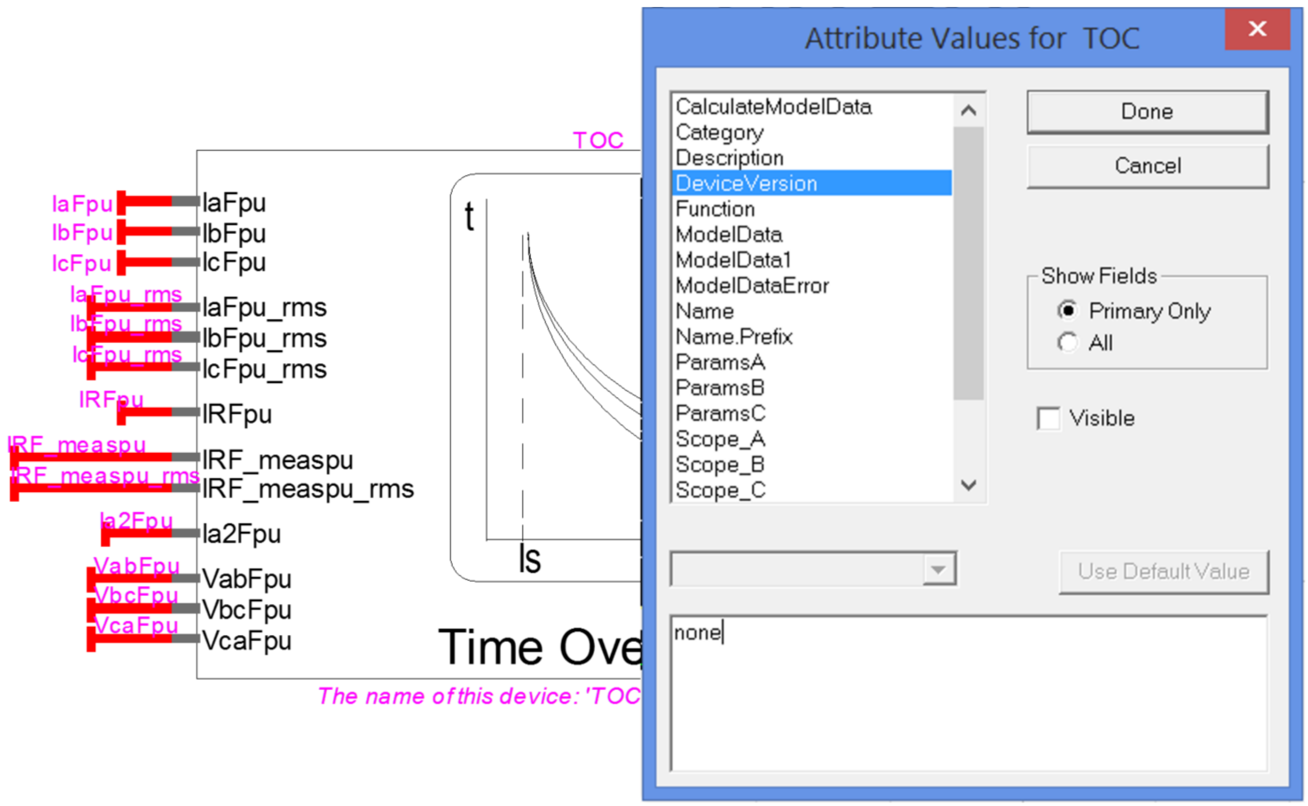


Figure 8-1 How to set the DeviceVersion attribute of an element to allow modifications.

9 References:

[1] D60 Line Distance Protection System, chapter 5.6 p5-159, UR Series Instruction Manual, GE Digital Energy, D60 Revision 7.1x

[2] Edmund O. Schweitzer, New Developments in Distance Relay Polarization and Fault Type Selection, Schweitzer Engineering Laboratories, Inc, March 1991

[3] SIPROTEC, Distance protection 7SA522, Manuel, Chapter 2.2.3.1 p99, V4.70