

Testing Tips

How to build polygonal zones in Test Universe

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Summary

This document will outline how to build polygonal zones in Test Universe using the Test Object's "Distance" function. The use-case will be for the SEL-T401L; but can be applied to any polygonal impedance zone shape.

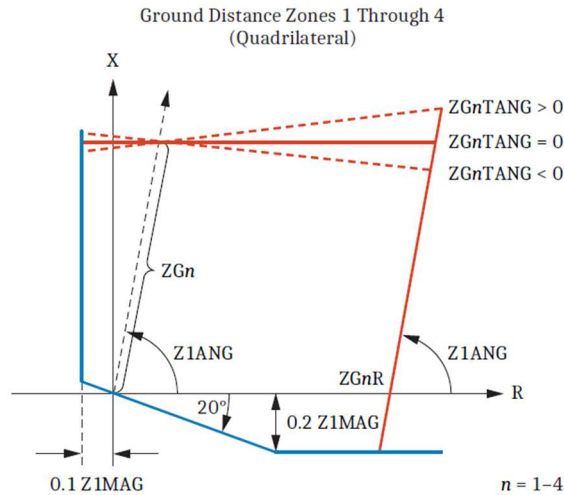
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1 Polygonal Zones in the SEL-T401L

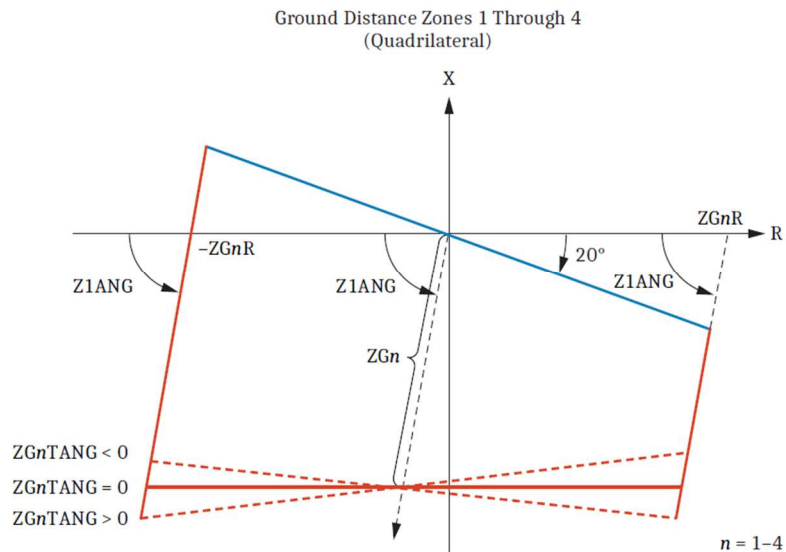
1.1 Forward Zones

For the SEL T401L, the forward “quad” zones are actually pentagons. See the instructions below from the user manual. This is relevant for both ground and phase zones.



1.2 Reverse Zones

The reverse zones are quadrilateral, and are configured in the following way:



2 Making Polygonal Zones in Test Universe

2.1 Settings

The following settings, taken from AcSElerator, are going to be our guide for building the zones.

	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Range
EZPn Enable Zone n Phase Distance	MHO	MHO	MHO	MHO	MHO	OFF, MHO, QUAD
EZGn Enable Zone n Ground Distance	QUAD	QUAD	QUAD	QUAD	QUAD	OFF, MHO, QUAD
ZDIRn Zone n Direction	F	F	R	F		F, R (F - Forward, R - Reverse)
Phase Distance						
ZPn Zone n Phase Distance Reach	6.02	13.52	11.99	13.52	18.90	0.05 to 64.00 (ohms, sec)
ZPnR Zone n Phase Distance Resistive Reach	7.80	7.80	7.80	7.80	7.80	0.05 to 64.00 (ohms, sec)
ZPSREV Zone 5 Phase Distance Reverse Reach					1.56	0.05 to 64.00 (ohms, sec)
ZPnTANG Zone n Phase Distance Reactance Tilt Angle	-7.0	7.0	7.0	7.0	7.0	-25.0 to 25.0 (deg)
ZPn_SOPP Zone n Phase Distance Phase-Phase Overcurrent Pickup	0.50	0.50	0.50	0.50	0.50	0.50 to 150.00 (A, sec)
Ground Distance						
ZSC Zero-Sequence Compensation Method [ADVIS]	AUTO					AUTO, MANUAL
kGm Zone n Zero-Sequence Compensation Factor Magnitude	0.686	0.686	0.686	0.686	0.686	0.000 to 10.000
kGAn Zone n Zero-Sequence Compensation Factor Angle	-4.46	-4.46	-4.46	-4.46	-4.46	-180.00 to 180.00 (deg)
ZGn Zone n Ground Distance Reach	6.02	13.52	11.99	13.52	18.90	0.05 to 64.00 (ohms, sec)
ZGnR Zone n Ground Distance Resistive Reach	22.81	51.25	41.05	51.25	64.00	0.05 to 64.00 (ohms, sec)
ZGSREV Zone 5 Ground Distance Reverse Reach					1.56	0.05 to 64.00 (ohms, sec)
ZGnTANG Zone n Ground Distance Reactance Tilt Angle	-7.0	7.0	7.0	7.0	7.0	-25.0 to 25.0 (deg)
ZGn_SOPP Zone n Ground Distance Phase Overcurrent Pickup	0.50	0.50	0.50	0.50	0.50	0.50 to 100.00 (A, sec)
ZGn_SOG Zone n Ground Distance 3B0 Overcurrent Pickup	0.50	0.50	0.50	0.50	0.50	0.50 to 100.00 (A, sec)

The line parameters are **7.5 Ohms** at **75 degrees**.

The **Forward Zone** has a reach (ZGn) of **6.02 Ohms** and a resistive reach ($ZGnR$) of **22.81 Ohms**.

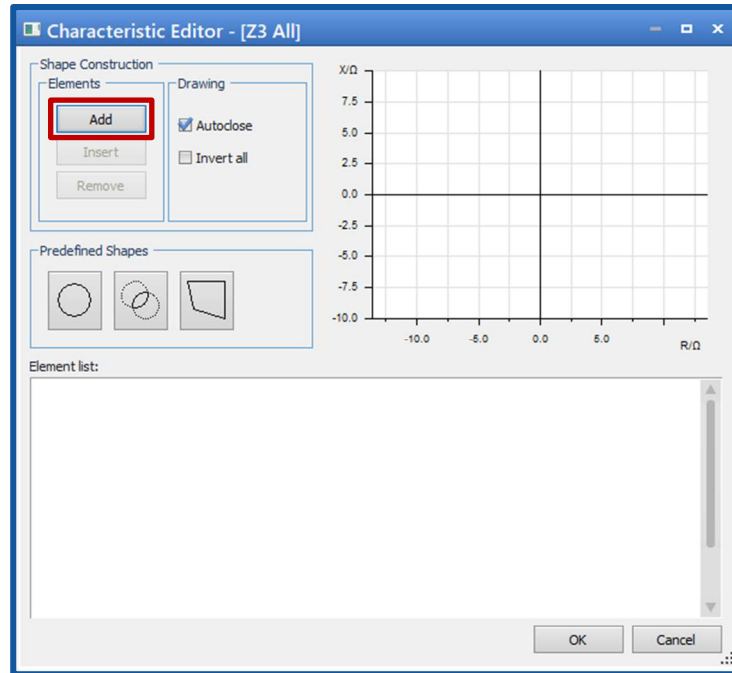
Ground distance reactance tilt angle ($ZGnTANG$) is set to **-7.0 degrees**.

The **Reverse Zone** has a reach (ZGn) of **11.99 Ohms** and a resistive reach ($ZGnR$) of **41.05 Ohms**.

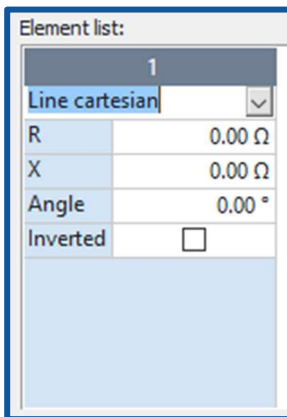
Ground distance reactance tilt angle ($ZGnTANG$) is set to **7.0 degrees**.

2.2 Setup

In Test Universe, under the “Distance” function in the Test Object, navigate to the “Zone” tab. When you select “New” then “Edit,” the Characteristic Editor window will appear.



After Clicking “Add,” change your type to Line Cartesian. This is the type we will use to make a polygon in the editor.



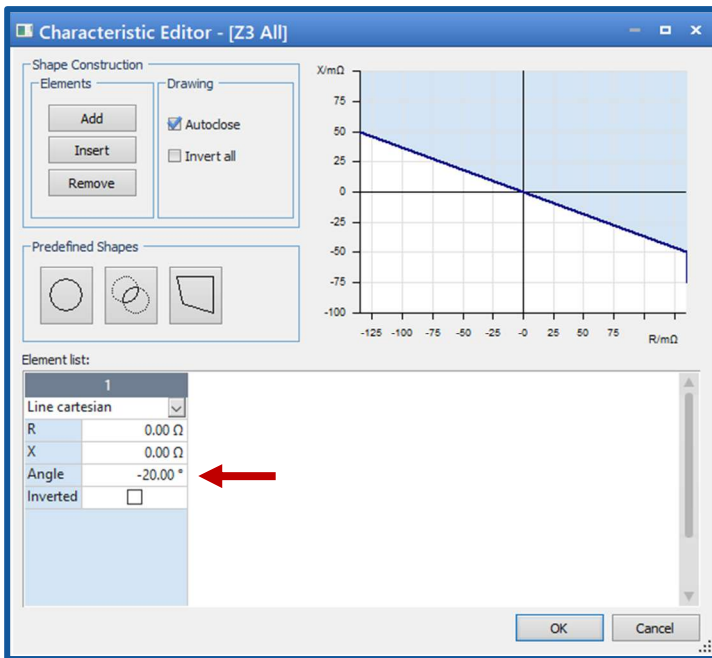
- > The R value shifts the center of the line on the X-Axis
- > The X value shifts the center of the line on the Y-Axis
- > The angle changes the tilt of the line

Using this info, we can now start to add the sides of the polygon zone.

2.3 Building the Forward Zone

Start with the line going through origin and work counterclockwise. Be sure to set the R or X values according to the diagrams on Page 1.

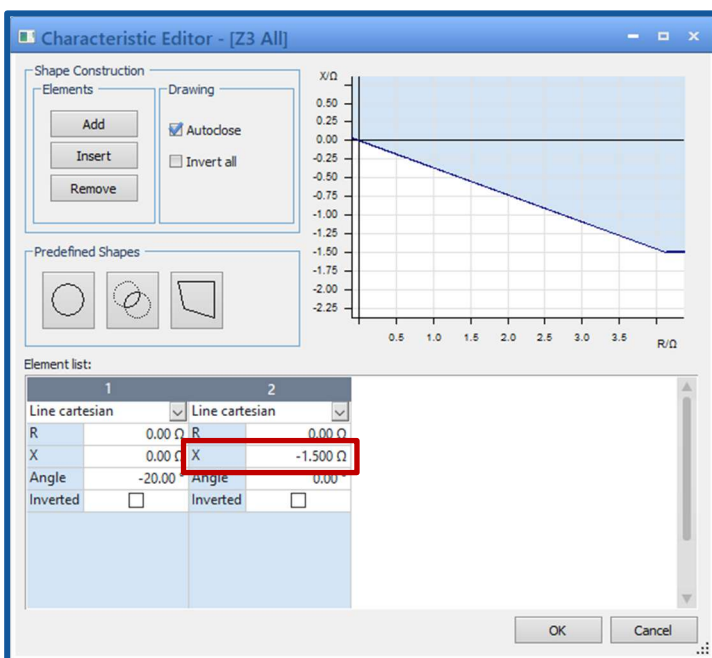
2.3.1 Line 1



There is no shift to the line, it goes through origin.

According to the user manual, it is set to a - **20 degree** angle.

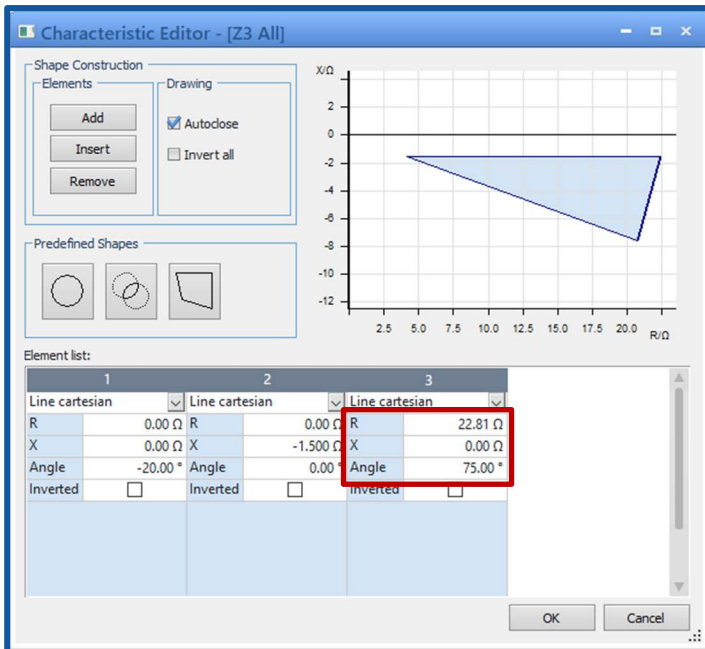
2.3.2 Line 2



The second line is a horizontal line shifted down on the Y-Axis by 20% of the positive sequence line impedance.

So: $7.5 \times 0.2 = 1.5 \text{ Ohms down}$

2.3.3 Line 3



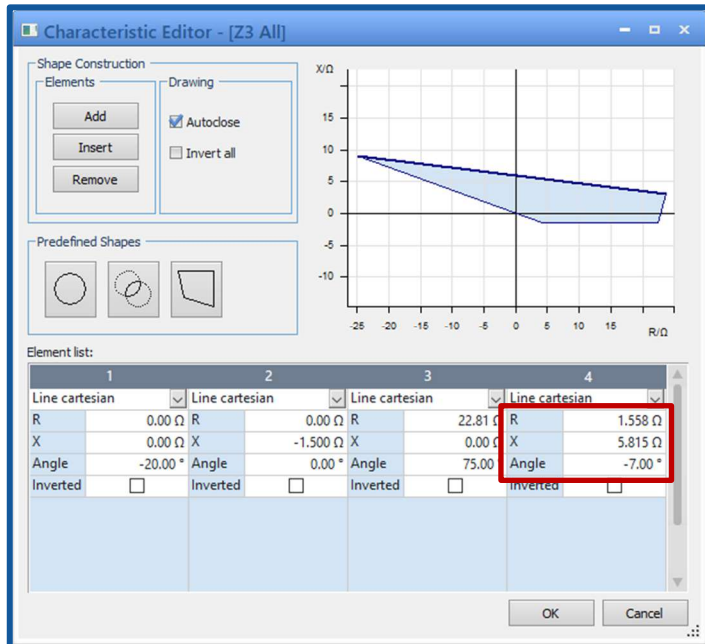
For the third line, shift it on the X-Axis by the “Resistive Reach” value.

So set R to **22.81 Ohms**

The angle of the line is at the positive sequence line angle.

Set Angle to **75 degrees**

2.3.4 Line 4



The line is centered around the end of the Zone 1 reach of 6.02 Ohms at 75 degrees. It is then set at an angle according to the “Reactance Tile Angle” setting.

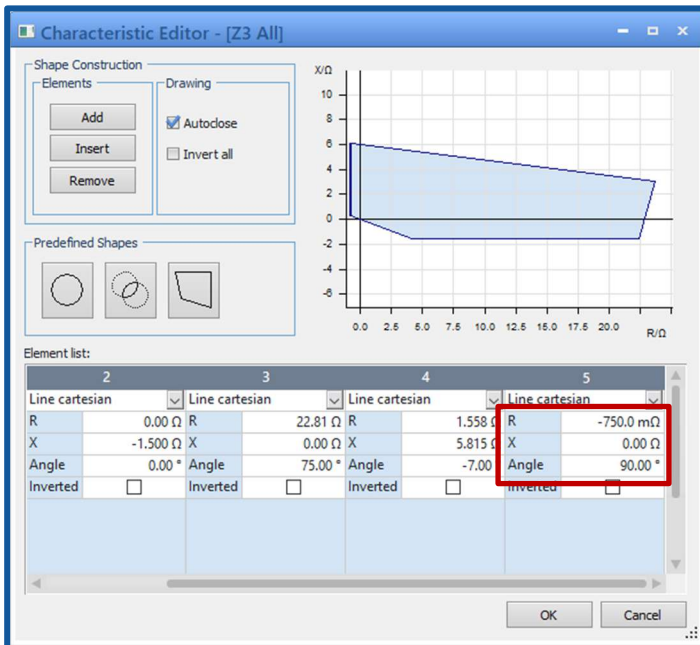
So set Angle to **-7 degrees**

To find the X and Y coordinates for this point we need to do some trigonometry. Using the right triangle where the line length is the hypotenuse:

Y-Axis shift will be $6.02\sin(75) = 5.815 \text{ Ohms}$

X-Axis shift will be $6.02\cos(75) = 1.558 \text{ Ohms}$

2.3.5 Line 5

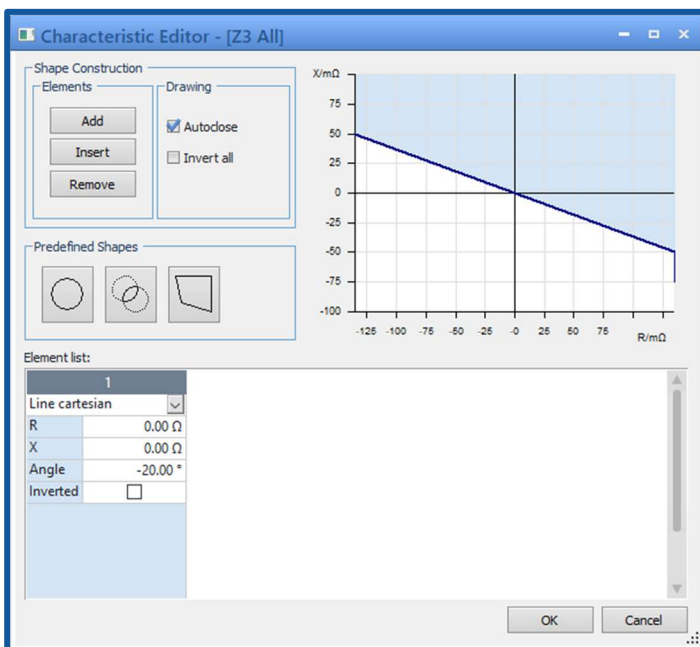


The final line is a vertical line shifted on the X-Axis by 10% of the positive sequence line impedance

So: $7.5 \times 0.1 = 0.75 \text{ Ohms}$

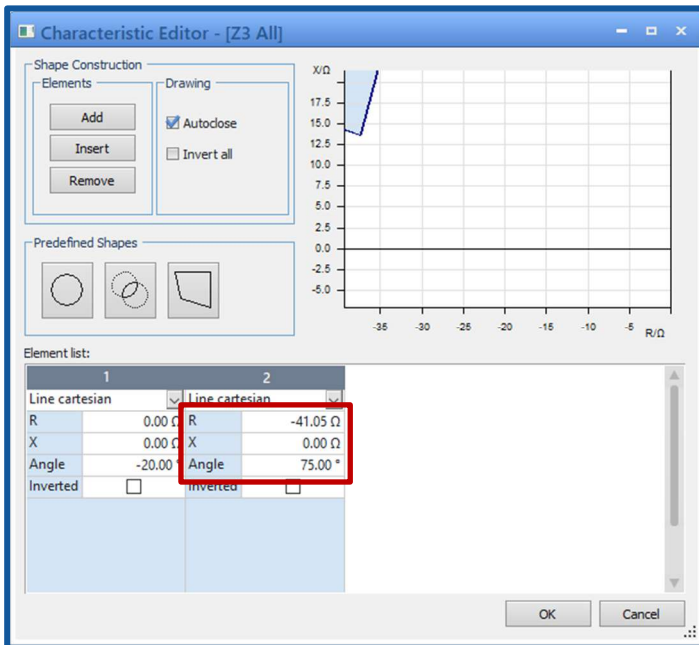
2.4 Building the Reverse Zone

2.4.1 Line 1



The first line on the reverse zone is identical to the first line on the forward zone.

2.4.2 Line 2



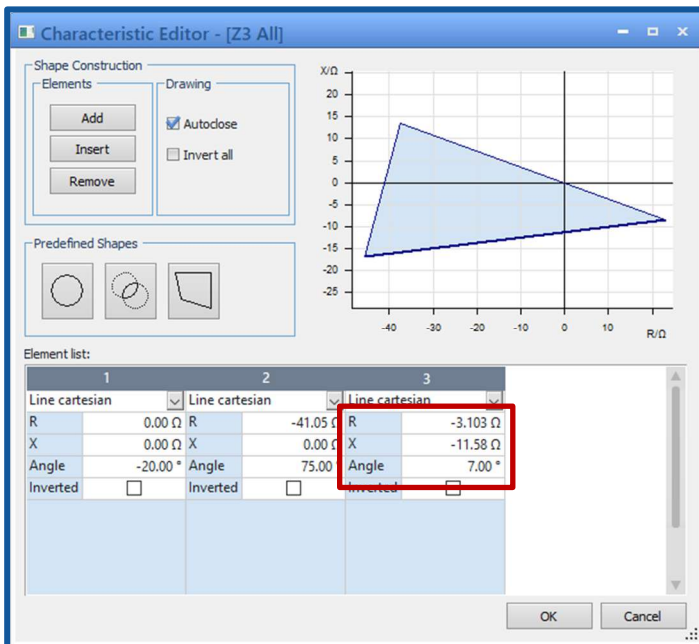
The second line is shifted on the X-Axis by the “Ground Distance Resistive Reach” setting in the negative direction.

Set R to **-41.05 Ohms**

It is then shifted by the positive sequence line angle

Set Angle to **75 degrees**

2.4.3 Line 3



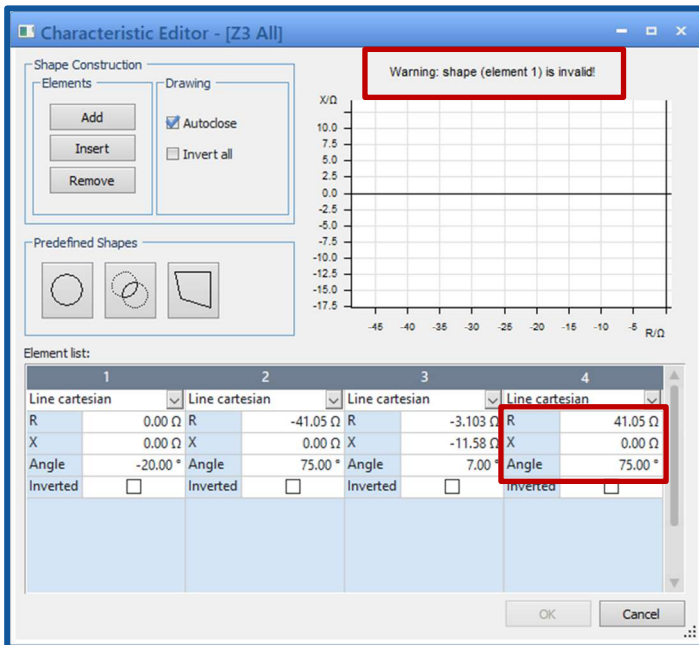
The third line is similar to the fourth line in the forward zone. It will require some trigonometry.

R value will be $11.99\cos(75) = 3.103 \text{ Ohms}$

X value will be $11.99\sin(75) = 11.58 \text{ Ohms}$

The Angle will be **7 degrees** per the setting.

2.4.4 Line 4



The fourth line in this zone brings in some additional complication, especially as it relates to the characteristic builder.

The manual says that it is a line shifted on the X-Axis according to the “resistive reach” setting. However, this value is greater than the intersection of Line 3 and Line 1, so it becomes obsolete.

If you attempt to add it to Test Universe anyways, the Characteristic Editor will give you an “Invalid” warning.

It is best (*in this case*) to not add the last side at all.

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