Test Tutorial

Equipment Type: Protection Relay

Brand: SCHWEITZER (SEL)

Model: 311C

Function: 21 or PDIS – Distance

Tool Used: CE-6006, CE-6707, CE-6710, CE-7012 or CE-7024

Objective: Search Test of zones with MHO and quadrilateral characteristics.

Version Control:

Version	Descriptions	Date	Author	Reviewer
1.0	Initial Version	16/08/2021	M.R.C.	M.P.S

Rua Visconde de Ouro Preto, 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202.
Fone (34) 3218-6800   Fax (34) 3218-6810
Home Page: www.conprove.com.br   -   E-mail: conprove@conprove.com.br

1

Summary

Rua Visconde de Ouro Preto, 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202.
Fone (34) 3218-6800   Fax (34) 3218-6810
Home Page: www.conprove.com.br   -   E-mail: conprove@conprove.com.br

2

Rua Visconde de Ouro Preto, 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202.
Fone (34) 3218-6800   Fax (34) 3218-6810
Home Page: www.conprove.com.br   -   E-mail: conprove@conprove.com.br

3

Statement of responsibility

The information contained in this tutorial is constantly verified. However, differences in description cannot be completely excluded; in this way, CONPROVE disclaims any responsibility for errors or omissions contained in the information transmitted.

Suggestions for improvement of this material are welcome, just user contact us via email suporte@conprove.com.br.

The tutorial contains knowledge gained from the resources and technical data at the time was writing. Therefore, CONPROVE reserves the right to make changes to this document without prior notice.

This document is intended as a guide only; the manual of the equipment under tested must always be consulted.

ATTENTION!

The equipment generates high current and voltage values during its operation.
Improper use of the equipment can result in material and physical damage.

Only suitably qualified people must handle the instrument. It should be noted that the user must have satisfactory training in maintenance procedures, a good knowledge of the equipment under tested and also be aware of safety standards and regulations.

Copyright

1. Connection with CE-6006

Appendix A-1 shows the relay terminal designations.

1.1 *Auxiliary Source*

Connect the positive (red terminal) of the Vdc Aux. Source to the *"Power +"* pin (Z25) of the relay, connect the negative (black terminal) of the Vdc Aux. Source to the *"Power -"* pin (Z26) of the relay.
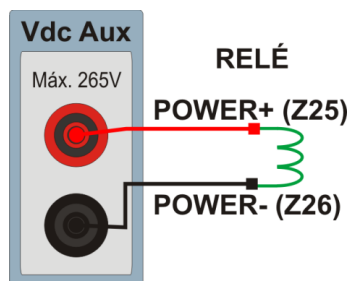

Figure 1

1.2 *Voltage and Current Coils*

To establish the voltage coil connection, connect V1, V2 and V3 voltage channels to pins Z09, Z10 and Z11 of the relay terminal and connect the commons of the voltage channels to pin Z12 of the relay. To establish the connection of the current coils, connect I4, I5 and I6 channels to pins Z01, Z03 and Z05 of the relay terminal and those common to pins Z02, Z04 and Z06. If these last three points are short circuited, connect all the common ones to that point.
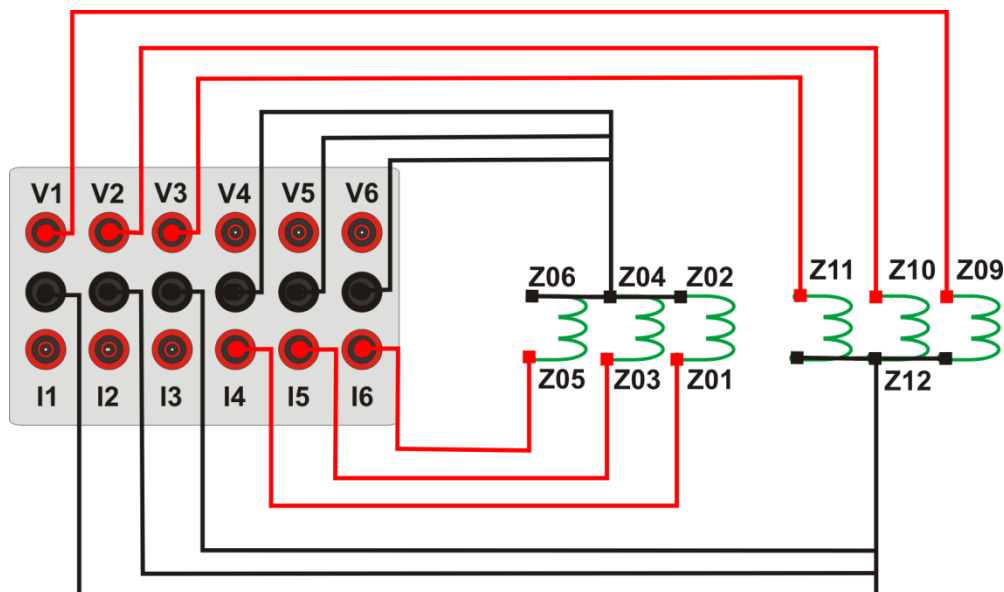

Figure 2

Rua Visconde de Ouro Preto, 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202.
Fone (34) 3218-6800   Fax (34) 3218-6810
Home Page: www.conprove.com.br   -   E-mail: conprove@conprove.com.br

5

1.3 *Binary Input*

Connect CE-6006 binary input to relay binary output.

- BI1 to pin B01 and its common to pin B02 of the relay.

The following figure shows the details of these connections
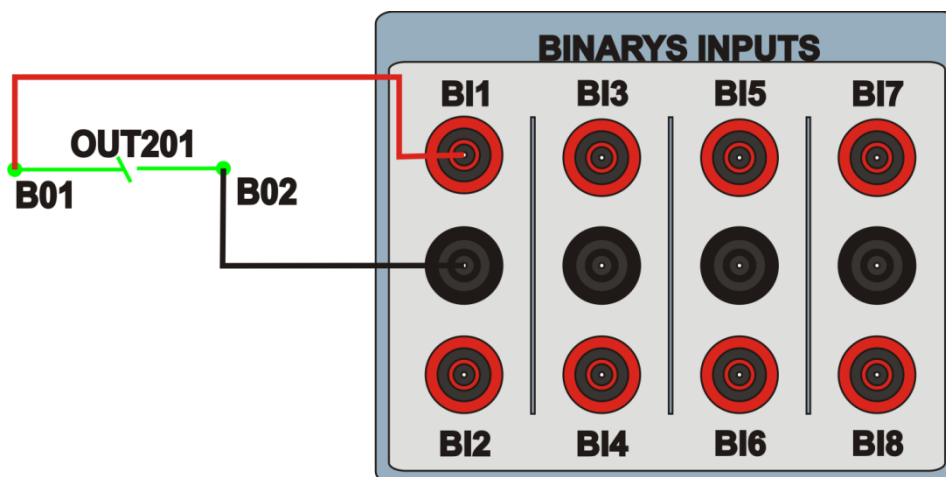
Figure 3

2. Communication with the 311C relay

First, open the **"AcSELerator QuickSet"** and connect an Ethernet (or serial) cable from the notebook to the relay. Then double click on the software icon.

Figure 4

When opening the program, the relay file is selected if communication has already been carried out. Otherwise click on *"New"*.

Rua Visconde de Ouro Preto, 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202.
Fone (34) 3218-6800   Fax (34) 3218-6810
Home Page: www.conprove.com.br   -   E-mail: conprove@conprove.com.br

6

Figure 5

In the next screen, the model and version of the tested relay are set. Check on the front panel by pressing the *"Status"* key.
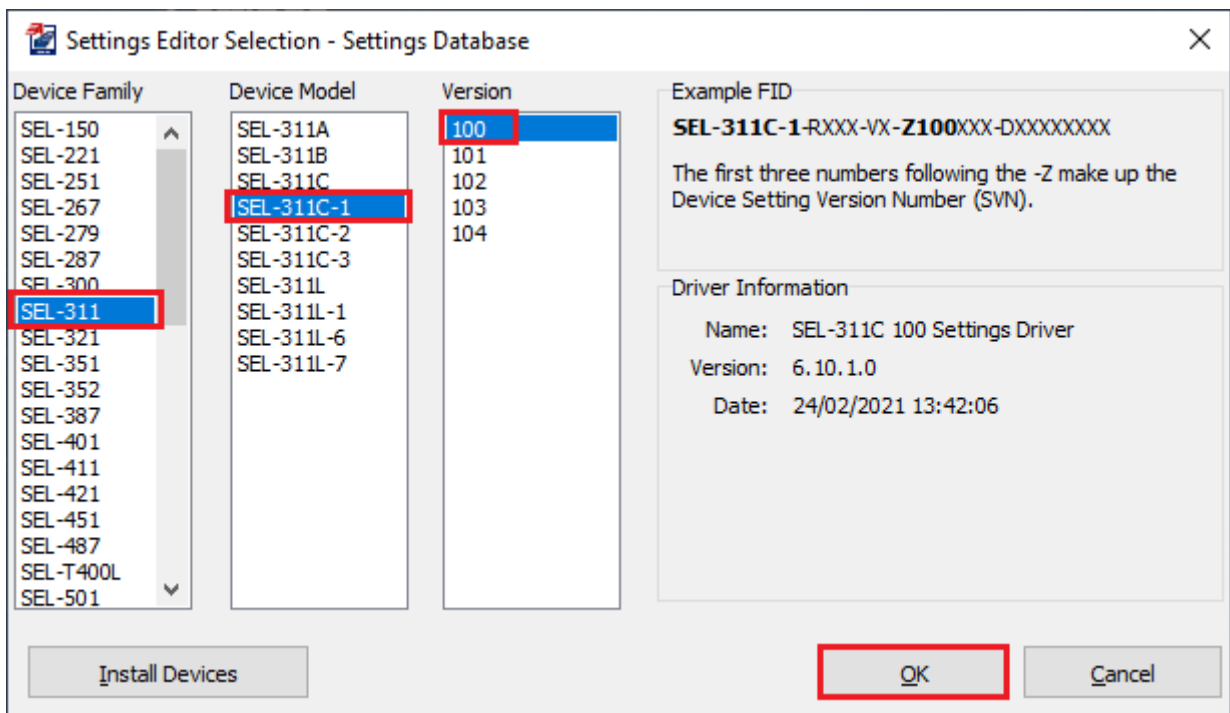
Figure 6

Then the *"Part Number"* must be set. This number appears on a stamp pasted on the back of the relay.

Rua Visconde de Ouro Preto, 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202.
Fone (34) 3218-6800   Fax (34) 3218-6810
Home Page: www.conprove.com.br   -   E-mail: conprove@conprove.com.br

7

Figure 7

Then click on the highlighted icon according to the figure below:

Rua Visconde de Ouro Preto, 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202.
Fone (34) 3218-6800   Fax (34) 3218-6810
Home Page: www.conprove.com.br   -   E-mail: conprove@conprove.com.br

8
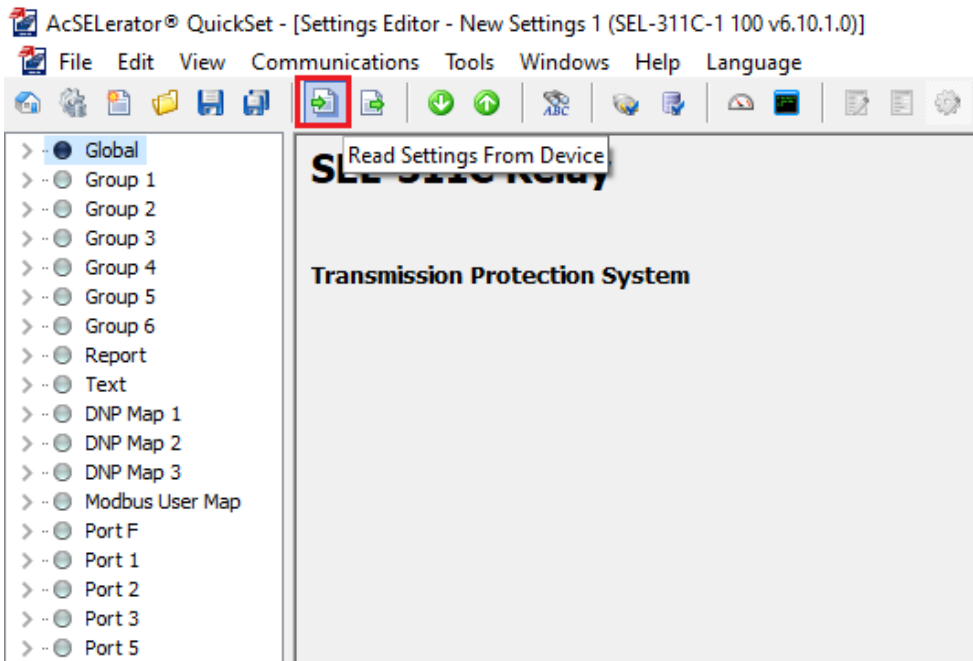
Figure 8

3. Parameterization of the SEL 311C relay

3.1. *General*

After the connection has been established, click on *"Global"* and *"General"* and adjust the connection of the voltage channels, the frequency value and the phase sequence.

Figure 9

Rua Visconde de Ouro Preto, 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202.
Fone (34) 3218-6800   Fax (34) 3218-6810
Home Page: www.conprove.com.br   -   E-mail: conprove@conprove.com.br
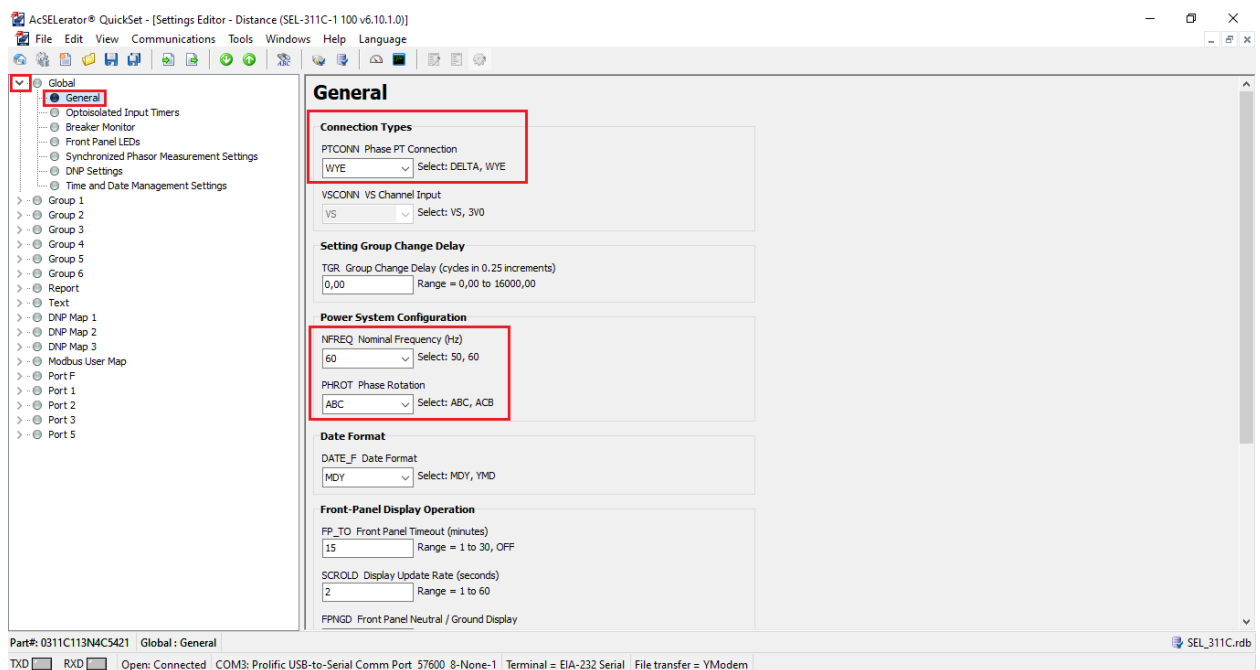
9

3.2. *General Settings*

Click on *"Group1 > Set 1"* then *"General Settings"*. In this window, the identification of the relay and its terminal, the current and voltage transformation ratios are set. Set the nominal secondary phase voltage, activate the *"EADVS"* setting and disable the *"EBBPT"* setting.
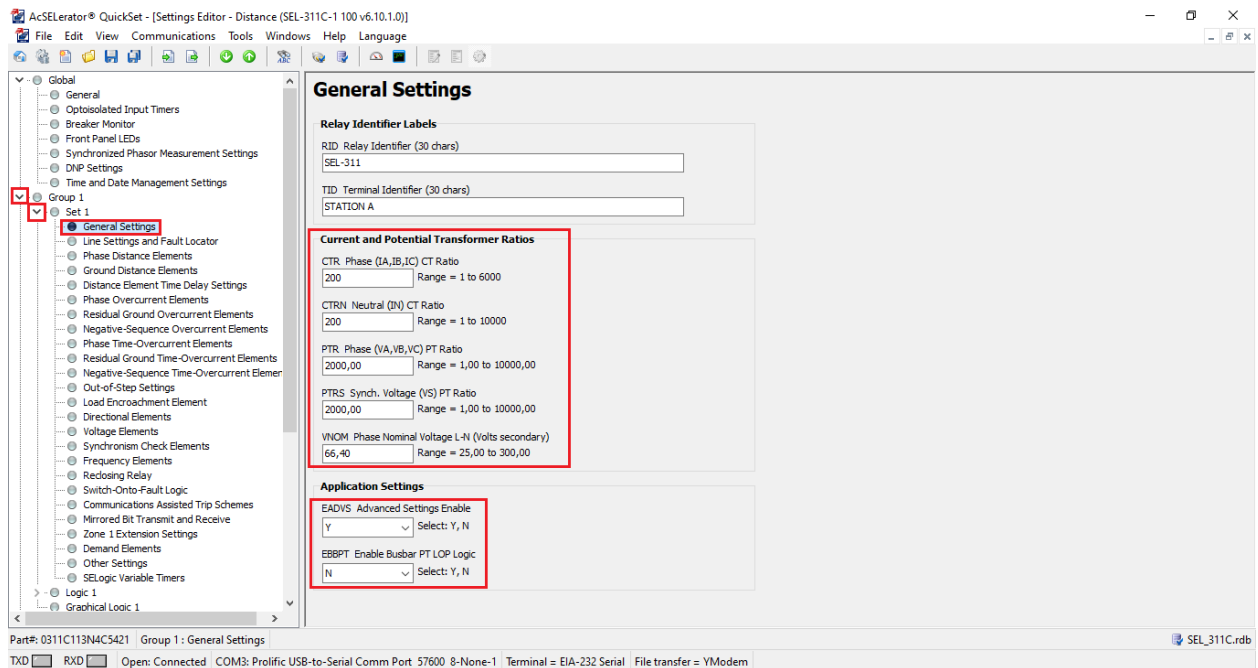

Figure 10

3.3. *Line Settings and Fault Locator*

Click on *"Line Settings and Fault Locator"* and adjust the module value and angle of the line impedance. Either positive-sequence or zero-sequence and adjust the line length. Disable the fault locator.

Rua Visconde de Ouro Preto, 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202.
Fone (34) 3218-6800   Fax (34) 3218-6810
Home Page: www.conprove.com.br   -   E-mail: conprove@conprove.com.br
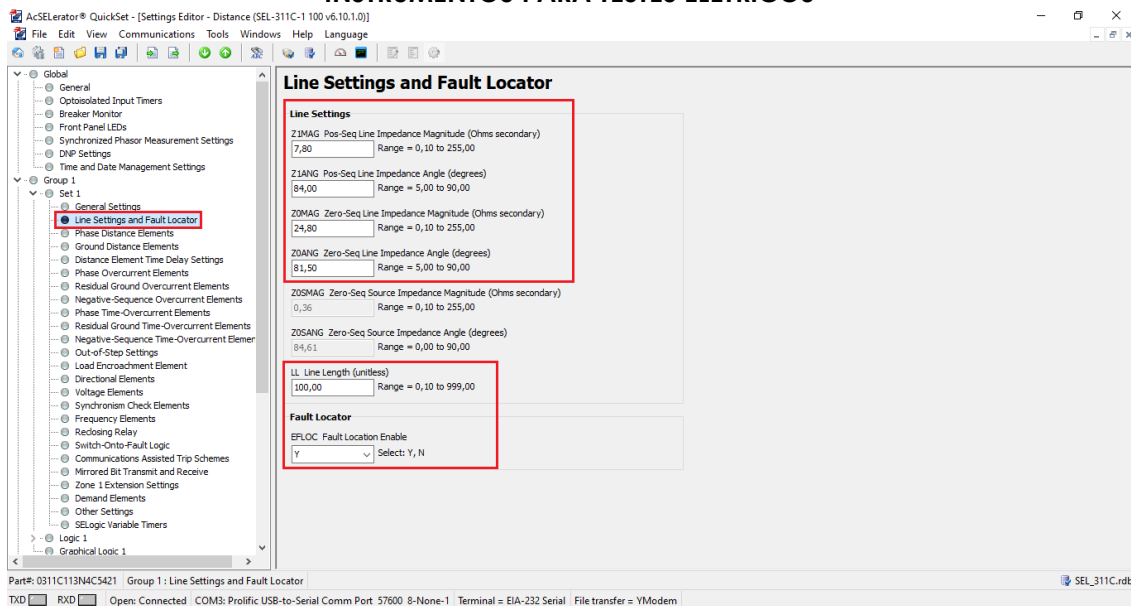
10

Figure 11

3.4. *Phase Distance Elements*

Click on *"Phase Distance Elements"* and activate a zone. In this case, this zone will be of the MHO type and is active for three-phase or two-phase faults.
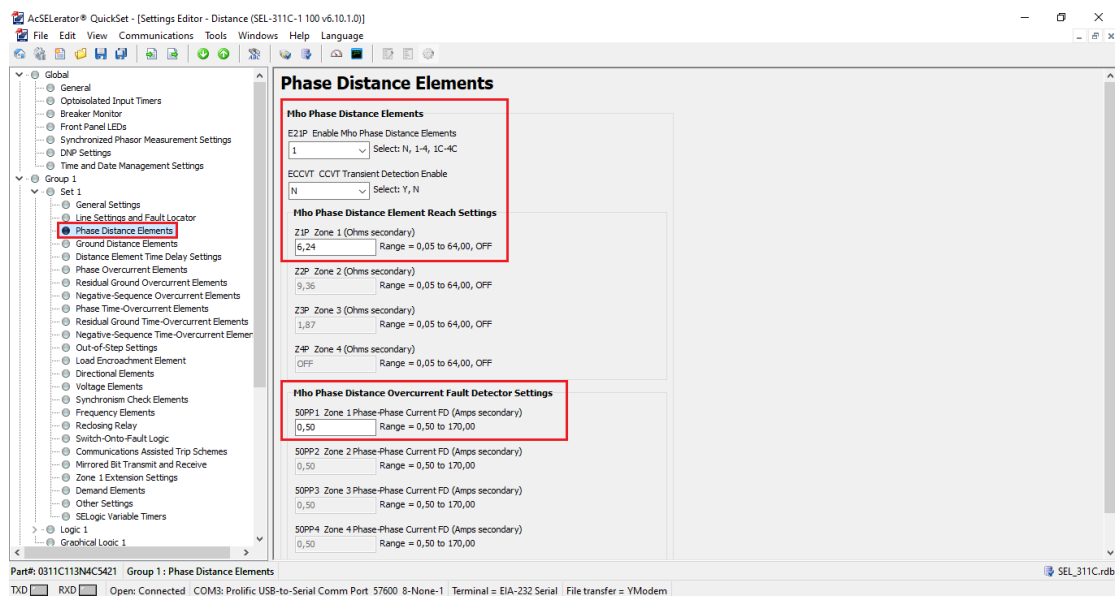

Figure 12

3.5. *Ground Distance Elements*
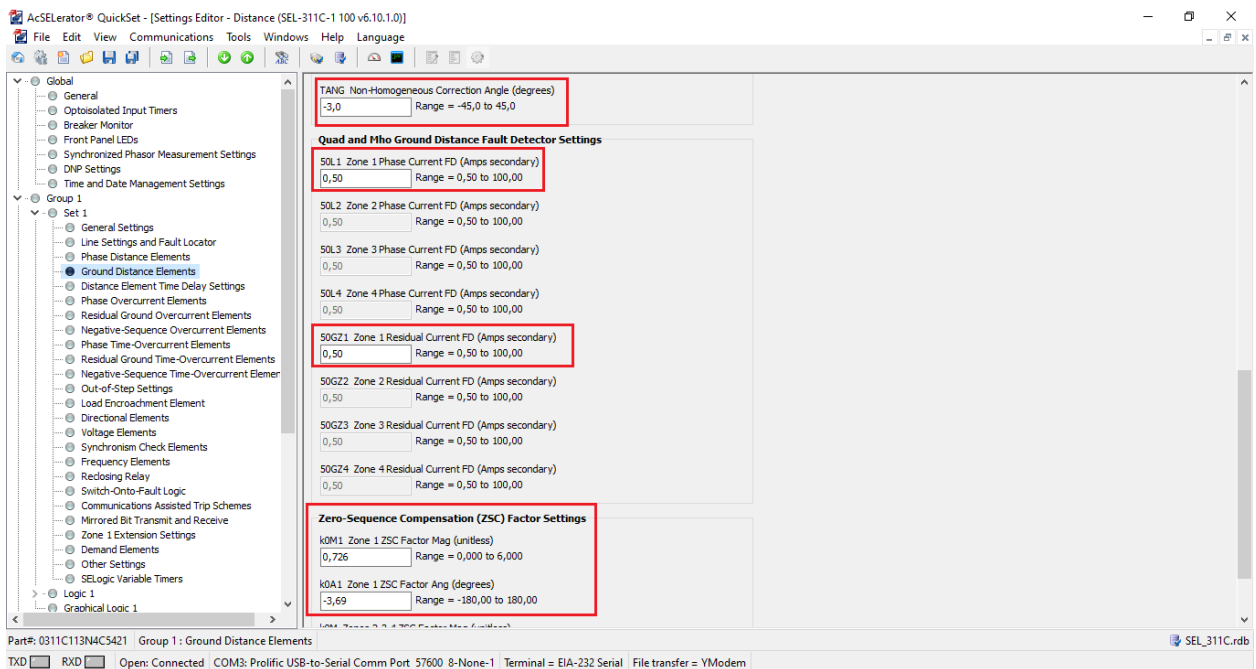
Click on *"Ground Distance Elements"* and activate a zone. In this case, this zone will be of the quadrilateral type and is only active for a phase-to-ground fault.

Rua Visconde de Ouro Preto, 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202.
Fone (34) 3218-6800   Fax (34) 3218-6810
Home Page: www.conprove.com.br   -   E-mail: conprove@conprove.com.br

11
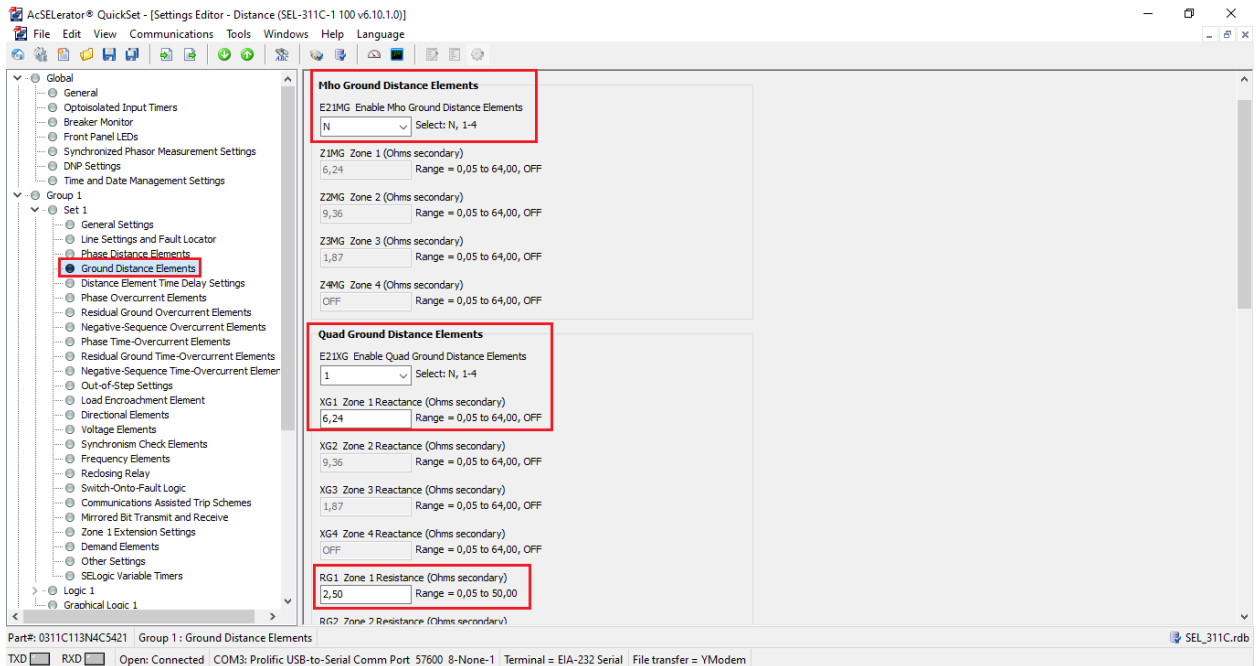
Figure 13

The *"XGPOL"* setting is configured as *"I2"* (not shown) and the other settings are shown in the following figure.

Figure 14

3.6. *Distance Element Time Delay Settings*

Rua Visconde de Ouro Preto, 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202.
Fone (34) 3218-6800   Fax (34) 3218-6810
Home Page: www.conprove.com.br   -   E-mail: conprove@conprove.com.br

12

Click on *"Distance Element Time Delay Settings"* and set the time delay to instantaneous for both phase and ground elements.

Figure 15

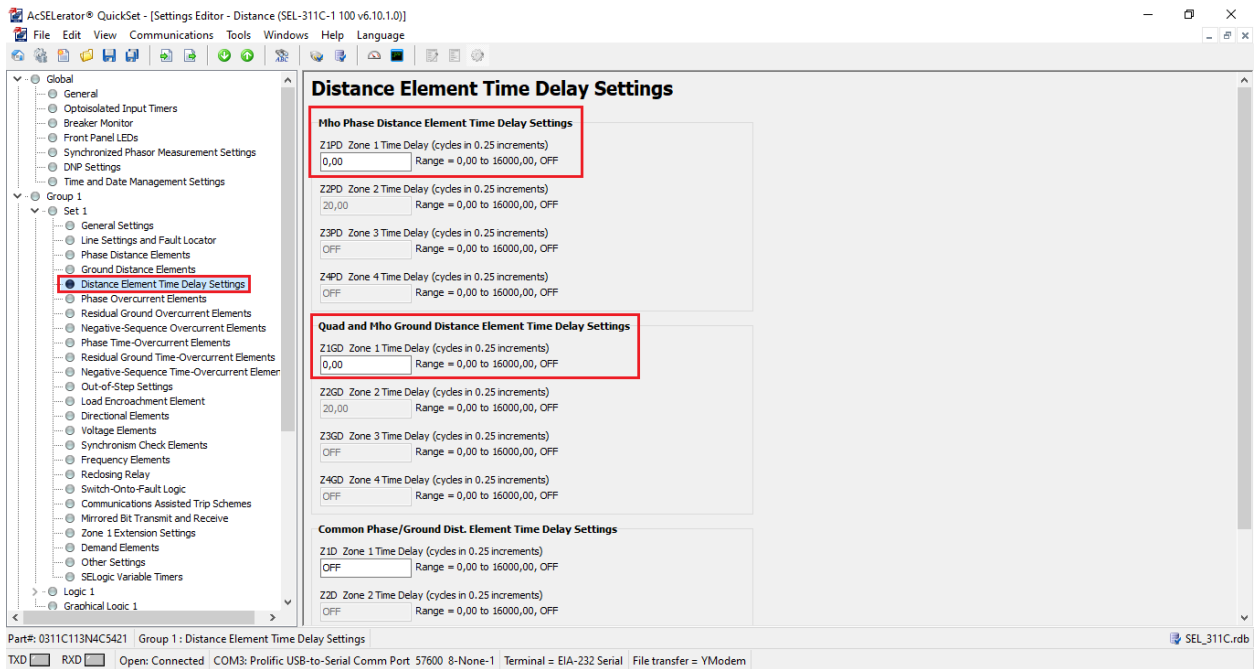### 3.7. *Load Encroachment Element*

Click on *"Load Encroachment Element"* and disable this function.
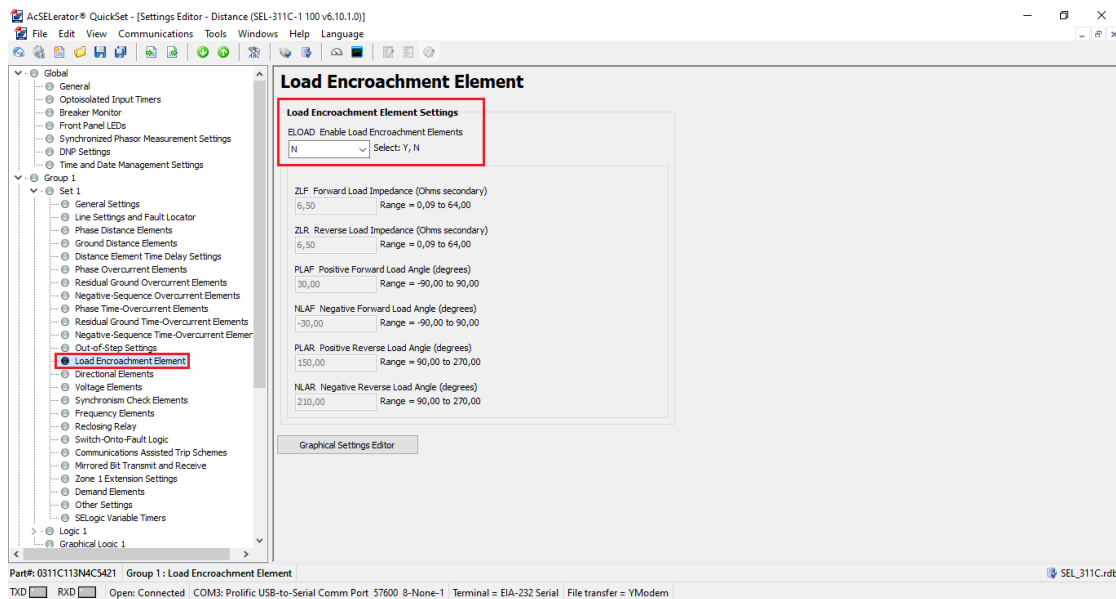

Figure 16

Rua Visconde de Ouro Preto, 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202.
Fone (34) 3218-6800   Fax (34) 3218-6810
Home Page: www.conprove.com.br   -   E-mail: conprove@conprove.com.br

13

3.8. *Directional Elements*

Click on *"Directional Element"* and choose the *"AUTO"* option to have the relay perform the calculations of the directionality control elements automatically. Zones 1 and 2 always have *"Forward"* directionality and cannot be changed. For zones 3 and 4, it is possible to choose the directionality *"F or Forward"* or *"R or Reverse"*.
In this tutorial only zone 1 is configured and the other zones can be evaluated in an analogous way.
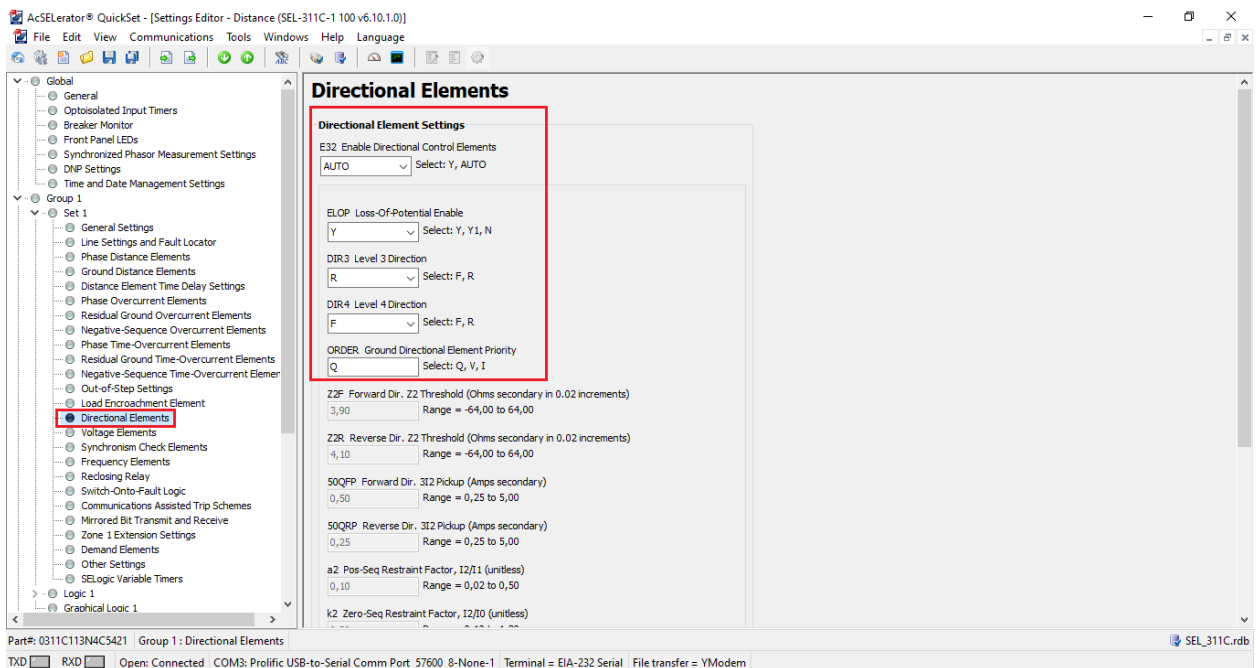

Figure 17

3.9. *Other Settings*

Click on *"Other Settings"* and configure the way the relay identifies the breaker's open pole, whether by contact signal or by undervoltage. Also set the *"50LP"* element to 0.25A.
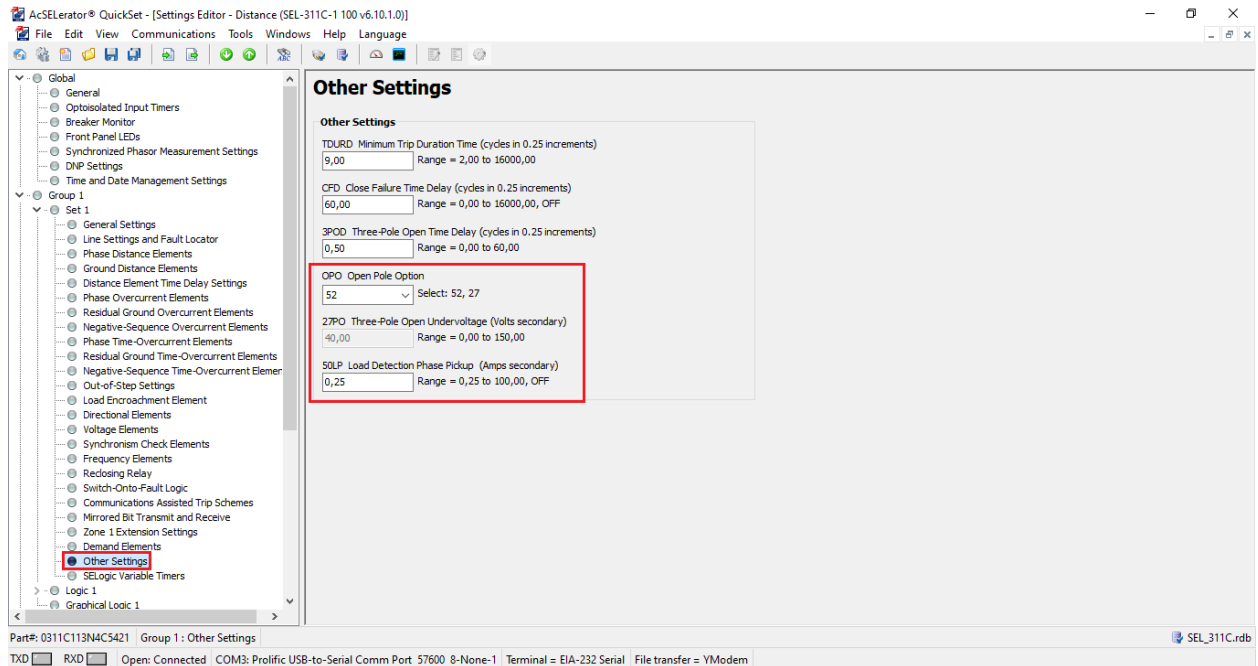
Figure 18

4. Binary Output Adjustments

4.1. *Output Contacts*

Click on *"Logic 1"* and select the option *"Output Contacts"* and make the following adjustments.
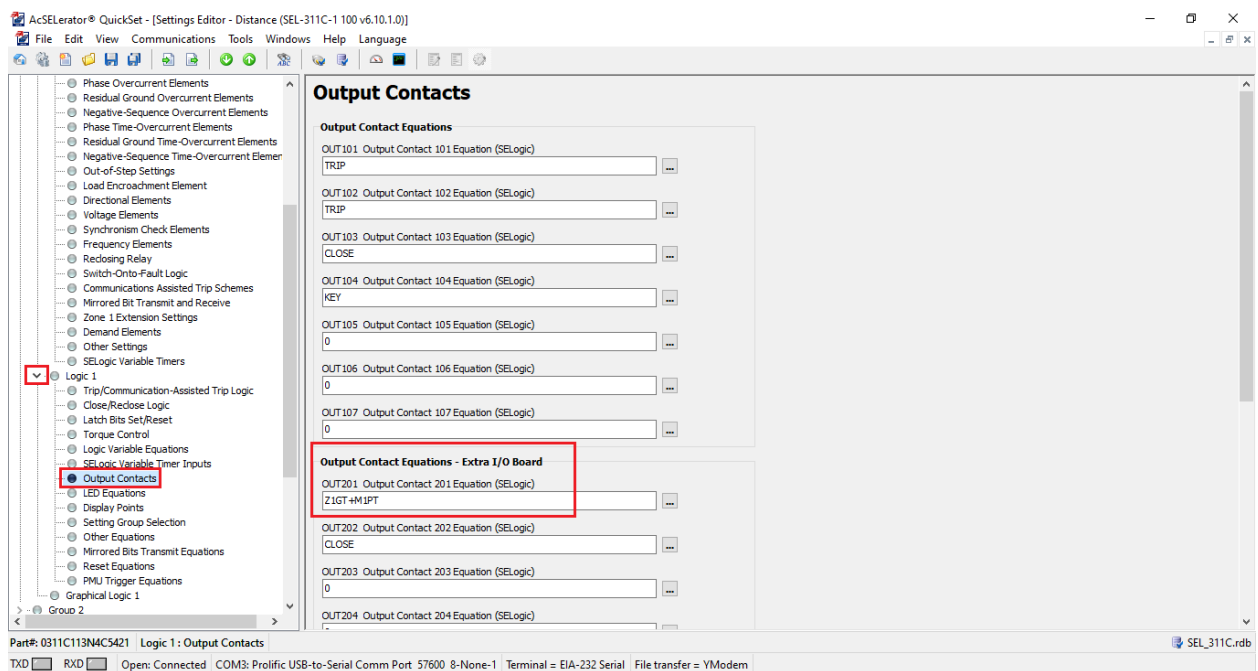

Figure 19

Rua Visconde de Ouro Preto, 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202.
Fone (34) 3218-6800   Fax (34) 3218-6810
Home Page: www.conprove.com.br   -   E-mail: conprove@conprove.com.br

15

4.2. *Other Equations*

Select the option *"Other Equations"* and make the following adjustment.

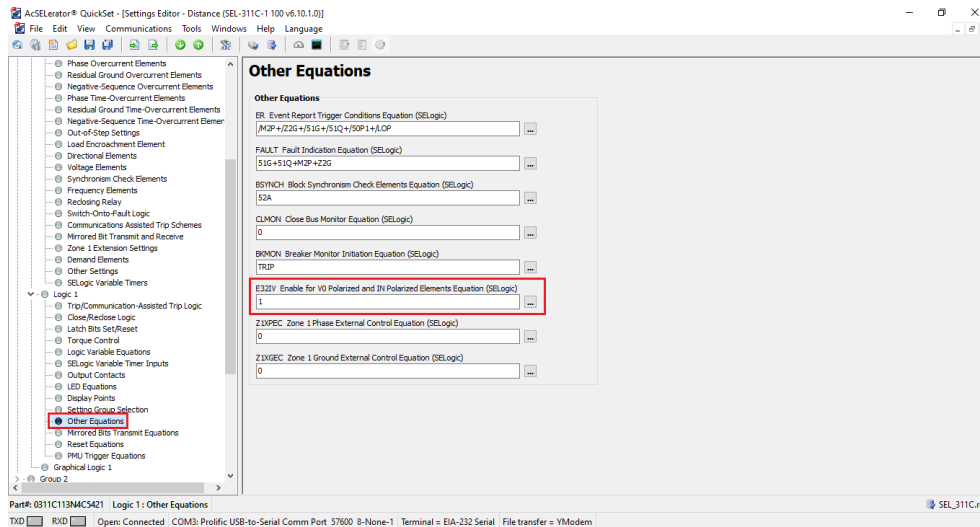**Figure 20**

4.3. *Submitting the Adjustments*

Click on the selected icon and submit at least the following adjustments.

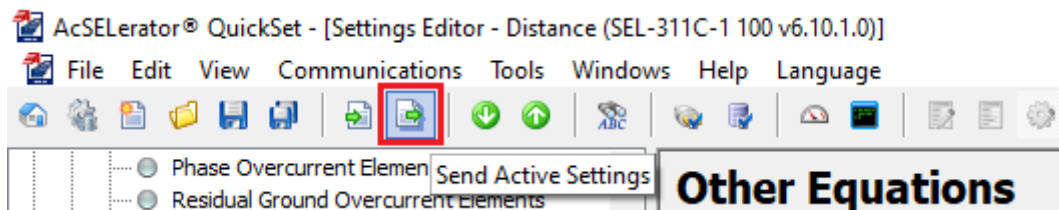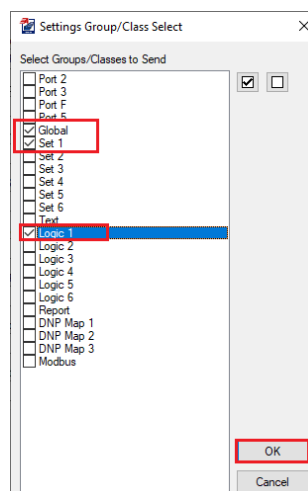

Figure 21

Figure 22

Rua Visconde de Ouro Preto, 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202.
Fone (34) 3218-6800   Fax (34) 3218-6810
Home Page: www.conprove.com.br   -   E-mail: conprove@conprove.com.br

16

5. Distance software adjustments

5.1. *Opening Distance*

Click on the *"CTC"* application manager icon.
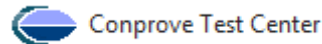
Figure 23

Double-click on the *"Distance"* software icon.

Figure 24

Rua Visconde de Ouro Preto, 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202.
Fone (34) 3218-6800   Fax (34) 3218-6810
Home Page: www.conprove.com.br   -   E-mail: conprove@conprove.com.br

17

Figure 25

5.2. *Configuring the Settings*

When opening the software the *"Settings"* screen will open automatically (provided that the option *"Open Settings when Start"* found in the *"Software Options"* menu is selected). Otherwise, click directly on the *"Settings"* icon.
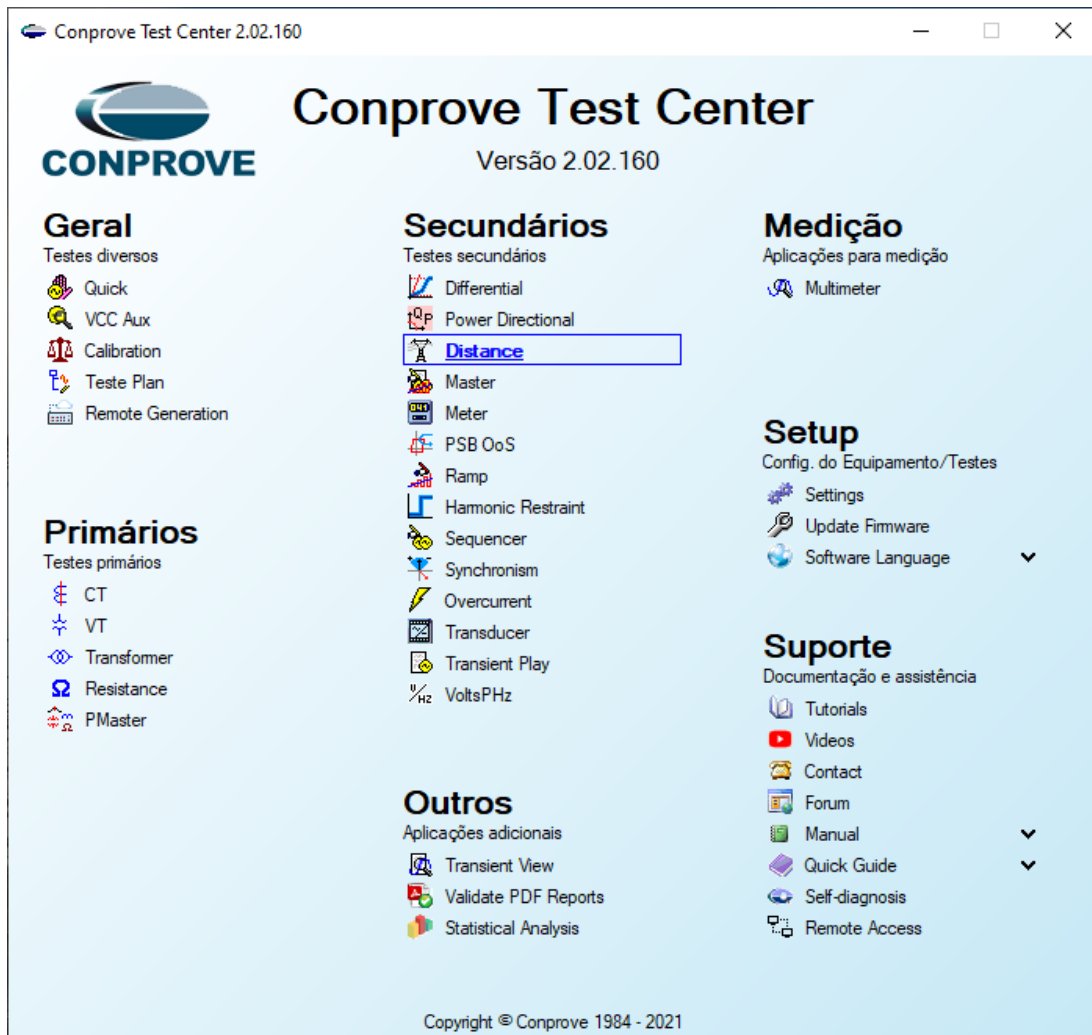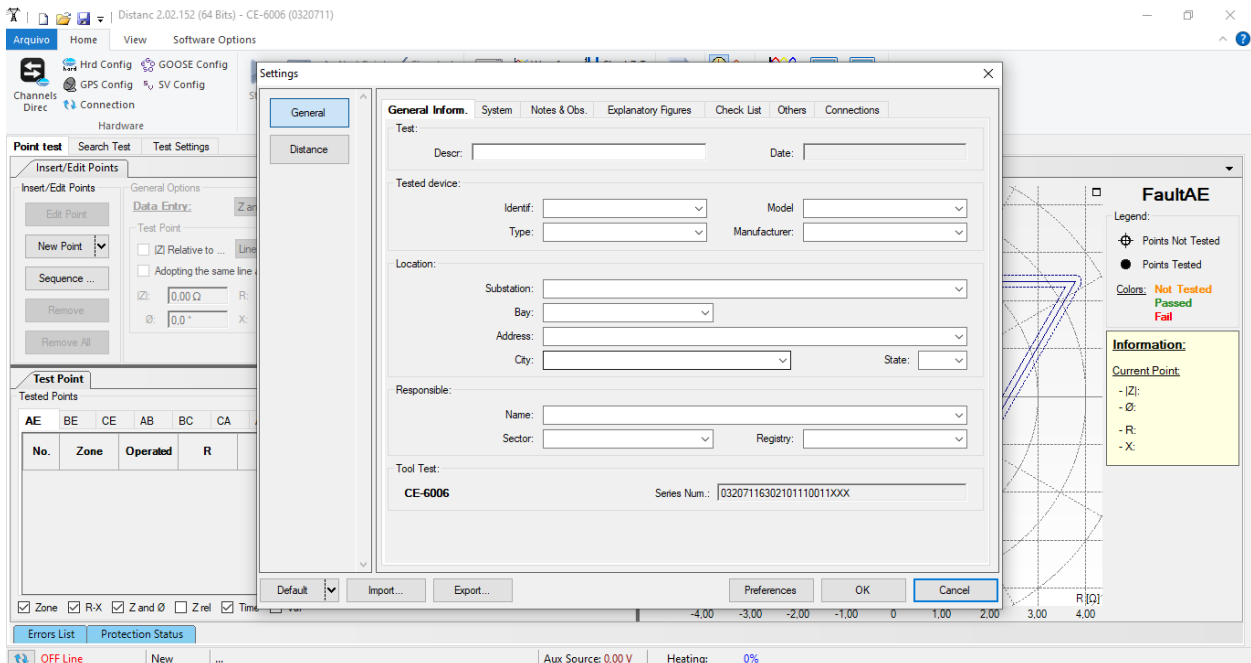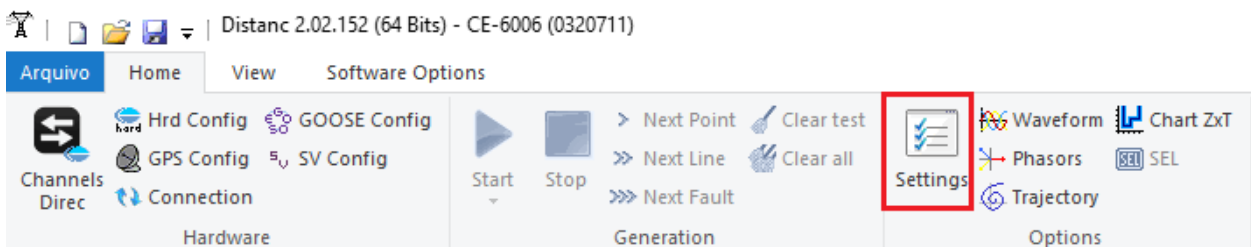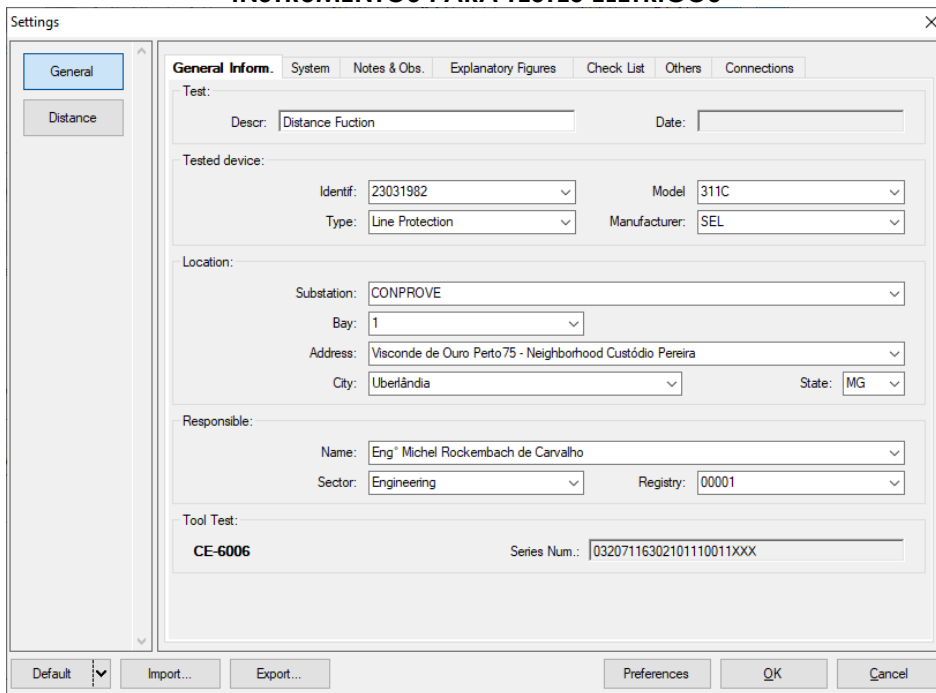

Figure 26

Inside the *"Settings"* screen, fill in the *"General Inform."* with details of the tested device, installation location and the person responsible. This facilitates the elaboration of the report as this tab will be the first to be shown.

Rua Visconde de Ouro Preto, 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202.
Fone (34) 3218-6800   Fax (34) 3218-6810
Home Page: www.conprove.com.br   -   E-mail: conprove@conprove.com.br

18
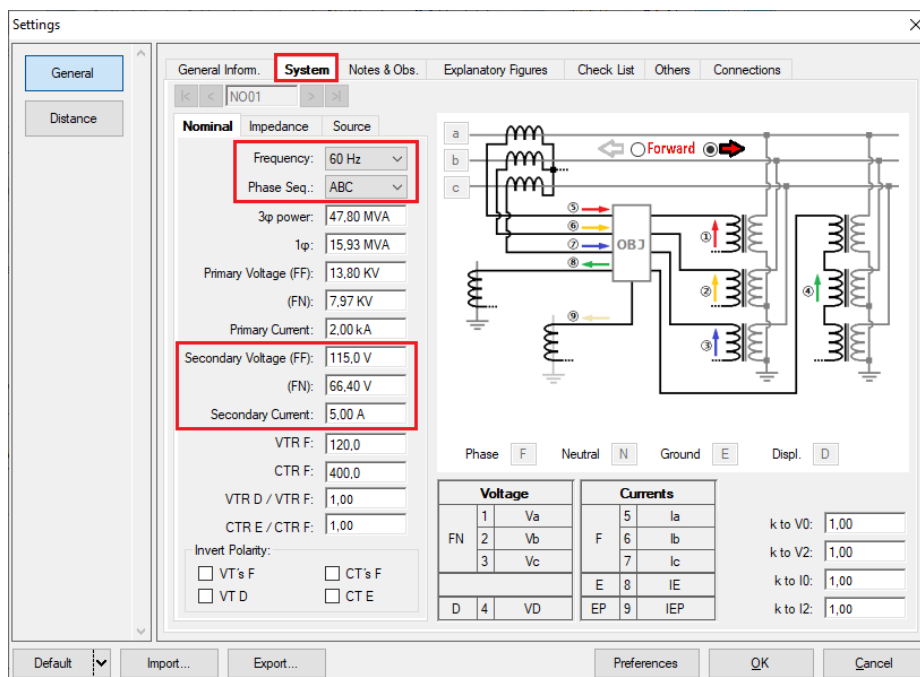
Figure 27

5.3. *System*

In the following screen, within the *"Nominal"* sub tab, the values of frequency, phase sequence, primary and secondary voltages, primary and secondary currents, transformation ratios of VTs and CTs are configured. There are also two sub-tabs *"Impedance"* and *"Source"* whose data are not relevant for this test.

Figure 28

Rua Visconde de Ouro Preto, 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202.
Fone (34) 3218-6800   Fax (34) 3218-6810
Home Page: www.conprove.com.br   -   E-mail: conprove@conprove.com.br

19

There are other tabs where the user can enter notes and observations, explanatory figures, can create a *"check list"* of the procedures for carrying out the test and even create a diagram with all the schematic of the connections between the test set and the test equipment.

6. Distance Adjustments

Note: The SEL 311C relay has peculiar characteristics for each type of fault. For the software to perform the test properly, 3 types of zones must be inserted, the first for phase-to-ground faults, the second phase-phase fault and the third for three -phase faults. This must be done because for each type of fault the characteristics of the zones are modified by the relay itself.

6.1. *Distance screen > Adjust Prot. Distance*

The first step is to adjust the length and angle of the line. Then adjust the ground compensation factor.
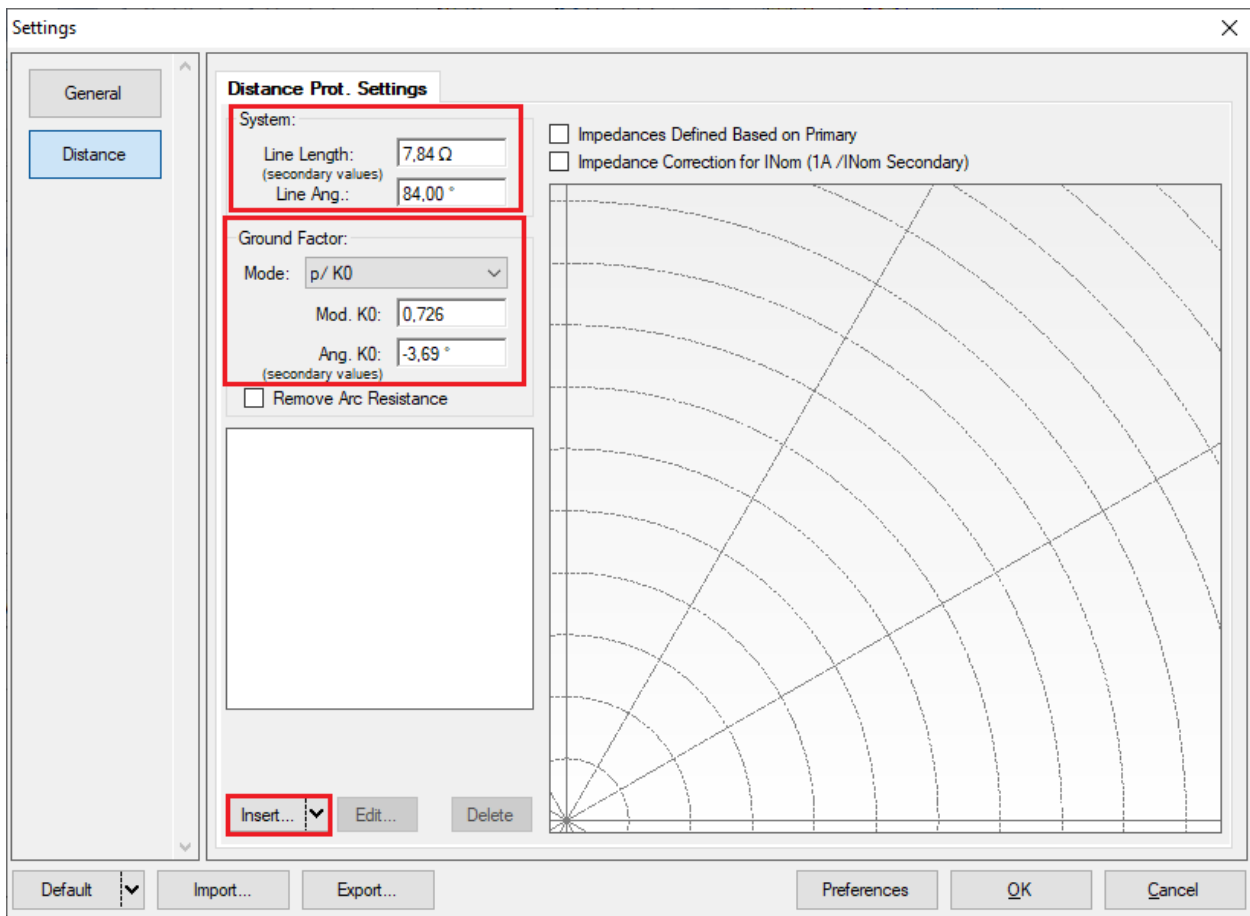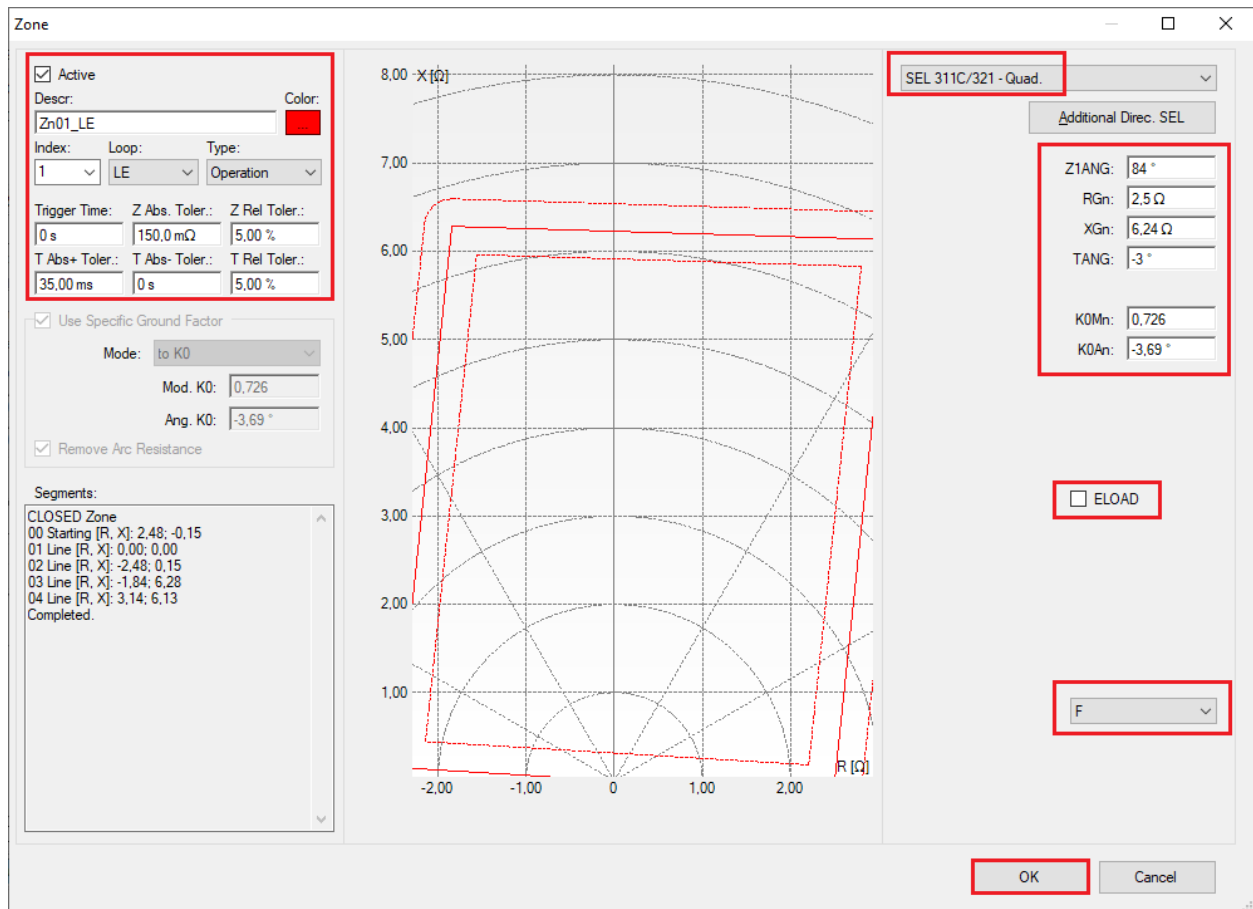

Figure 29

6.2. *Entering the Zone (Phase-Ground)*

The first zone to be entered will be zone-1 (LE). Click on the *"Insert"* field in the previous figure. In the settings screen, first choose the relay mask *"SEL 311C / 321 - __Quadr.__"*. You must adjust the actuation time, choose the type of fault (loop) for *"LE"* and enter the characteristics of the zone. Change the name to *"Zn01_LE"* and after the settings click on *"OK"*.

Figure 30

6.3. *Entering the Zone (Phase-Phase)*

Clicking *"Insert"* again selects the relay mask *"SEL 311C/321- __Mho__"*. You must adjust the actuation time, choose the fault type (loop) for *"FF only"* and enter the zone characteristics. Change the name to *"Zn01_FF"* and after the settings click on *"OK"*.

Rua Visconde de Ouro Preto, 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202.
Fone (34) 3218-6800   Fax (34) 3218-6810
Home Page: www.conprove.com.br   -   E-mail: conprove@conprove.com.br

21

Figure 31

6.4. *Entering the Zone (Phase-Phase-Phase)*

Clicking *"Insert"* again selects the relay mask *"SEL 311C/321- Mho"*. You must adjust the actuation time, choose the type of fault (loop) for *"ABC"* and enter the characteristics of the zone. Change the name to *"Zn01_FFF"* and after the settings click on *"OK"*.
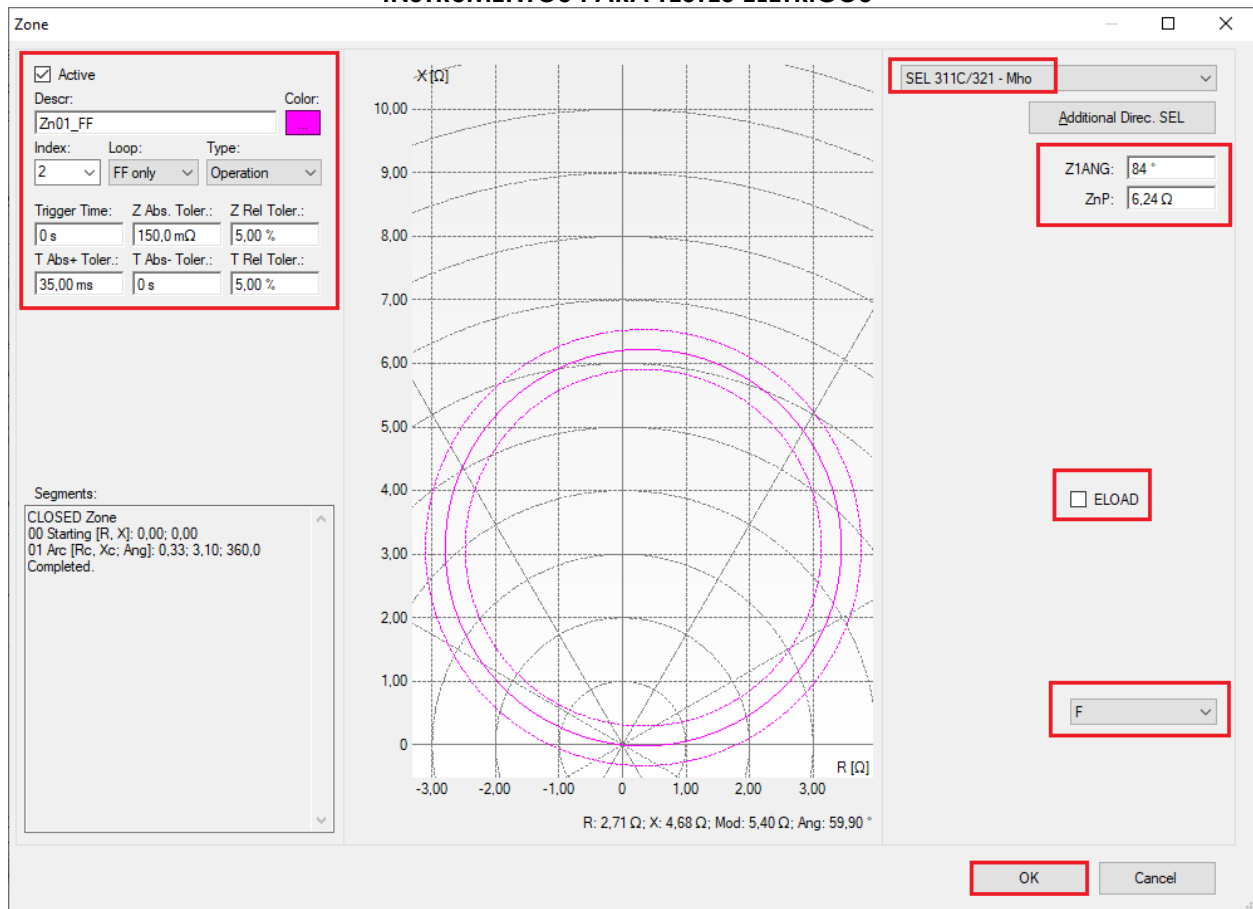
Rua Visconde de Ouro Preto, 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202.
Fone (34) 3218-6800   Fax (34) 3218-6810
Home Page: www.conprove.com.br   -   E-mail: conprove@conprove.com.br
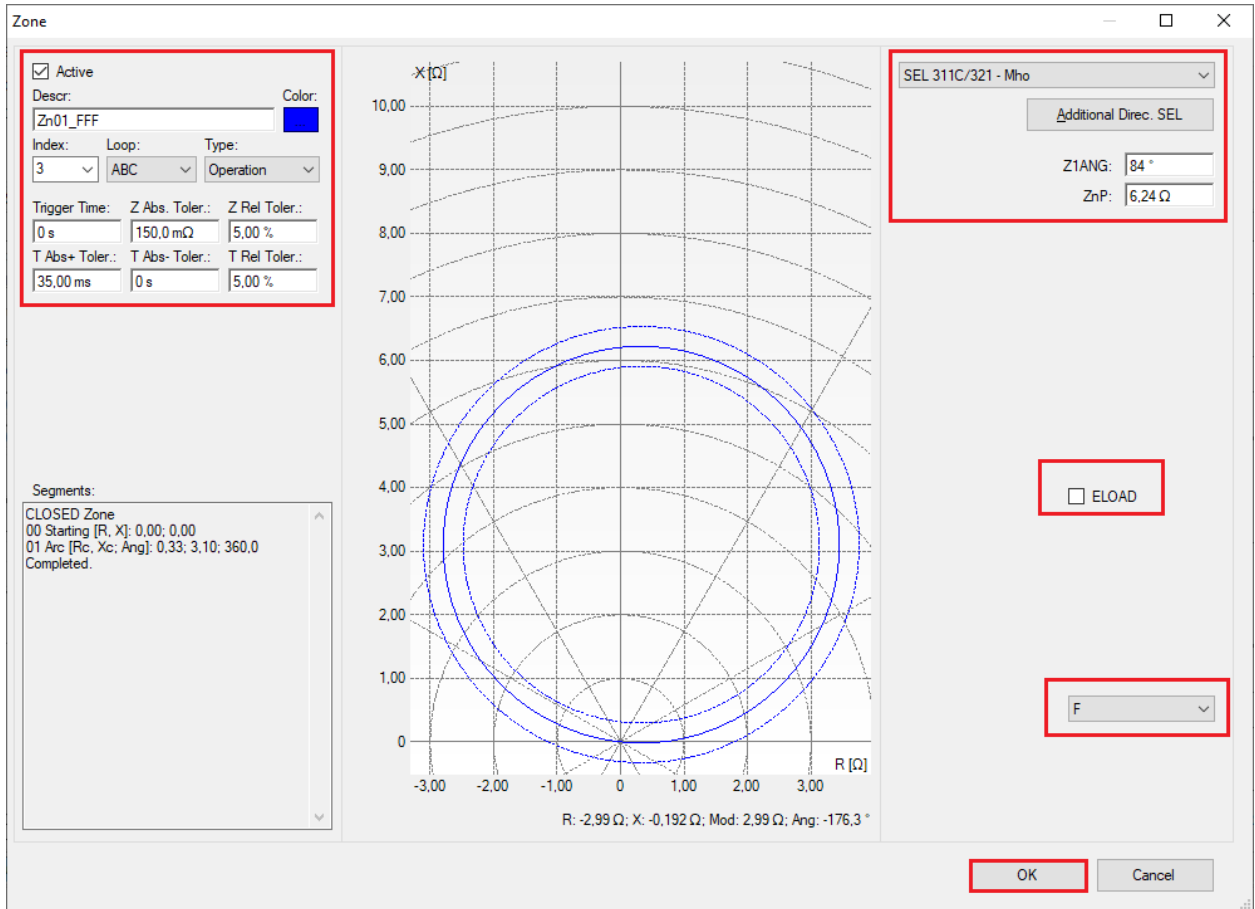
22

Figure 32

7. Channel Targeting and Hardware Configurations

Click on the icon illustrated below.
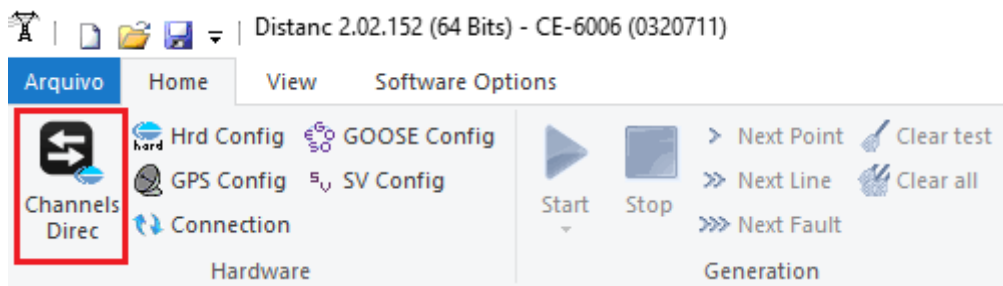
Figure 33

Then click on the highlighted icon to configure the hardware.

Rua Visconde de Ouro Preto, 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202.
Fone (34) 3218-6800   Fax (34) 3218-6810
Home Page: www.conprove.com.br   -   E-mail: conprove@conprove.com.br

23

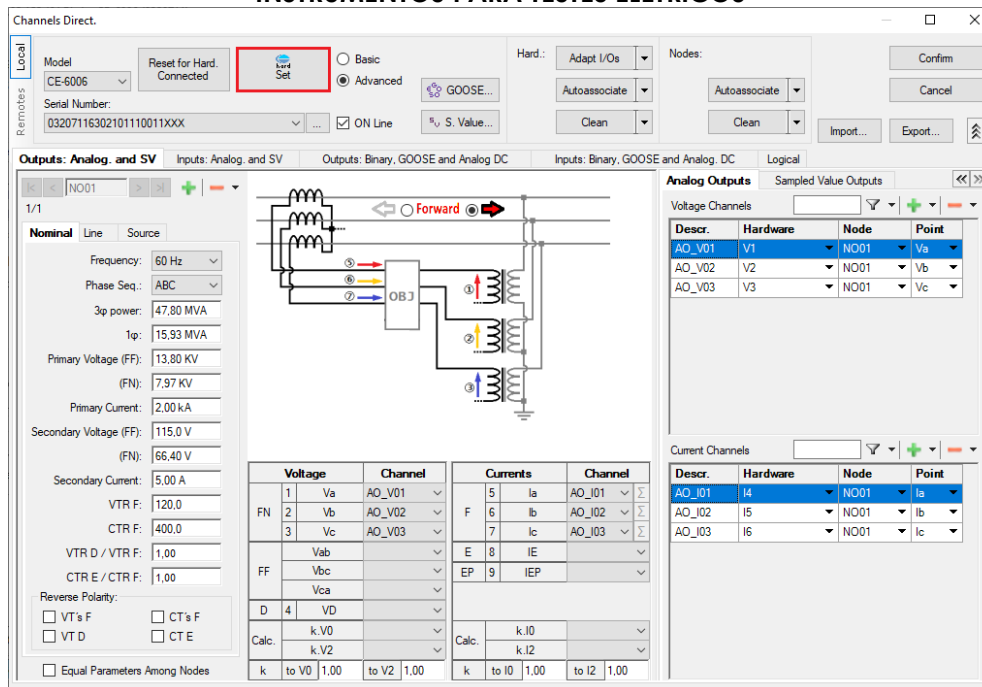**Figure 34**

Choose the channel configuration, adjust the auxiliary source and the stopping method of the binary inputs. To finish click on *"OK"*.

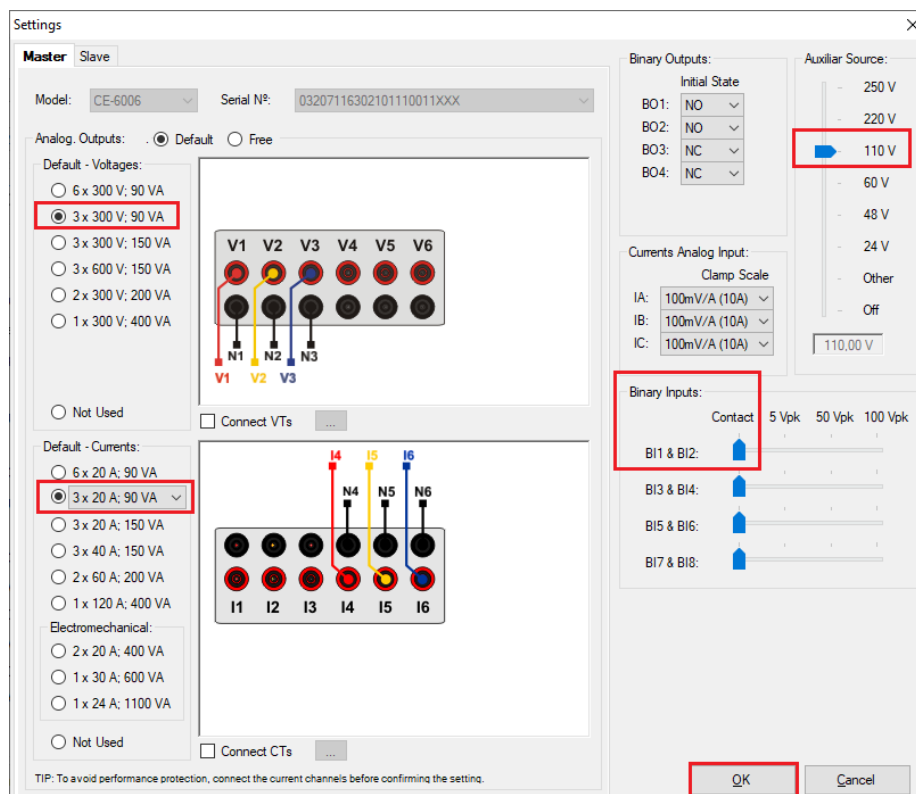**Figure 35**

Rua Visconde de Ouro Preto, 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202.
Fone (34) 3218-6800   Fax (34) 3218-6810
Home Page: www.conprove.com.br   -   E-mail: conprove@conprove.com.br

24

On the next screen choose *"Basic"* and on the next window (not shown) choose *"YES",* finally click on *"Confirm"*.
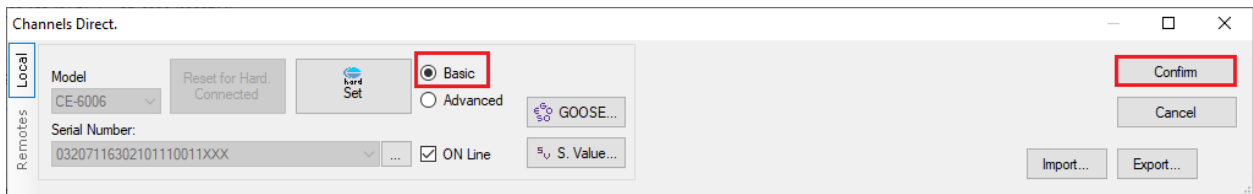

Figure 36

8. Test structure for the distance function

8.1. *Test Settings*

By clicking on the test settings tab, the user must enter a pre-fault in *"Nominal"* mode. Another important setting is the binary input used as a *"Stop Interf."* which in this example is set to *"BI01"*.
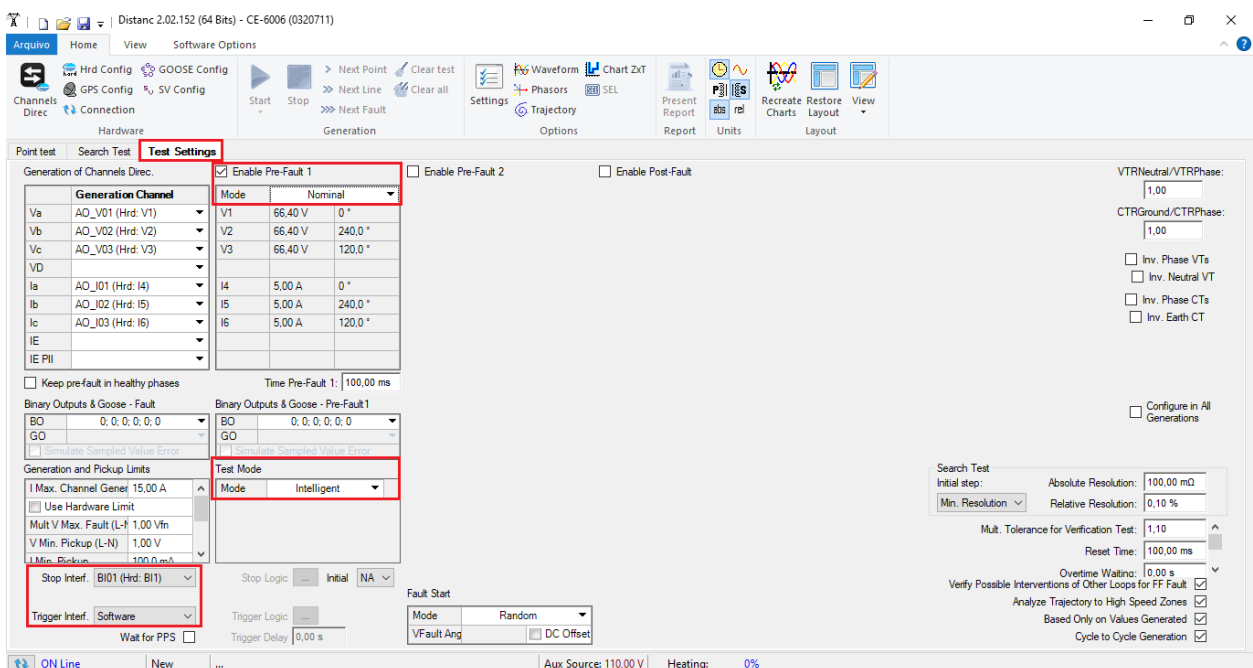
Figure 37

8.2. *Search Test*

8.2.1. *Single-phase Loop*

Click on the *"Search Test"* tab and then on the *"Insert/Edit Points"* tab click on the *"Sequence"* button. Choose the fault types in this case only single-phase faults, i.e. *"AE, BE and CE"*.

Rua Visconde de Ouro Preto, 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202.
Fone (34) 3218-6800   Fax (34) 3218-6810
Home Page: www.conprove.com.br   -   E-mail: conprove@conprove.com.br

25

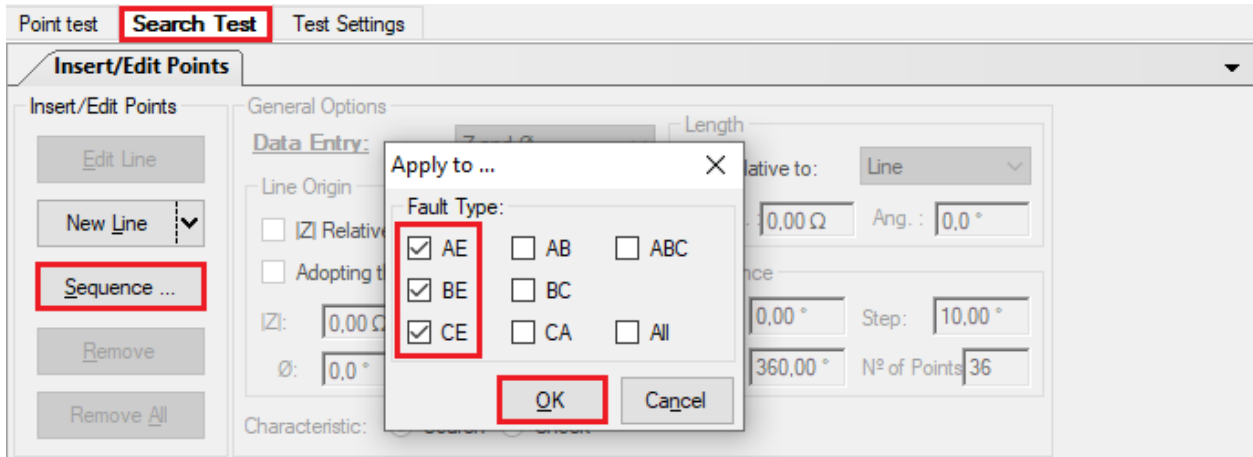**Figure 38**

Choose a start point approximately in the middle of the zone, adjust a length value, and choose a start angle, end angle and step. In this way the search lines are drawn automatically.

Figure 39

By clicking on the *"Confirm"* button the following search lines are created.

Rua Visconde de Ouro Preto, 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202.
Fone (34) 3218-6800   Fax (34) 3218-6810
Home Page: www.conprove.com.br   -   E-mail: conprove@conprove.com.br

26

Figure 40

Start the generation by clicking on the icon highlighted below or through the shortcut *"Alt + G"*.
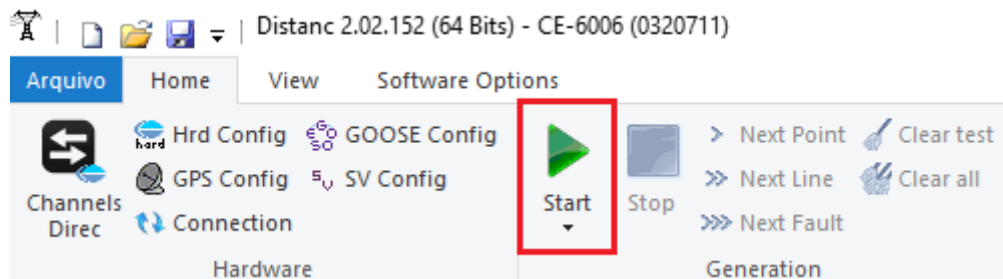
Figure 41

The final result is shown below showing the characteristics of the zones. To zoom in, left click and drag defining the region to be zoomed in, and then release the button.

8.2.2. Final Result Fault AE

By clicking on the *"AE"* tab, the final result is verified. It is observed that all points are within the tolerances given by the manufacturer so that the test is approved.
Click on the *"BE"* or *"CE"* tabs if you want to see the results for these types of faults (not shown in this tutorial).

Rua Visconde de Ouro Preto, 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202.
Fone (34) 3218-6800   Fax (34) 3218-6810
Home Page: www.conprove.com.br   -   E-mail: conprove@conprove.com.br

27

Figure 42

8.2.3. Two-Phase Loop

Click on the *"Search Test"* tab in the previous figure and then, on the *"Insert/Edit Points"* tab, click on the *"Sequence"* button. Choose the fault types in this case only two-phase faults, i.e. *"AB, BC and CA"*.

Figure 43

Choose a start point approximately in the middle of the zone, adjust a length value, choose a start angle, end angle and step. In this way the search lines are drawn automatically.
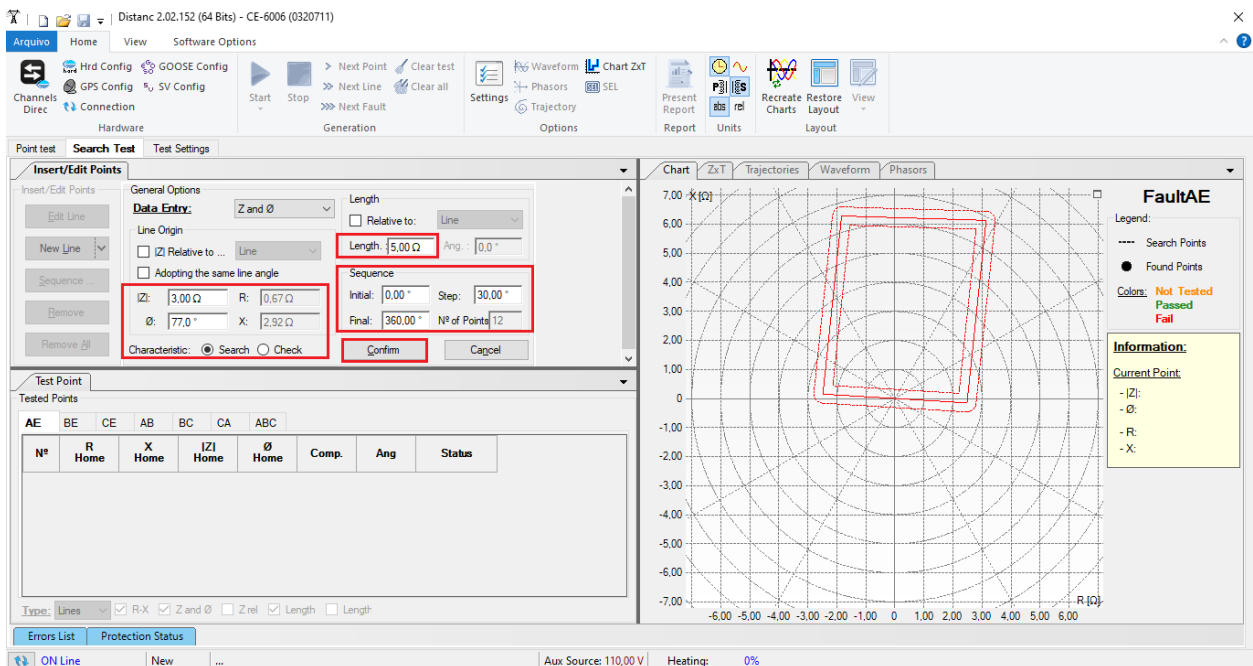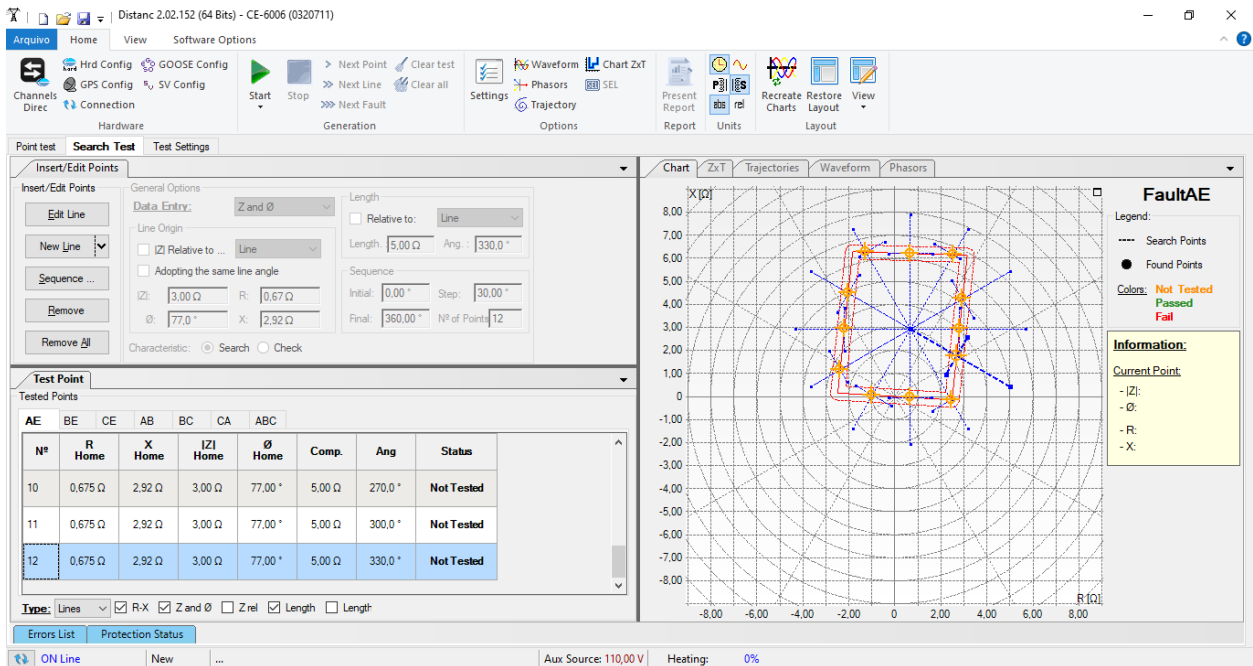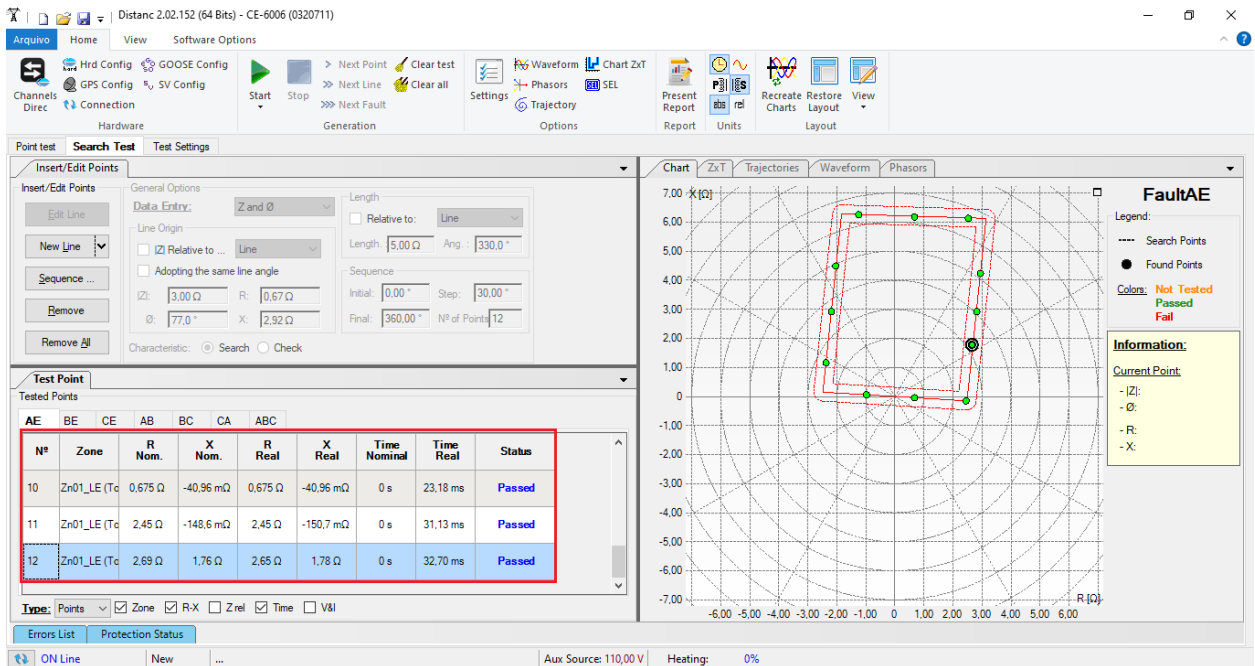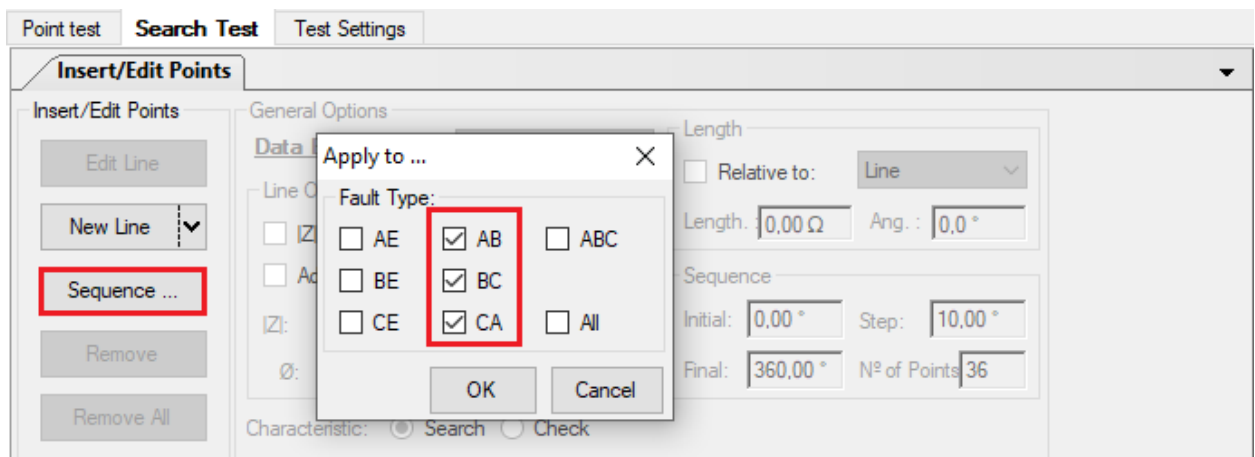
Rua Visconde de Ouro Preto, 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202.
Fone (34) 3218-6800   Fax (34) 3218-6810
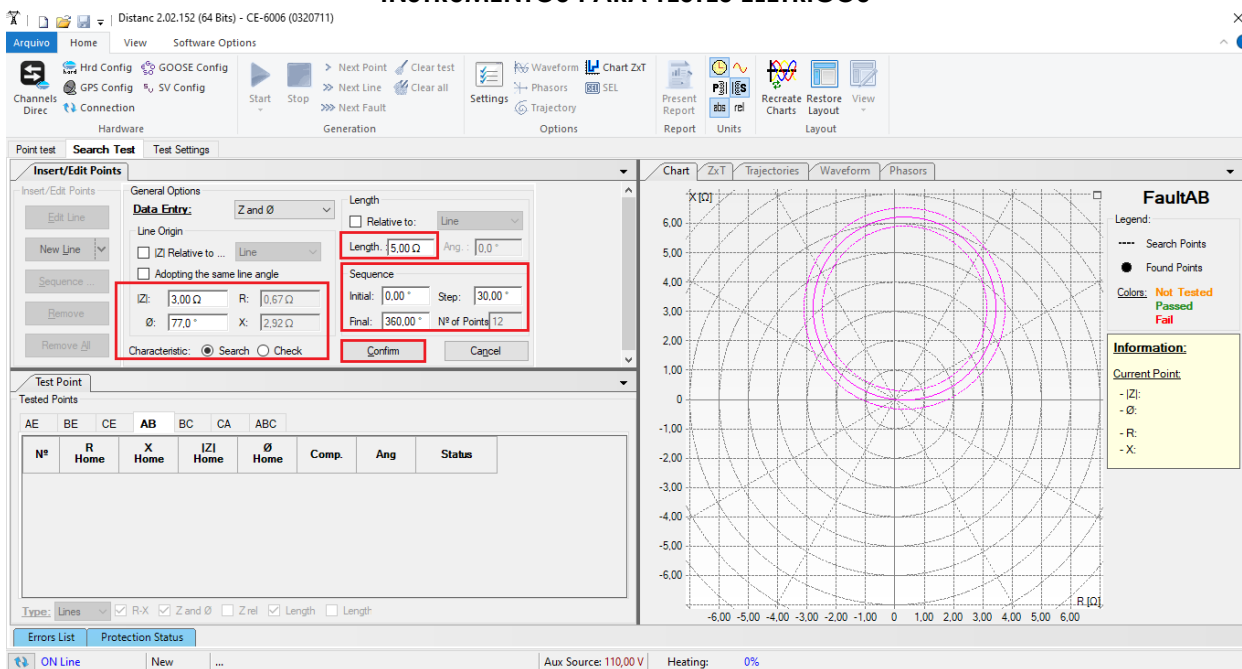Home Page: www.conprove.com.br   -   E-mail: conprove@conprove.com.br

28

Figure 44

By clicking on the *"Confirm"* button the following search lines are created.
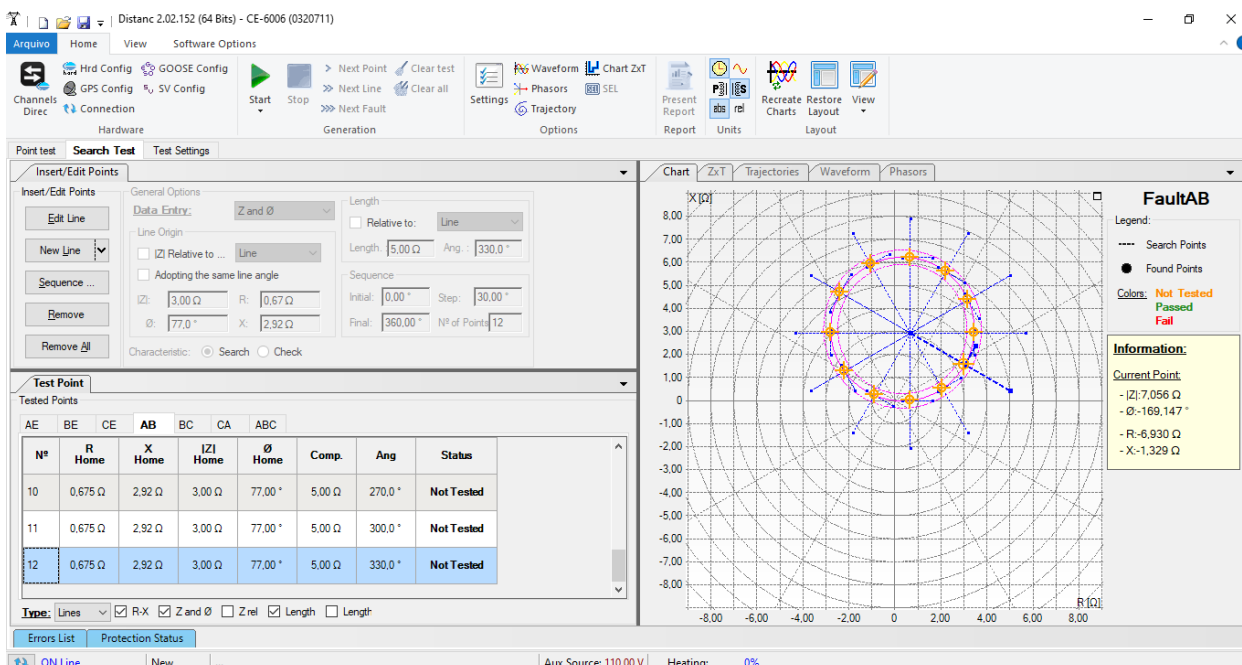
Figure 45

Start the generation by clicking on the icon highlighted below or through the shortcut *"Alt + G"*.
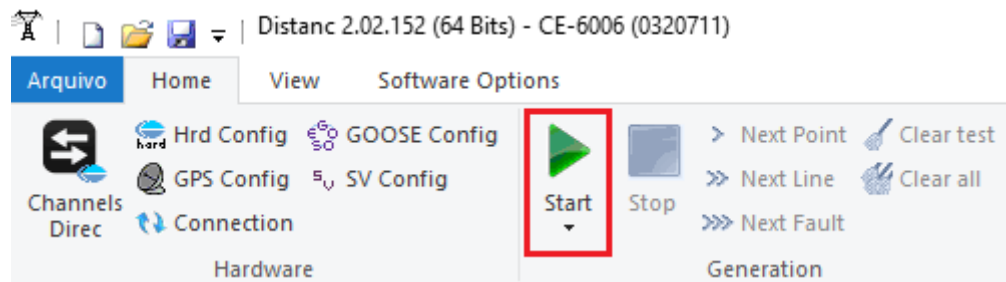
Figure 46

The final result is shown below showing the characteristics of the zones. To zoom in, left click and drag defining the region to be zoomed in and then release the button.

8.2.4. Final Result Fault BC

By clicking on the *"BC"* tab, the final result is checked. It is observed that all points are within the tolerances given by the manufacturer so that the test is approved.

Figure 47
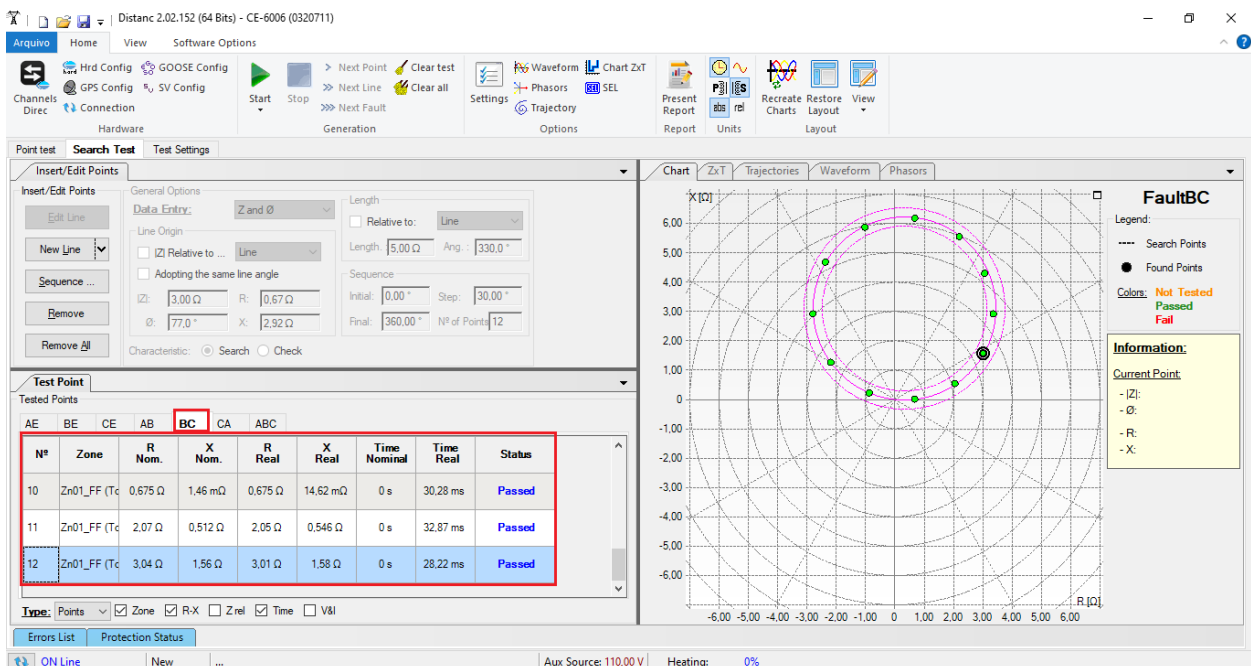
8.2.5. Three-Phase Loop

Click on the *"Search Test"* tab in the previous Figure and then, on the *"Insert/Edit Points"* tab, click on the *"Sequence"* button. Choose the fault types, in this case only three-phase faults, i.e. ABC.
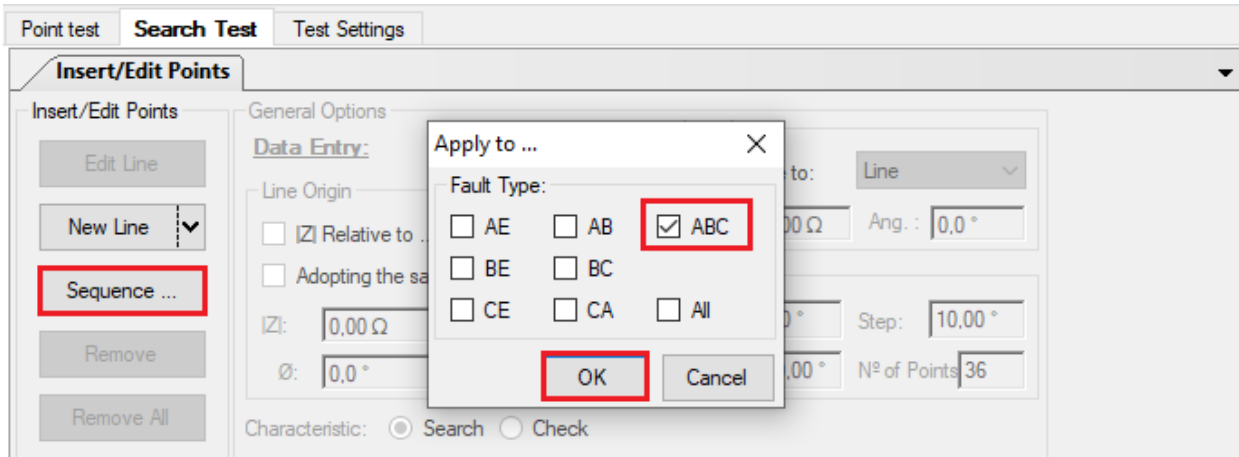
Figure 48

Choose a start point as the origin, set a length value, choose a start angle, end angle, and step. In this way the search lines are drawn automatically.

Figure 49

By clicking on the *"Confirm"* button the following search lines are created.

Rua Visconde de Ouro Preto, 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202.
Fone (34) 3218-6800   Fax (34) 3218-6810
Home Page: www.conprove.com.br   -   E-mail: conprove@conprove.com.br

31
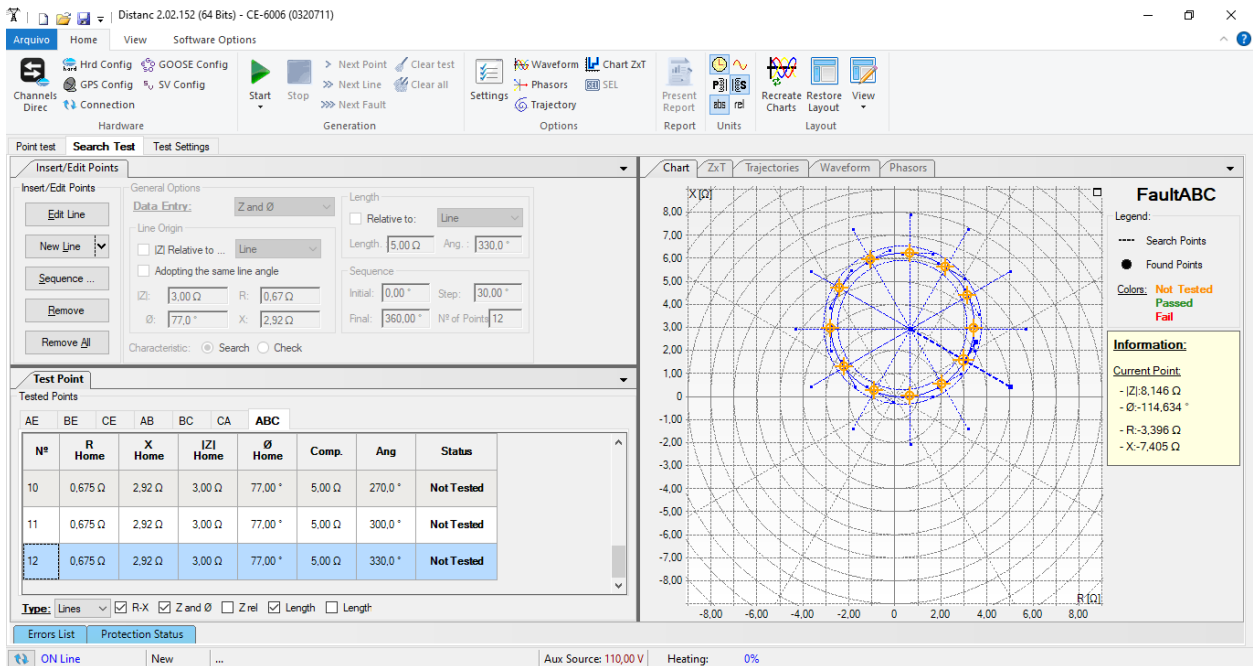
Figure 50

Start the generation by clicking on the icon highlighted below or through the shortcut *"Alt + G"*.
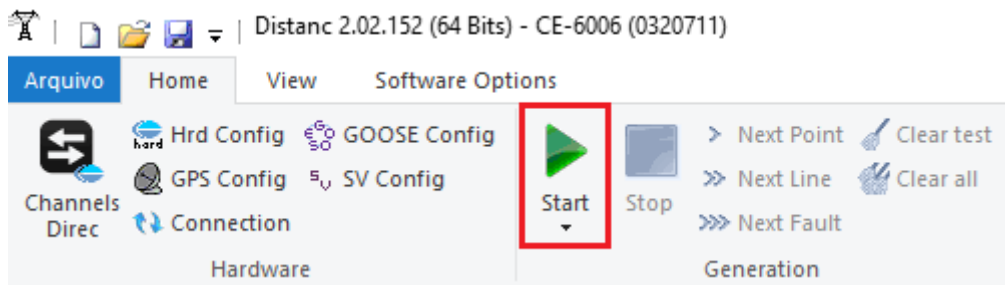
Figure 51

The final result is shown below with the characteristics of the zones. To zoom in, left click and drag defining the region to be zoomed in and then release the button.

8.2.6. Final Result Fault ABC

By clicking on the *"ABC"* tab, the final result is verified. It is observed that all points are within the tolerances given by the manufacturer so that the test is approved.
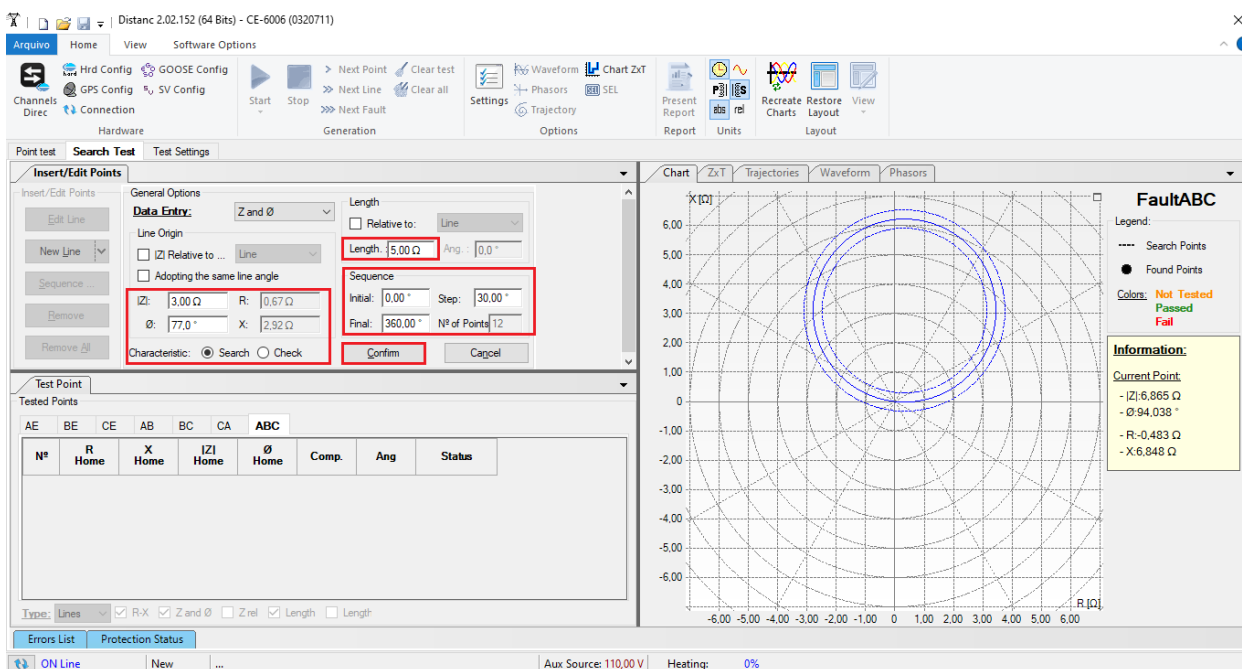
Rua Visconde de Ouro Preto, 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202.
Fone (34) 3218-6800   Fax (34) 3218-6810
Home Page: www.conprove.com.br   -   E-mail: conprove@conprove.com.br

32
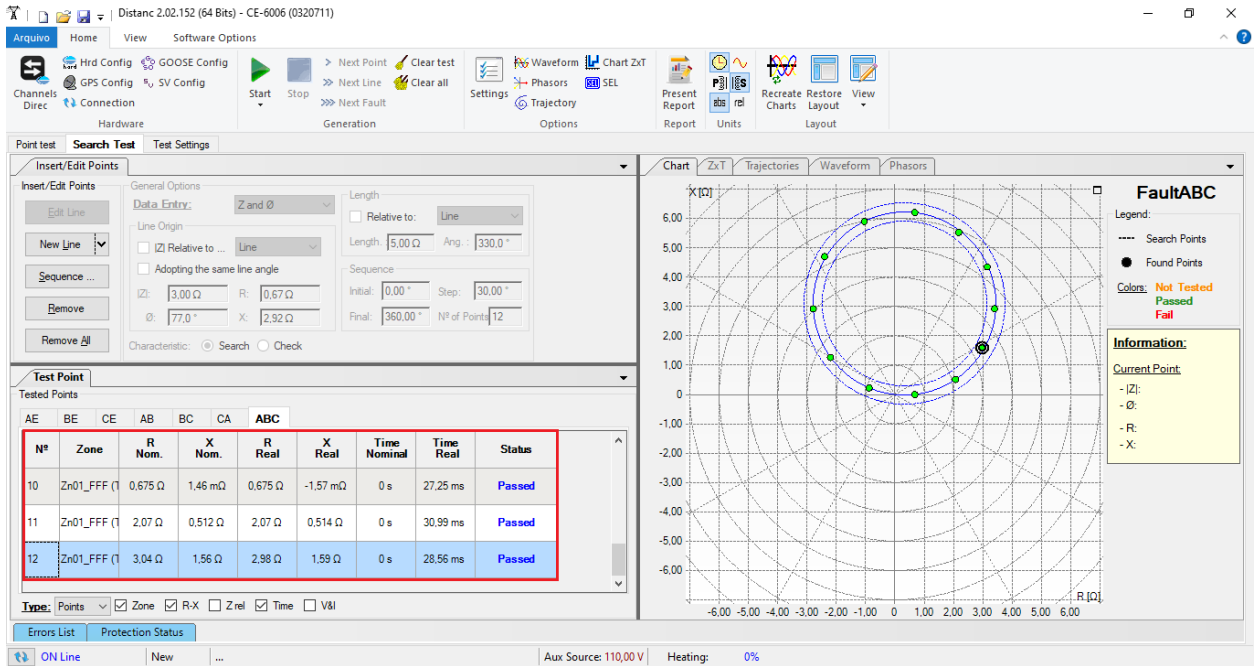
Figure 52

9. Report

After finishing the test, click on the icon *"Present Report"* or through the command *"Ctrl +R"* to call the report pre-configuration screen. Choose the desired language as well as the options that should be part of the report.
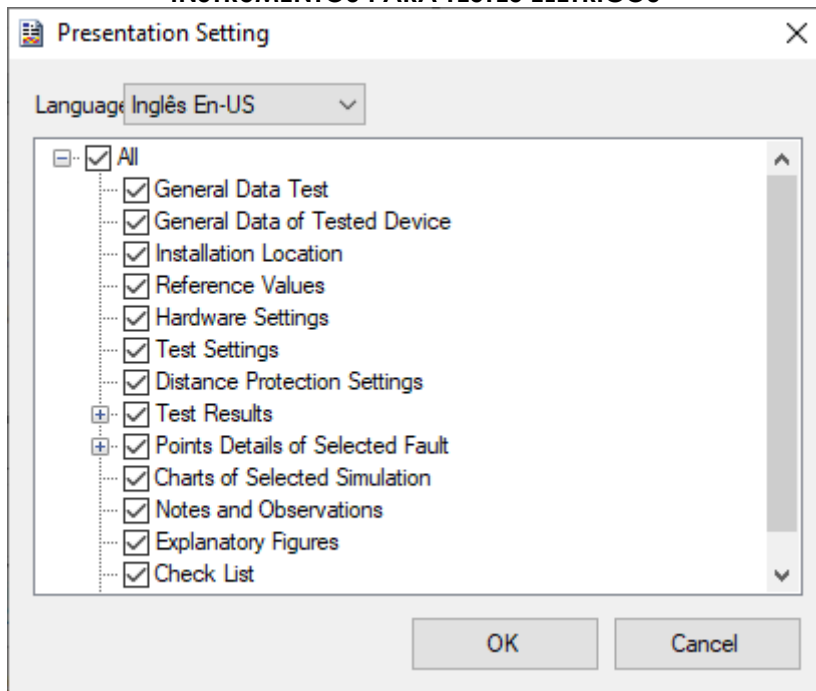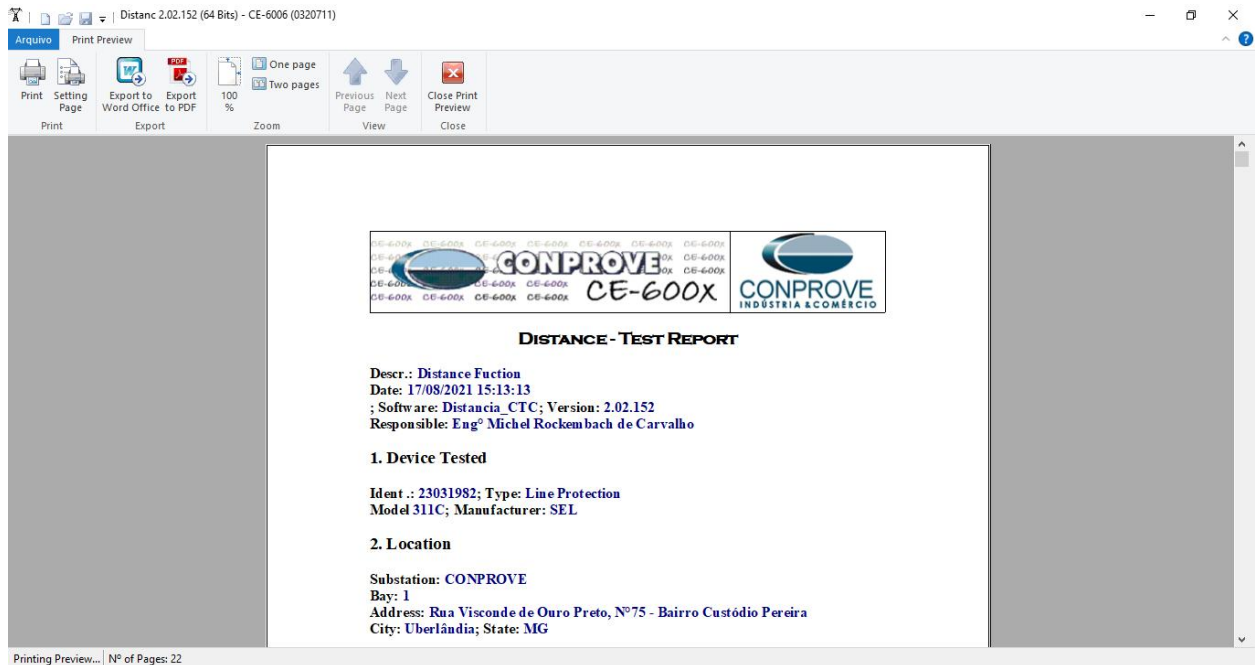
Figure 53

Figure 54

APPENDIX A
A.1 Terminal Designations

Figure 55

Rua Visconde de Ouro Preto, 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202.
Fone (34) 3218-6800   Fax (34) 3218-6810
Home Page: www.conprove.com.br   -   E-mail: conprove@conprove.com.br

35
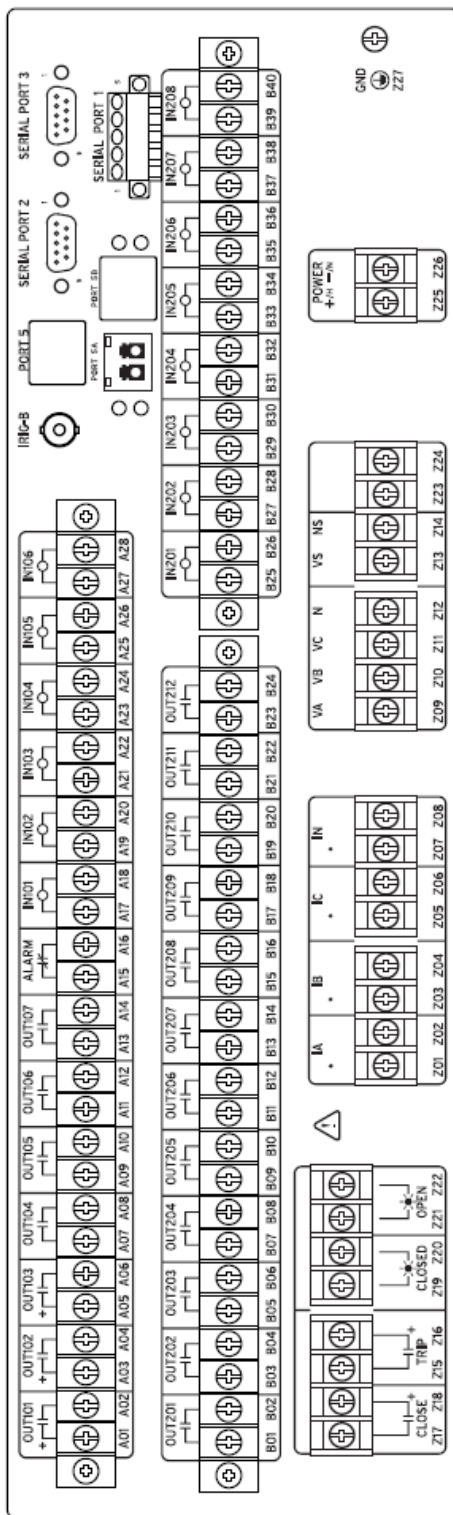
A.2 Technical Data

Mho Phase Distance Elements

Zones 1-4 Impedance Reach

Setting Range:	OFF, 0.05 to 64 Ω sec, 0.01 Ω steps (5 A nominal) OFF, 0.25 to 320 Ω sec, 0.01 Ω steps (1 A nominal) Minimum sensitivity is controlled by the pickup of the supervising phase-to-phase overcurrent elements for each zone.
Accuracy:	±5% of setting at line angle for 30 ≤ SIR ≤ 60 ±3% of setting at line angle for SIR < 30
Transient Overreach:	<5% of setting plus steady-state accuracy

Zones 1-4 Phase-to-Phase Current Fault Detectors (FD)

Setting Range:	0.5–170.00 A_{P-P} secondary, 0.01 A steps (5 A nominal) 0.1–34.00 A_{P-P} secondary, 0.01 A steps (1 A nominal)
Accuracy:	±0.05 A and ±3% of setting (5 A nominal) ±0.01 A and ±3% of setting (1 A nominal)
Transient Overreach:	<5% of pickup
Max. Operating Time:	See *Figure 3.13–Figure 3.16*.

Mho and Quadrilateral Ground Distance Element

Zones 1-4 Impedance Reach

Mho Element Reach:	OFF, 0.05 to 64 Ω sec, 0.01 Ω steps (5 A nominal) OFF, 0.25 to 320 Ω sec, 0.01 Ω steps (1 A nominal)
Quadrilateral Reactance Reach:	OFF, 0.05 to 64 Ω sec, 0.01 Ω steps (5 A nominal) OFF, 0.25 to 320 Ω sec, 0.01 Ω steps (1 A nominal)
Quadrilateral Resistance Reach:	OFF, 0.05 to 50 Ω sec, 0.01 Ω steps (5 A nominal) OFF, 0.25 to 250 Ω sec, 0.01 Ω steps (1 A nominal) Minimum sensitivity is controlled by the pickup of the supervising phase and residual overcurrent elements for each zone.
Accuracy:	±5% of setting at line angle for 30 ≤ SIR ≤ 60 ±3% of setting at line angle for SIR < 30
Line Angle:	≥45° (Quadrilateral)
Transient Overreach:	<5% of setting plus steady-state accuracy

Zones 1-4 Phase and Residual Current Fault Detectors (FD)

Setting Range:	0.5–100.00 A secondary, 0.01 A steps (5 A nominal) 0.1–20.00 A secondary, 0.01 A steps (1 A nominal)
Accuracy:	±0.05 A and ±3% of setting (5 A nominal) ±0.01 A and ±3% of setting (1 A nominal)
Transient Overreach:	<5% of pickup
Max. Operating Time:	See *Figure 3.17–Figure 3.20*.

Rua Visconde de Ouro Preto, 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202.
Fone (34) 3218-6800   Fax (34) 3218-6810
Home Page: www.conprove.com.br   -   E-mail: conprove@conprove.com.br

36

APPENDIX B

Equivalence of software parameters and the relay under test.

Table 1

Distance Software		SEL 311C Relay	
Parameter	**Figure**	**Parameter**	**Figure**
Secondary Current	28	Secondary Input Current	07
Frequency	28	NFREQ	09
Phase Seq.	28	PHROT	09
Line Length	29	Z1MAG	11
Line Ang	29	Z1ANG	11
Znp	31	Z1P	12
Xgn	30	XG1	13
RGn	30	RG1	13
TANG	30	TANG	14
Mod K0	29	K0M1	14
Ang K0	29	K0A1	14
Trigger Time	31	Z1PD	15
Trigger Time	30	Z1GD	15

Rua Visconde de Ouro Preto, 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202.
Fone (34) 3218-6800   Fax (34) 3218-6810
Home Page: www.conprove.com.br   -   E-mail: conprove@conprove.com.br

37