



— INSTRUMENTOS PARA TESTES ELÉTRICOS —

## Test Tutorial

**Equipment Type:** Protection Relay

**Brand:** SIEMENS

**Model:** 7SA611

**Functions:** 21 or PDIS – Distance

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

**Objective:** Search and Point Test of Zones with Quadrilateral Characteristics

**Version Control:**

| Version | Descriptions    | Date       | Author | Reviewer |
|---------|-----------------|------------|--------|----------|
| 1.0     | Initial Version | 06/08/2021 | M.R.C. | M.P.S    |

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**Statement of responsibility**

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Suggestions for improvement of this material are welcome, just user contacting us via email [suporte@conprove.com.br](mailto: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 should 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 should 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.

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**INSTRUMENTOS PARA TESTES ELÉTRICOS**  
**Sequence for testing the 7SA6 relay in the Distance software**

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## 1. Relay connection to CE-6006

Appendix A shows the relay terminal designations.

### 1.1 Auxiliary Source

Connect the positive (red terminal) of the Vdc Aux. Source to F1 pin (UH+) of the relay and the negative (black terminal) of the Vdc Aux. Source to F2 pin (UH-) of the relay.

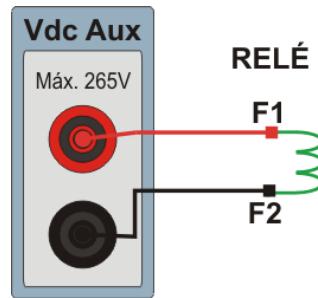


Figure 1

### 1.2 Current and Voltage Coils

To establish the voltage coil connection, connect V1, V2 and V3 channels with the relay terminal pins R15, R17 and R18 and the common ones to pin R16. To establish the connection of the current coils, connect I4, I5 and I6 channels with pins Q1, Q3 and Q5 of the relay terminal and make a short circuit between pins Q2, Q4 and Q6, finally connect pin Q6 to Q8 and connect the current channel commons to pin Q7.

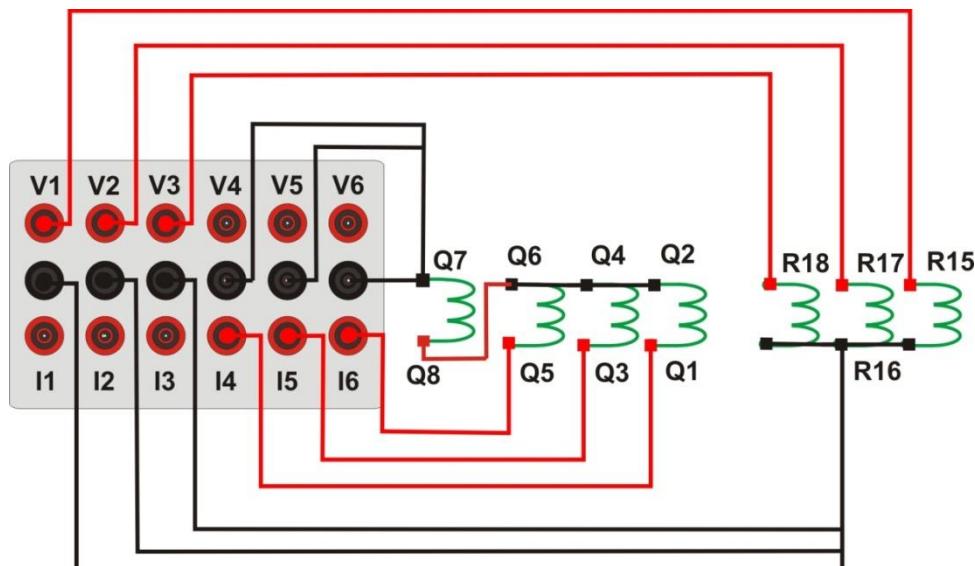


Figure 2

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### 1.3 Binary Inputs

Connect the CE-6006 binary input to the relay binary output, BI1 to pin R1 and its common to R5 in this way, the trip signal sent by the relay is monitored.

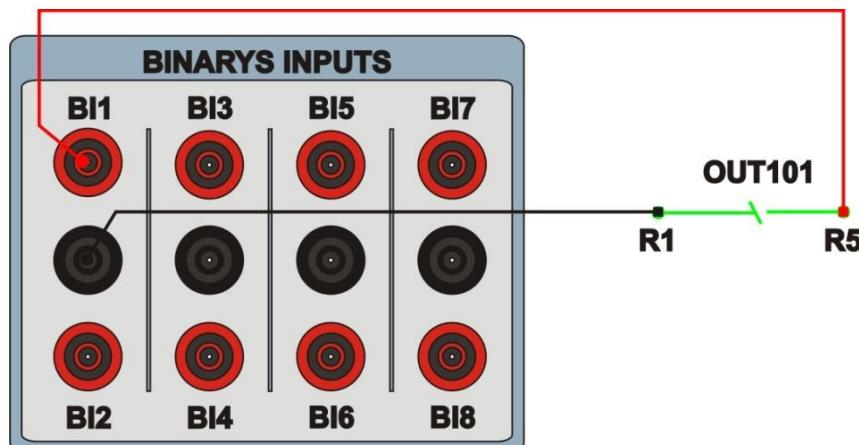


Figure 3

### 2. Communication with 7SA6 relay

First open the “DIGSI” and connect an Ethernet cable (or serial) from the notebook with the relay. Then double click on the software icon.



Figure 4

When opening the program, the substation that contains the relay (7SA6) is selected. After selecting the relay, right-click and select the “Open Object” option and then select the connection mode, as shown in the following figures.

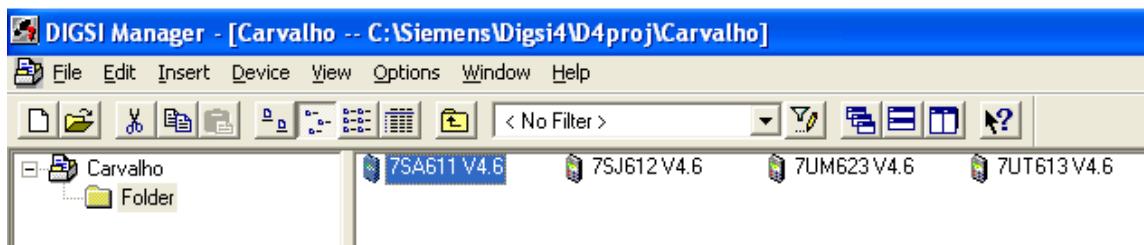


Figure 5

## INSTRUMENTOS PARA TESTES ELÉTRICOS

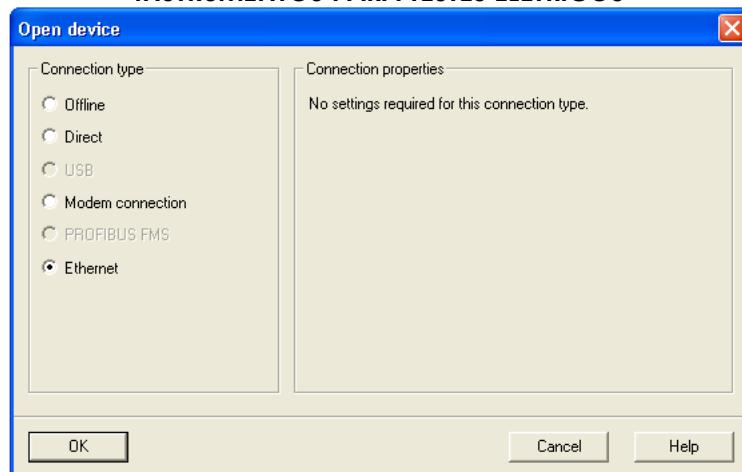


Figure 6

### 3. Parameterization of the 7SA6 relay

#### 3.1 Device Configurations

After the connection has been established, access the general relay settings by double left-clicking on “*Settings*” and repeat the operation for “*Device Configuration*”.

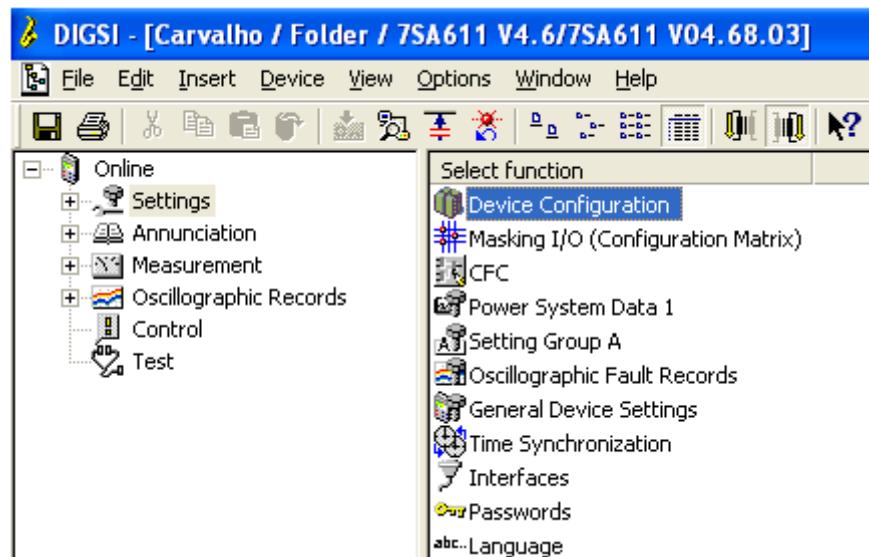


Figure 7

In the “*Functional Scope*” screen, disable all functions leaving only the “*21 Distance protection pickup program*” and “*Trip mode*” functions enabled. This prevents trips from other functions interfering with the test. After the adjustments click “OK”.

### INSTRUMENTOS PARA TESTES ELÉTRICOS

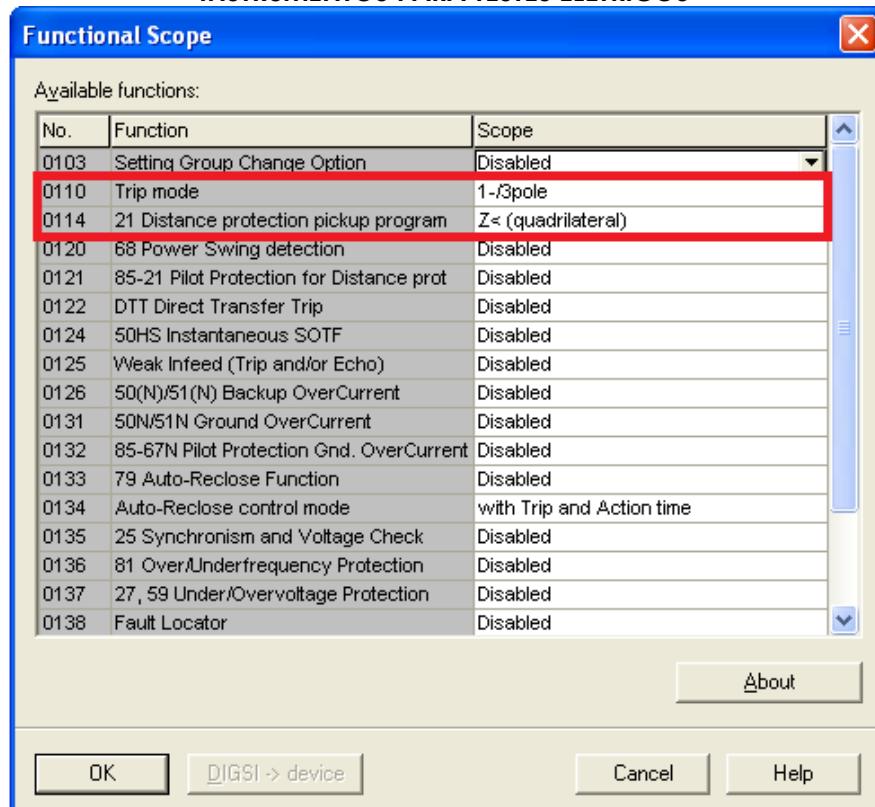


Figure 8

### 3.2 Masking I/O

The next step is to adjust the relay output. To access these parameters, double-click with the left button on “Masking I/O (Configuration Matrix)” as illustrated in the next figure.

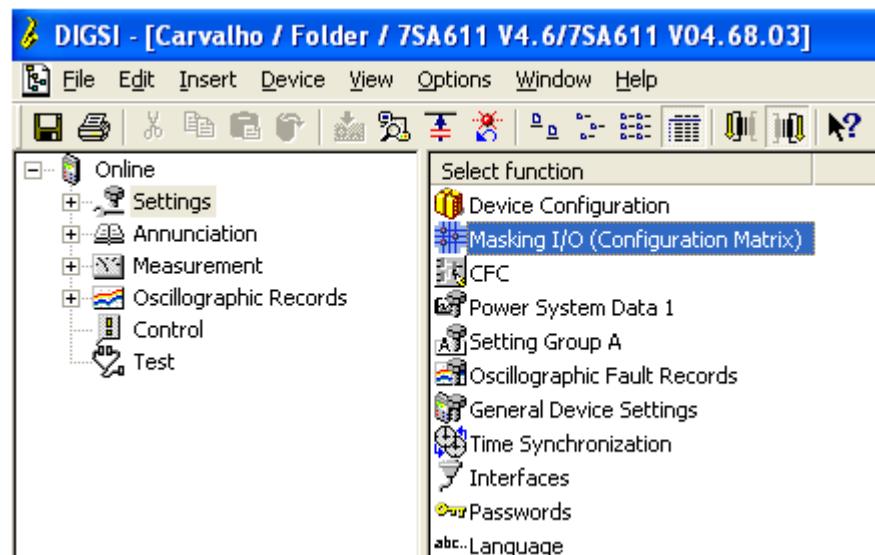


Figure 9

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Binary output BO1 is designated for sending the trip of zones 1, 2, 3 and 4. In order to aid the test, LED 1 is used to signal the trip sending of zone 1, LED 2 to signal the zone 2 trip send, LED 3 to signal zone 3 trip send and LED 4 to signal zone 4 trip send.

|                  | Number | Display text    | L   | Type | Source |   |   |   |   |   |      |   |   |   |   |   | Destination |    |    |    |    |    |   |   |   |    |   |   |  |
|------------------|--------|-----------------|-----|------|--------|---|---|---|---|---|------|---|---|---|---|---|-------------|----|----|----|----|----|---|---|---|----|---|---|--|
|                  |        |                 |     |      | BO     |   |   |   |   |   | LEDs |   |   |   |   |   | Buffer      |    |    |    |    |    | S | X | C | CM |   |   |  |
|                  |        |                 |     |      | B1     | F | S | C | 1 | 2 | 3    | 4 | 5 | 6 | 7 | 8 | 9           | 10 | 11 | 12 | 13 | 14 | O | S | T |    |   |   |  |
| Device, General  |        |                 |     |      | *      | * |   |   |   |   |      |   |   |   |   |   |             |    |    |    |    |    |   | * | * | *  | * |   |  |
| P.System Data 1  |        |                 |     |      |        |   |   |   |   |   |      |   |   |   |   |   |             |    |    |    |    |    |   |   |   |    |   |   |  |
| Osc. Fault Rec.  |        |                 |     |      |        |   |   |   |   |   |      |   |   |   |   |   |             |    |    |    |    |    |   |   |   |    |   |   |  |
| P.System Data 2  |        |                 |     |      |        |   |   |   |   |   |      |   |   |   |   |   |             |    |    |    |    |    |   |   |   |    |   |   |  |
| 21 Dis.General   | 03801  | 21 TRIP         | OUT |      |        | U |   |   |   |   |      |   |   |   |   |   | U           |    |    |    |    |    |   |   |   |    |   | X |  |
|                  | 03811  | 21 TRIP 1p. Z1  | OUT |      |        |   |   |   |   |   |      |   |   |   |   |   |             | U  |    |    |    |    |   |   |   |    |   | X |  |
|                  | 03823  | 21 TRIP3p. Z1sf | OUT |      |        |   |   |   |   |   |      |   |   |   |   |   |             | U  |    |    |    |    |   |   |   |    |   | X |  |
|                  | 03824  | 21 TRIP3p. Z1mf | OUT |      |        |   |   |   |   |   |      |   |   |   |   |   |             | U  |    |    |    |    |   |   |   |    |   | X |  |
|                  | 03816  | 21 TRIP 1p. Z2  | OUT |      |        |   |   |   |   |   |      |   |   |   |   |   |             | U  |    |    |    |    |   |   |   |    |   | X |  |
|                  | 03817  | 21 TRIP 3p. Z2  | OUT |      |        |   |   |   |   |   |      |   |   |   |   |   |             | U  |    |    |    |    |   |   |   |    |   | X |  |
| 21 Dis.ZoneQuad  |        |                 |     |      |        |   |   |   |   |   |      |   |   |   |   |   |             |    |    |    |    |    |   |   |   |    |   |   |  |
| Measurem. Superv |        |                 |     |      |        |   |   |   |   |   |      |   |   |   |   |   |             |    |    |    |    |    |   |   |   |    |   |   |  |
| EN100-Modul 1    |        |                 |     |      |        |   |   |   |   |   |      |   |   |   |   |   |             |    |    |    |    |    |   |   |   |    |   |   |  |
| Testing          |        |                 |     |      |        |   |   |   |   |   |      |   |   |   |   |   |             |    |    |    |    |    |   |   |   |    |   |   |  |
| Cntrl Authority  |        |                 |     |      |        |   |   |   |   |   |      |   |   |   |   |   |             |    |    |    |    |    |   |   |   |    |   |   |  |
| Control Device   |        |                 |     |      |        |   |   |   |   |   |      |   |   |   |   |   |             |    |    |    |    |    |   |   |   |    |   |   |  |
| Process Data     |        |                 |     |      |        |   |   |   |   |   |      |   |   |   |   |   |             |    |    |    |    |    |   |   |   |    |   |   |  |
| Measurement      |        |                 |     |      |        |   |   |   |   |   |      |   |   |   |   |   |             |    |    |    |    |    |   |   |   |    |   |   |  |
| Set Points(MV)   |        |                 |     |      |        |   |   |   |   |   |      |   |   |   |   |   |             |    |    |    |    |    |   |   |   |    |   |   |  |
| Energy           |        |                 |     |      |        |   |   |   |   |   |      |   |   |   |   |   |             |    |    |    |    |    |   |   |   |    |   |   |  |
| Statistics       |        |                 |     |      |        |   |   |   |   |   |      |   |   |   |   |   |             |    |    |    |    |    |   |   |   |    |   |   |  |
| Thresh-Switch    |        |                 |     |      |        |   |   |   |   |   |      |   |   |   |   |   |             |    |    |    |    |    |   |   |   |    |   |   |  |

Figure 10

### 3.3 Power System Data 1

Double-click on “Power System Data 1” to access the system settings.

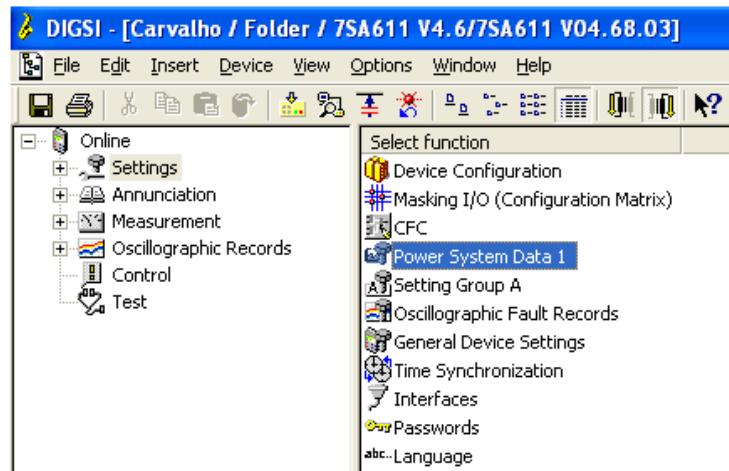


Figure 11

Those settings highlighted in red need special attention. Firstly, the VT and CT data are shown, then the system data and finally the breaker data.

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### 3.4 Transformers

In the “*Transformers*” tab, the CT and VT ratio of the system is configured.

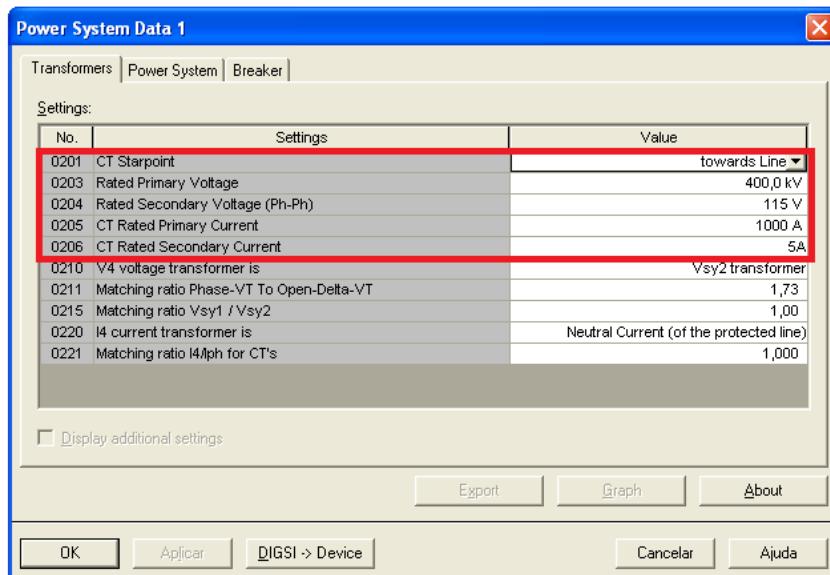


Figure 12

### 3.5 Power System

In the “*Power System*” tab, the nominal frequency, the phase sequence, whether the system is grounded and how the ground compensation for ground faults will be set up.

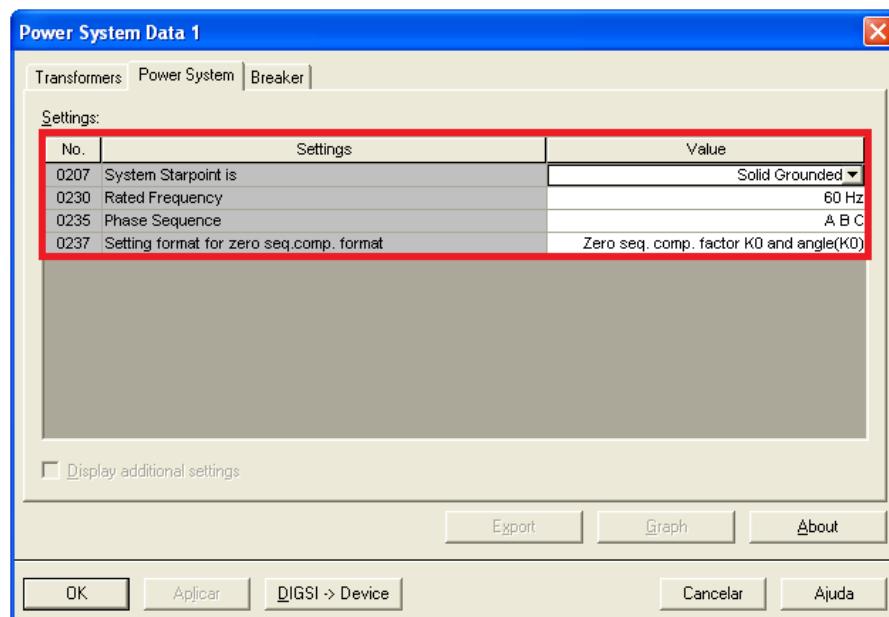


Figure 13

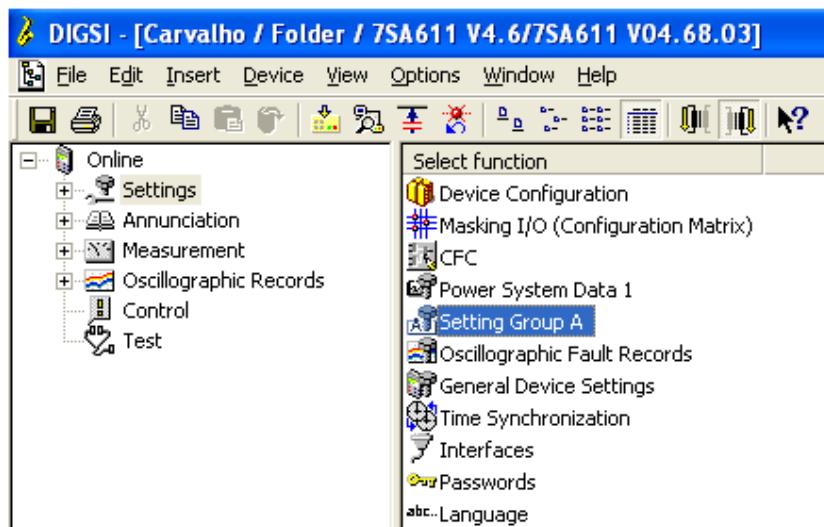
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### 3.6 Setting Group A

This option sets important data about the protected transmission line and the parameters of the impedance function, whose calculations will be shown later.



**Figure 14**

Double-click on the “Power System Data 2” option.

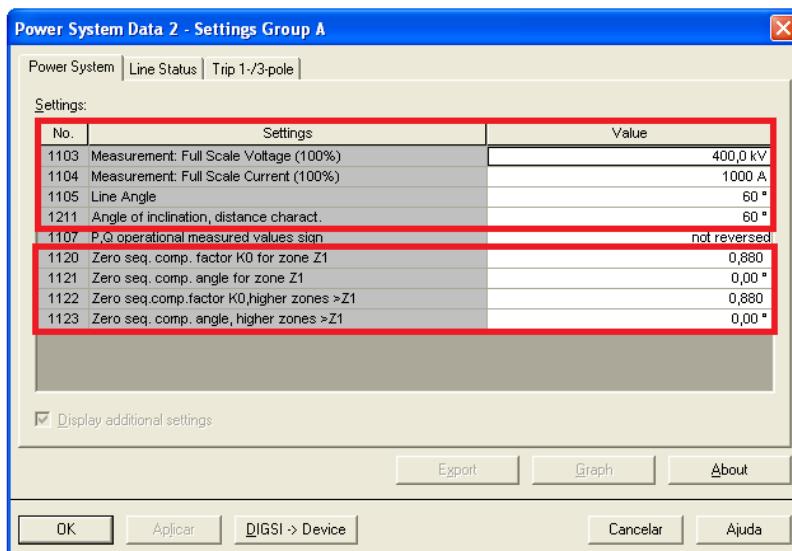


**Figure 15**

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### 3.7 Power System Data 2

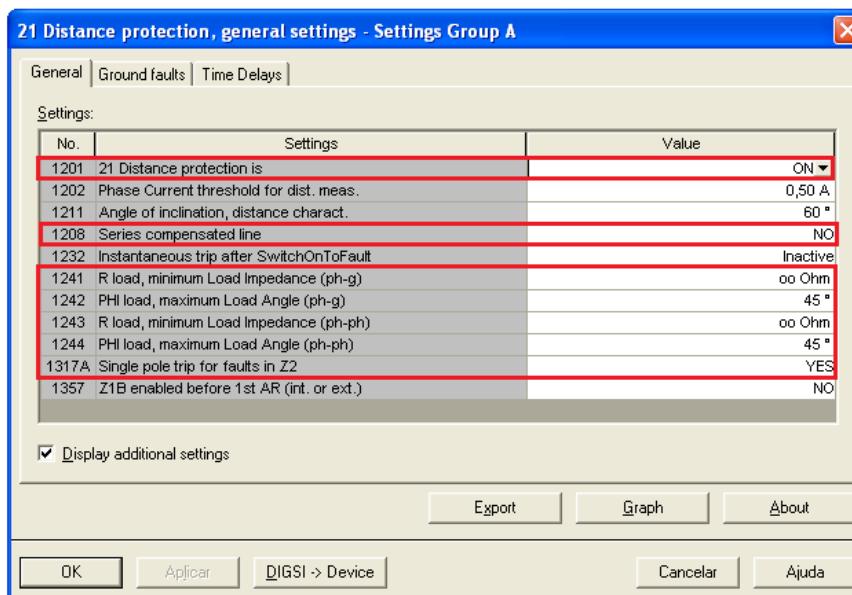
In the “Power System” tab, important data such as: measurement full scale voltage and current, line angle, slope angle of the distance characteristic and the compensation factors for ground faults are parameterized.



**Figure 16**

### 3.8 21 Distance Protection/General settings

The next step in the “General” tab is to activate function 21, disable the series compensation line and adjust the load compensation, which in this case will be infinite.



**Figure 17**

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In the “Time Delays” tab, the time delays for each zone are adjusted, both for three-phase faults and for ground faults.

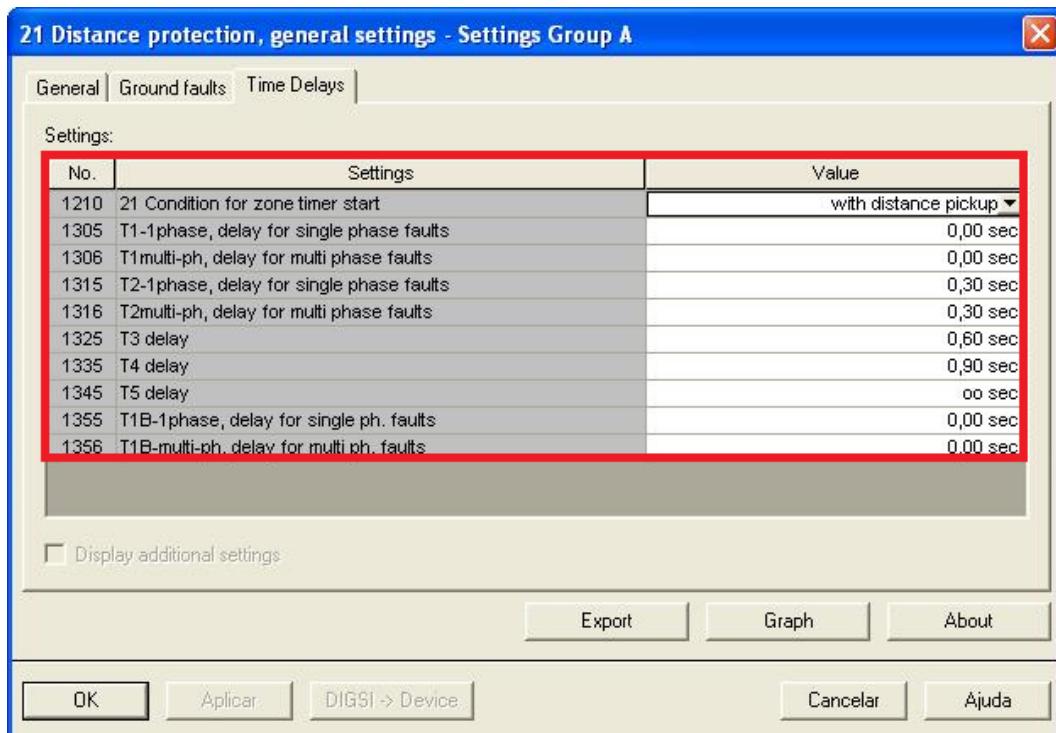


Figure 18

### 3.9 21 Impedance Distance Zones (Quadrilateral)

Set the impedance values of zones 1, 2, 3 and 4 for three-phase/single-phase faults and their respective delays. In this test the Z1B zone will not be used.

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21 Distance zones (quadrilateral) - Setting Group A

Zone Z1 | Zone Z1B-exten. | **Zone Z2** | Zone Z3 | Zone Z4 | Zone Z5 |

**Settings:**

| No.  | Settings                                 | Value     |
|------|--|-----------|
| 1301 | Operating mode Z1                        | Forward ▾ |
| 1302 | R(Z1), Resistance for ph-ph-faults       | 0,250 Ohm |
| 1303 | X(Z1), Reactance                         | 0,500 Ohm |
| 1304 | RG(Z1), Resistance for ph-gnd faults     | 0,500 Ohm |
| 1305 | T1-1phase, delay for single phase faults | 0,00 sec  |
| 1306 | T1multi-ph, delay for multi phase faults | 0,00 sec  |
| 1307 | Zone Reduction Angle (load compensation) | 0 °       |

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Figure 19

21 Distance zones (quadrilateral) - Setting Group A

Zone Z1 | Zone Z1B-exten. | **Zone Z2** | Zone Z3 | Zone Z4 | Zone Z5 |

**Settings:**

| No.   | Settings                                 | Value     |
|-------|--|-----------|
| 1311  | Operating mode Z2                        | Forward ▾ |
| 1312  | R(Z2), Resistance for ph-ph-faults       | 0,500 Ohm |
| 1313  | X(Z2), Reactance                         | 1,000 Ohm |
| 1314  | RG(Z2), Resistance for ph-gnd faults     | 1,000 Ohm |
| 1315  | T2-1phase, delay for single phase faults | 0,30 sec  |
| 1316  | T2multi-ph, delay for multi phase faults | 0,30 sec  |
| 1317A | Single pole trip for faults in Z2        | NO        |

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Figure 20

## INSTRUMENTOS PARA TESTES ELÉTRICOS

21 Distance zones (quadrilateral) - Setting Group A

Zone Z1 | Zone Z1B-exten. | Zone Z2 | **Zone Z3** | Zone Z4 | Zone Z5 |

**Settings:**

| No.  | Settings                             | Value     |
|------|--------------------------------------|-----------|
| 1321 | Operating mode Z3                    | Reverse ▾ |
| 1322 | R(Z3), Resistance for ph-ph-faults   | 1,000 Ohm |
| 1323 | X(Z3), Reactance                     | 2,000 Ohm |
| 1324 | RG(Z3), Resistance for ph-gnd faults | 2,000 Ohm |
| 1325 | T3 delay                             | 0,60 sec  |

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**OK** | **Aplicar** | **DIGSI -> Device** | **Cancelar** | **Ajuda**

Figure 21

21 Distance zones (quadrilateral) - Setting Group A

Zone Z1 | Zone Z1B-exten. | Zone Z2 | Zone Z3 | **Zone Z4** | Zone Z5 |

**Settings:**

| No.  | Settings                             | Value             |
|------|--------------------------------------|-------------------|
| 1331 | Operating mode Z4                    | Non-Directional ▾ |
| 1332 | R(Z4), Resistance for ph-ph-faults   | 2,400 Ohm         |
| 1333 | X(Z4), Reactance                     | 2,400 Ohm         |
| 1334 | RG(Z4), Resistance for ph-gnd faults | 2,400 Ohm         |
| 1335 | T4 delay                             | 0,90 sec          |

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Figure 22

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4. Distance software adjustments

4.1 Opening Distance

Click on the CTC application manager icon.



Figure 23

Click on the “Distance” software icon.

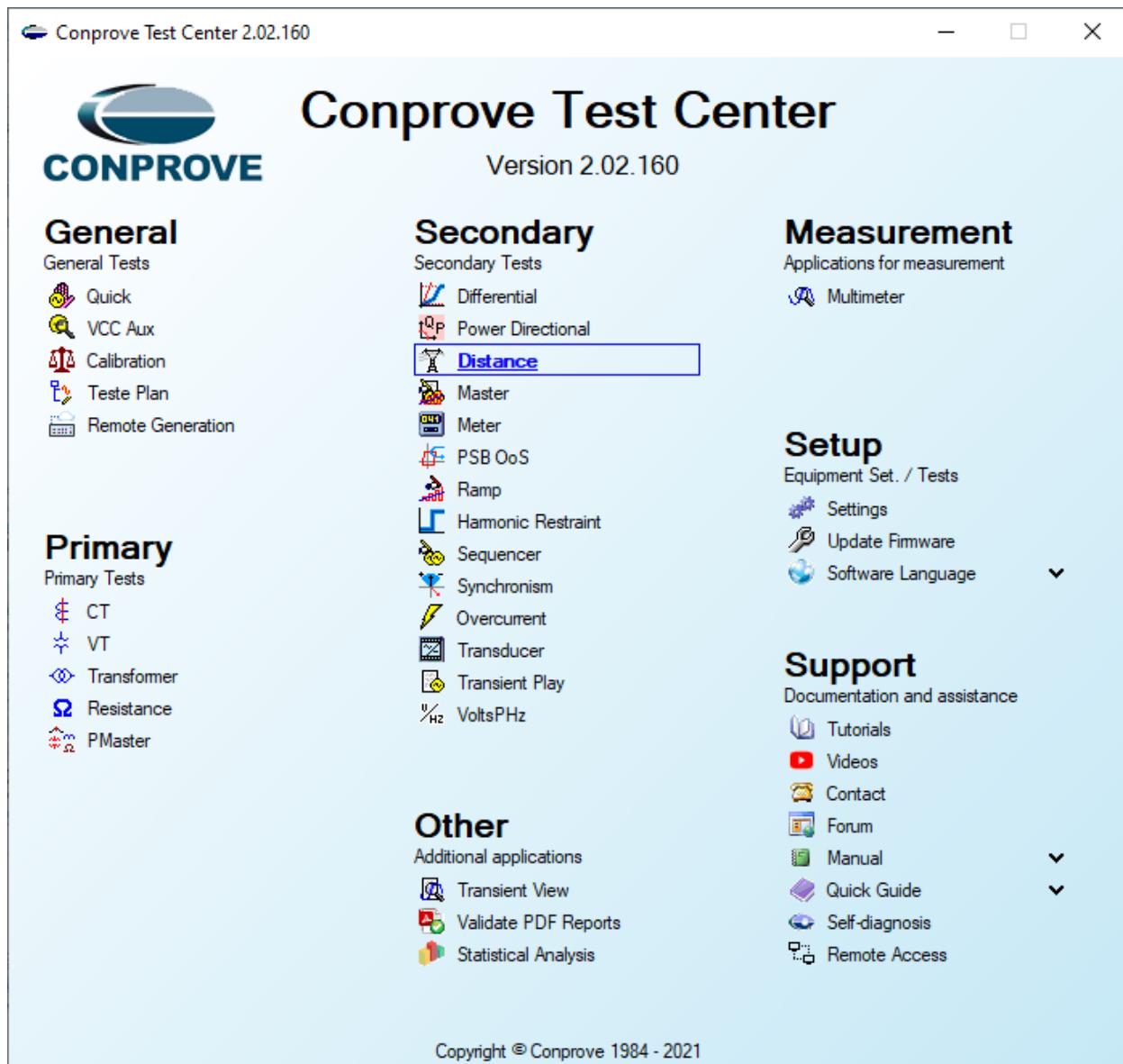
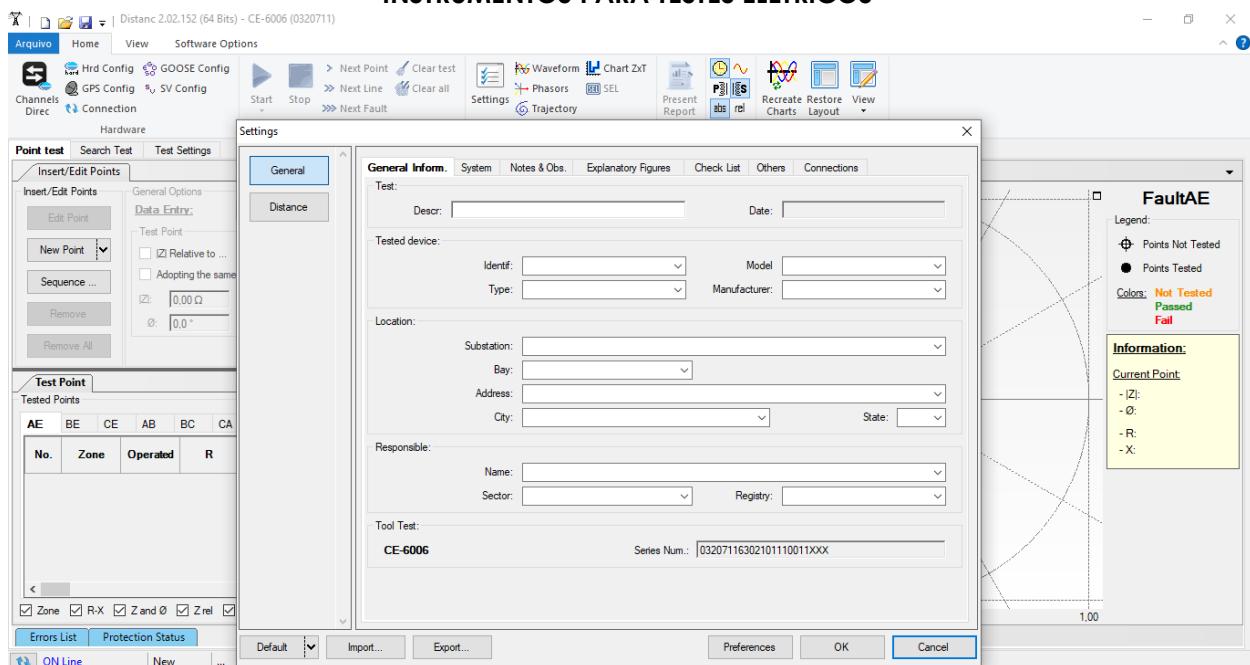


Figure 24



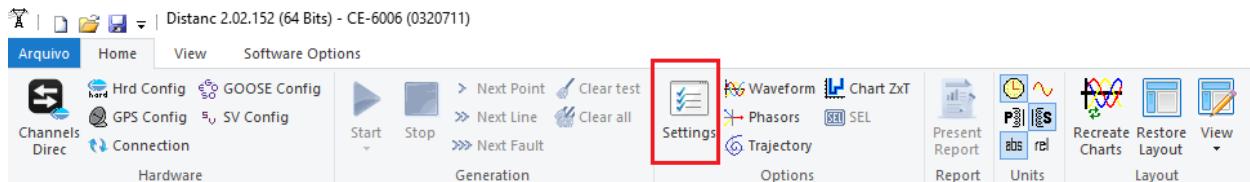
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**Figure 25**

### 4.2 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.*” tab with details of the tested device, location and the person responsible. This facilitates the elaboration of the report as this tab will be the first to be shown.

## INSTRUMENTOS PARA TESTES ELÉTRICOS

Settings

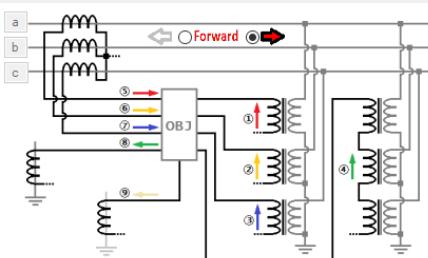
|   |                 |              |                     |
|---|-----------------|--------------|---------------------|
| General   | General Inform. |              |                     |
| Distance  | System          | Notes & Obs. | Explanatory Figures |
|   | Check List      | Others       | Connections         |
| <b>Test:</b><br>Descr.: Distance Function      Date:<br><b>Tested device:</b><br>Identif.: 23031982      Model: 7SA611<br>Type: Line Protection      Manufacturer: Siemens<br><b>Location:</b><br>Substation: CONPROVE      Bay: 1<br>Address: Visconde de Ouro Preto 75 - Neighborhood Custódio Pereira<br>City: Uberlândia      State: MG<br><b>Responsible:</b><br>Name: Eng° Michel Rockembach de Carvalho      Registry: 00001<br>Sector: Engenharia<br><b>Tool Test:</b><br>CE-6006      Series Num.: 03207116302101110011XXX |                 |              |                     |
| <input type="button" value="Default"/> <input type="button" value="Import..."/> <input type="button" value="Export..."/> <input type="button" value="Preferences"/> <input type="button" value="OK"/> <input type="button" value="Cancel"/>   |                 |              |                     |

**Figure 27**

### 4.3 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 PTs and CTs are configured. There are also two sub-tabs “Impedance” and “Source” whose data is not relevant for this test.

Settings

| General   | General Inform. |                     |            |         |  |          |  |    |      |   |      |      |      |   |      |      |      |   |      |  |       |    |  |
|---|-----------------|---------------------|------------|---------|--|----------|--|----|------|---|------|------|------|---|------|------|------|---|------|--|-------|----|--|
| Distance  | System          |                     |            |         |  |          |  |    |      |   |      |      |      |   |      |      |      |   |      |  |       |    |  |
|   | Notes & Obs.    | Explanatory Figures | Check List |         |  |          |  |    |      |   |      |      |      |   |      |      |      |   |      |  |       |    |  |
|   | Others          | Connections         |            |         |  |          |  |    |      |   |      |      |      |   |      |      |      |   |      |  |       |    |  |
| <b>Nominal</b> <b>Impedance</b> <b>Source</b>   |                 |                     |            |         |  |          |  |    |      |   |      |      |      |   |      |      |      |   |      |  |       |    |  |
| Frequency: 60 Hz      Phase Seq.: ABC<br>3φ power: 47,80 MVA      1p: 15,93 MVA<br>Primary Voltage (FF): 13,80 KV      (FN): 7,97 KV<br>Primary Current: 2,00 kA<br>Secondary Voltage (FF): 115,0 V      (FN): 66,40 V<br>Secondary Current: 5,00 A<br>VTR F: 120,0      CTR F: 400,0<br>VTR D / VTR F: 1,00      CTR E / CTR F: 1,00<br>Invert Polarity:<br><input type="checkbox"/> VTs F <input type="checkbox"/> CTs F<br><input type="checkbox"/> VT D <input type="checkbox"/> CT E   |                 |                     |            |         |  |          |  |    |      |   |      |      |      |   |      |      |      |   |      |  |       |    |  |
|   |                 |                     |            |         |  |          |  |    |      |   |      |      |      |   |      |      |      |   |      |  |       |    |  |
| Phase <input type="button" value="F"/> Neutral <input type="button" value="N"/> Ground <input type="button" value="E"/> Disp. <input type="button" value="D"/><br><table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th colspan="2">Voltage</th> <th colspan="2">Currents</th> </tr> <tr> <td>FN</td> <td>1 Va</td> <td>F</td> <td>5 Ia</td> </tr> <tr> <td>2 Vb</td> <td>6 Ib</td> <td>E</td> <td>7 Ic</td> </tr> <tr> <td>3 Vc</td> <td>8 IE</td> <td>D</td> <td>4 VD</td> </tr> <tr> <td></td> <td>9 IEP</td> <td>EP</td> <td></td> </tr> </table> |                 |                     |            | Voltage |  | Currents |  | FN | 1 Va | F | 5 Ia | 2 Vb | 6 Ib | E | 7 Ic | 3 Vc | 8 IE | D | 4 VD |  | 9 IEP | EP |  |
| Voltage   |                 | Currents            |            |         |  |          |  |    |      |   |      |      |      |   |      |      |      |   |      |  |       |    |  |
| FN  | 1 Va            | F                   | 5 Ia       |         |  |          |  |    |      |   |      |      |      |   |      |      |      |   |      |  |       |    |  |
| 2 Vb  | 6 Ib            | E                   | 7 Ic       |         |  |          |  |    |      |   |      |      |      |   |      |      |      |   |      |  |       |    |  |
| 3 Vc  | 8 IE            | D                   | 4 VD       |         |  |          |  |    |      |   |      |      |      |   |      |      |      |   |      |  |       |    |  |
|   | 9 IEP           | EP                  |            |         |  |          |  |    |      |   |      |      |      |   |      |      |      |   |      |  |       |    |  |
| <input type="button" value="Default"/> <input type="button" value="Import..."/> <input type="button" value="Export..."/> <input type="button" value="Preferences"/> <input type="button" value="OK"/> <input type="button" value="Cancel"/>   |                 |                     |            |         |  |          |  |    |      |   |      |      |      |   |      |      |      |   |      |  |       |    |  |

**Figure 28**

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## INSTRUMENTOS PARA TESTES ELÉTRICOS

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.

### 4.4 Distance Adjustments

**Note:** The relay will be parameterized differently for phase-to-ground faults compared to two-phase and three-phase faults. For the software to perform the test properly, 8 types of zones must be inserted, the first four for two-phase and three-phase faults and the last four for phase-to-ground faults.

### 4.5 Distance Screen > Adjust Prot. Distance

The first step is to adjust the ground compensation factor.

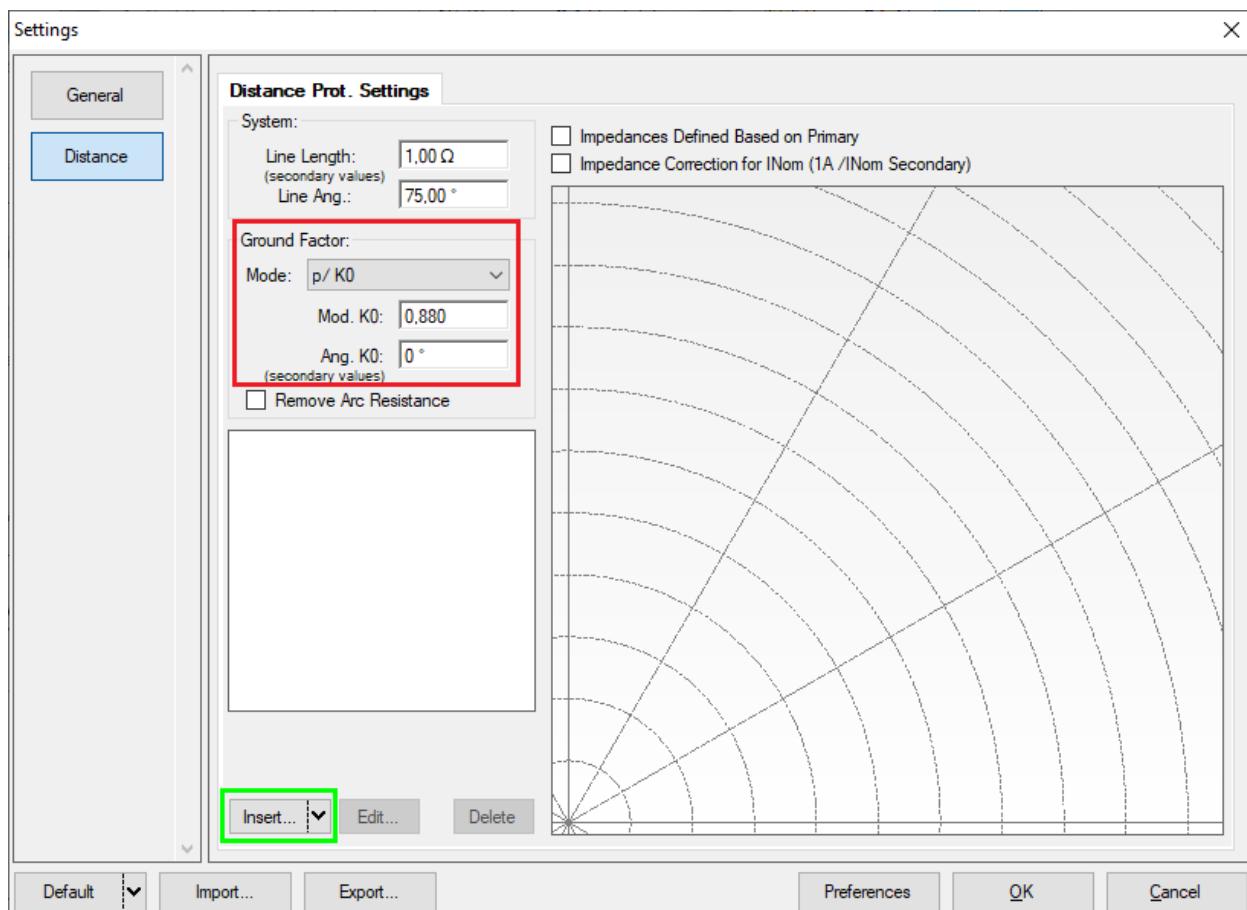
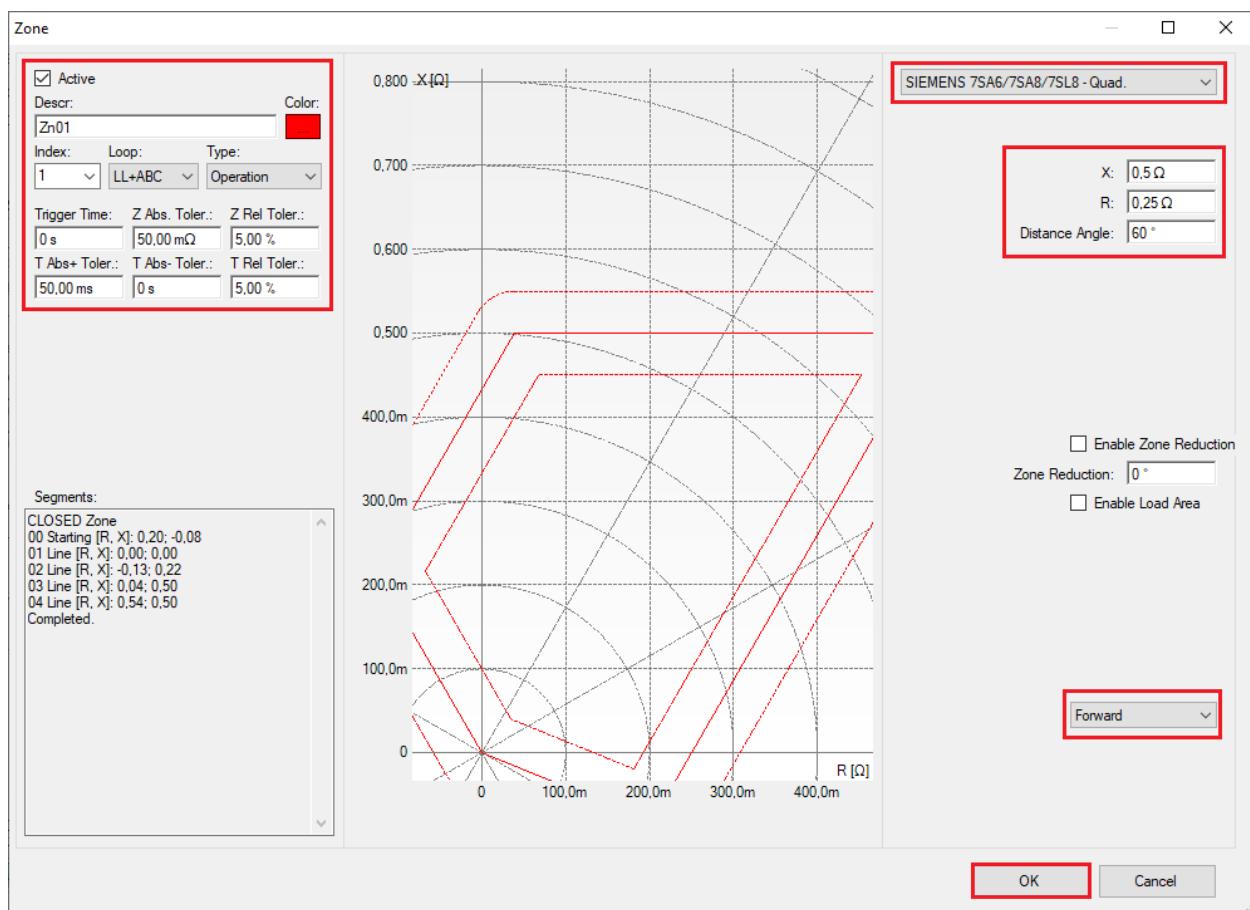


Figure 29

## INSTRUMENTOS PARA TESTES ELÉTRICOS

### 4.6 Inserting Phase Zones

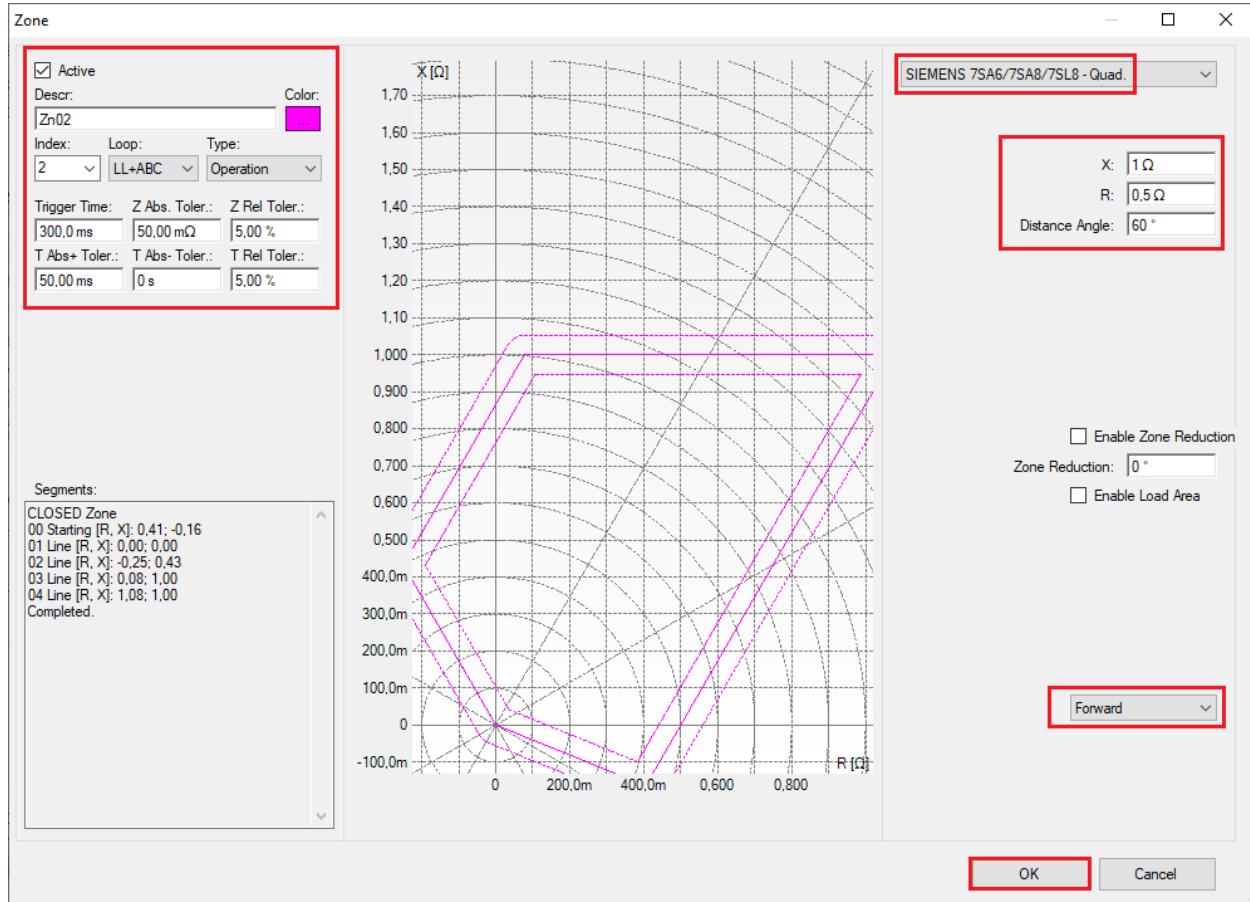
The first zone to be entered will be zone-1 (LL+ABC). Click on the “Insert” field highlighted in green in the previous figure. In the settings screen, first select the relay mask “SIEMENS 7SA6/7SA8/7SL8 - Quad.”. You must adjust the actuation time, choose the type of fault (loop) enter the zone characteristics and directionality. Adjust the tolerance values and finally click on “OK”.



**Figure 30**

Clicking “Insert” again adjusts the values for zone 2.

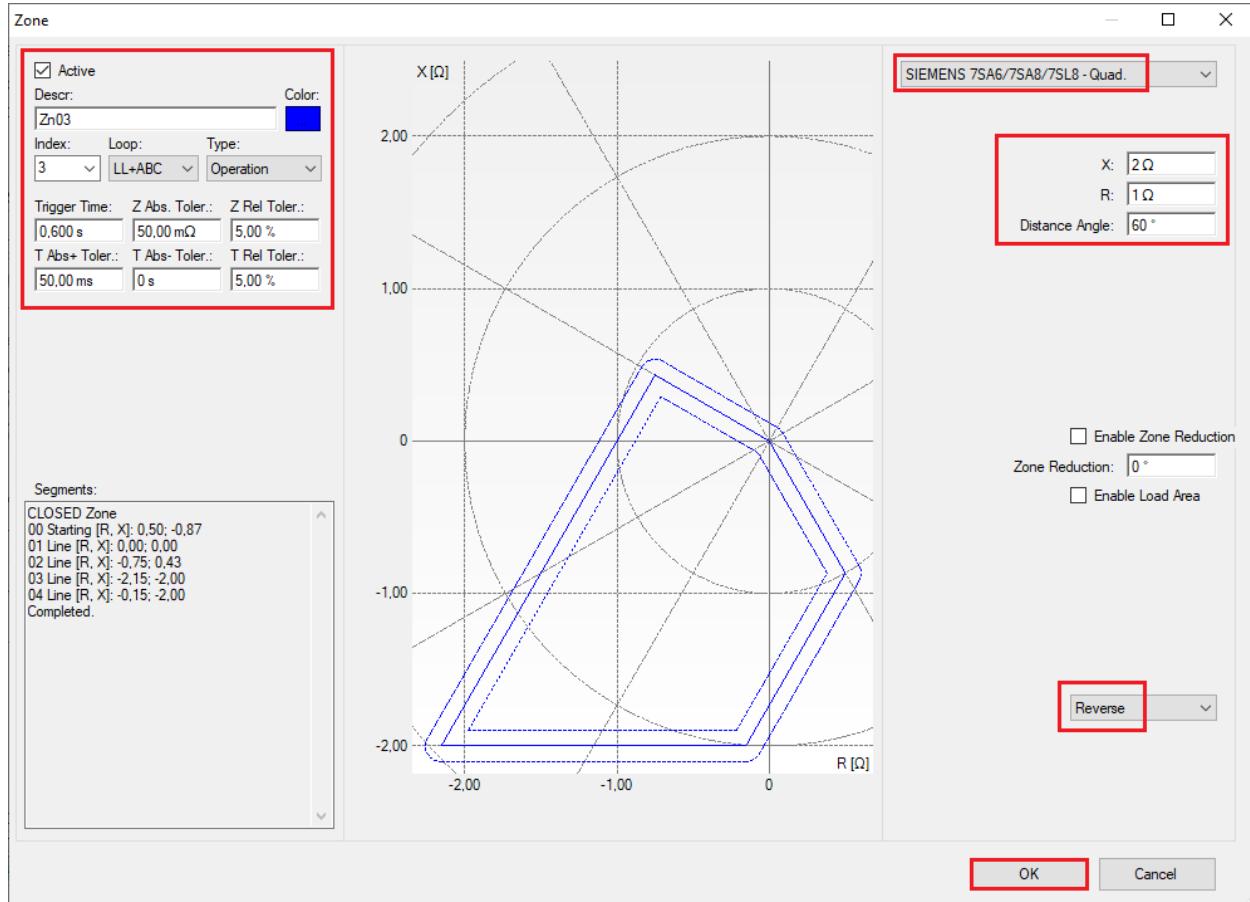
## INSTRUMENTOS PARA TESTES ELÉTRICOS



**Figure 31**

By clicking on “Insert” the values for zone 3 are adjusted.

## INSTRUMENTOS PARA TESTES ELÉTRICOS



**Figure 32**

By clicking on “Insert” the values for zone 4 are adjusted.

## INSTRUMENTOS PARA TESTES ELÉTRICOS

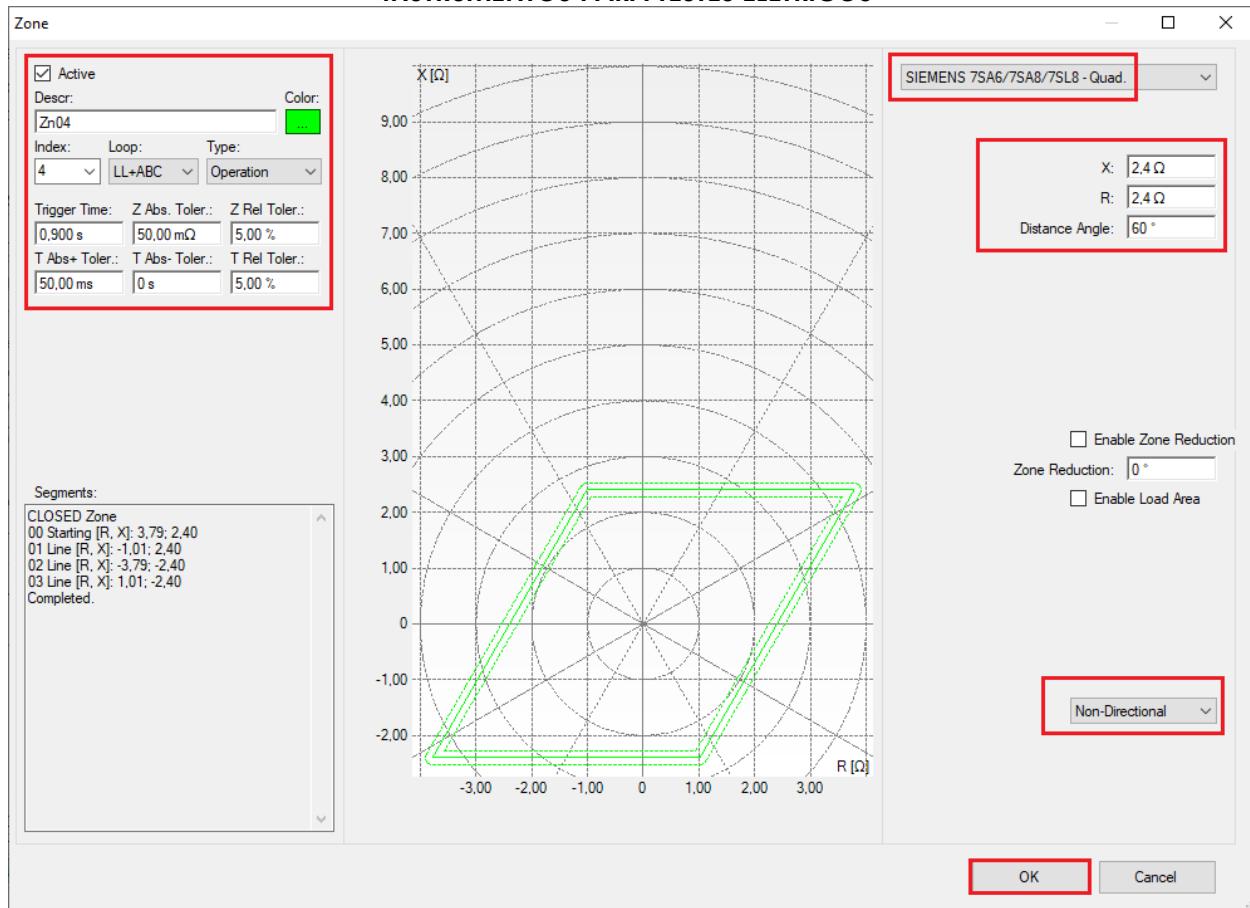


Figure 33

### 4.7 Inserting the Zones (Line-Earth)

The first FT zone to be entered will be zone-5 (LE). Change the name of zone 5 to “Zn01\_LE”. Click on the “Insert” field highlighted in green in the Figure 29. In the settings screen, first select the relay mask “SIEMENS 7SA6/7SA8/7SL8 - Quad.”.

## INSTRUMENTOS PARA TESTES ELÉTRICOS

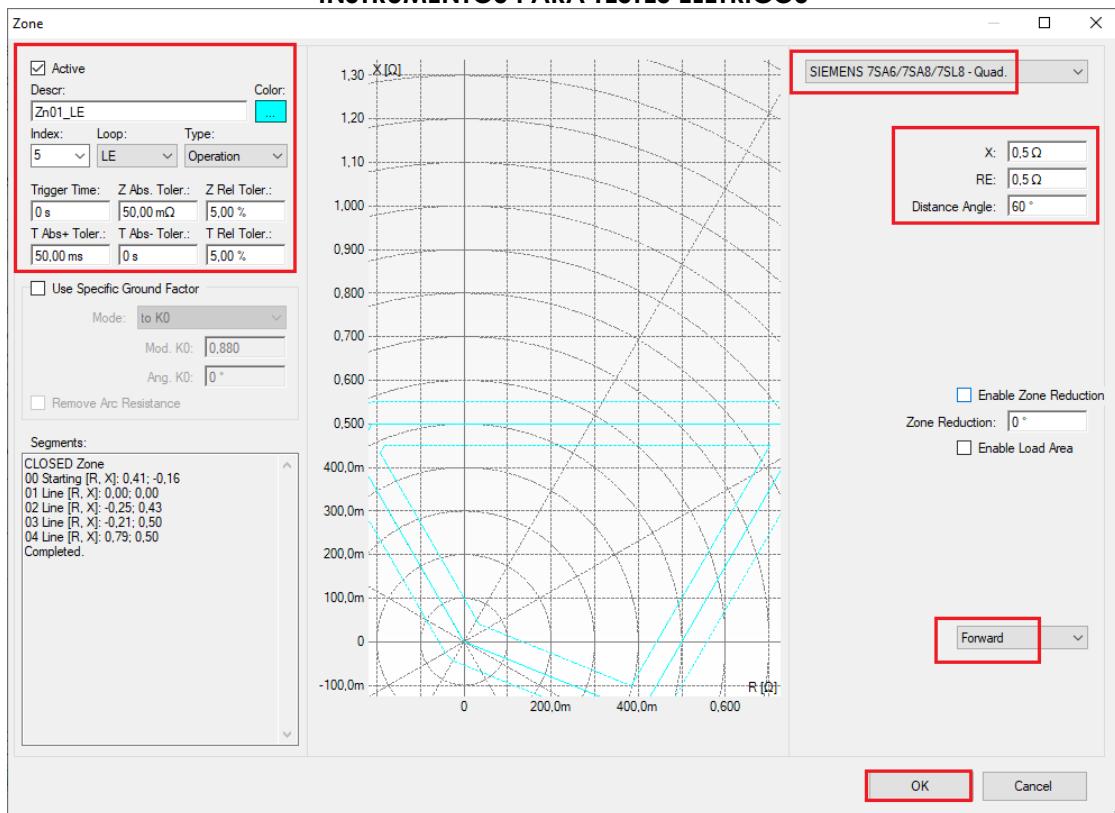


Figure 34

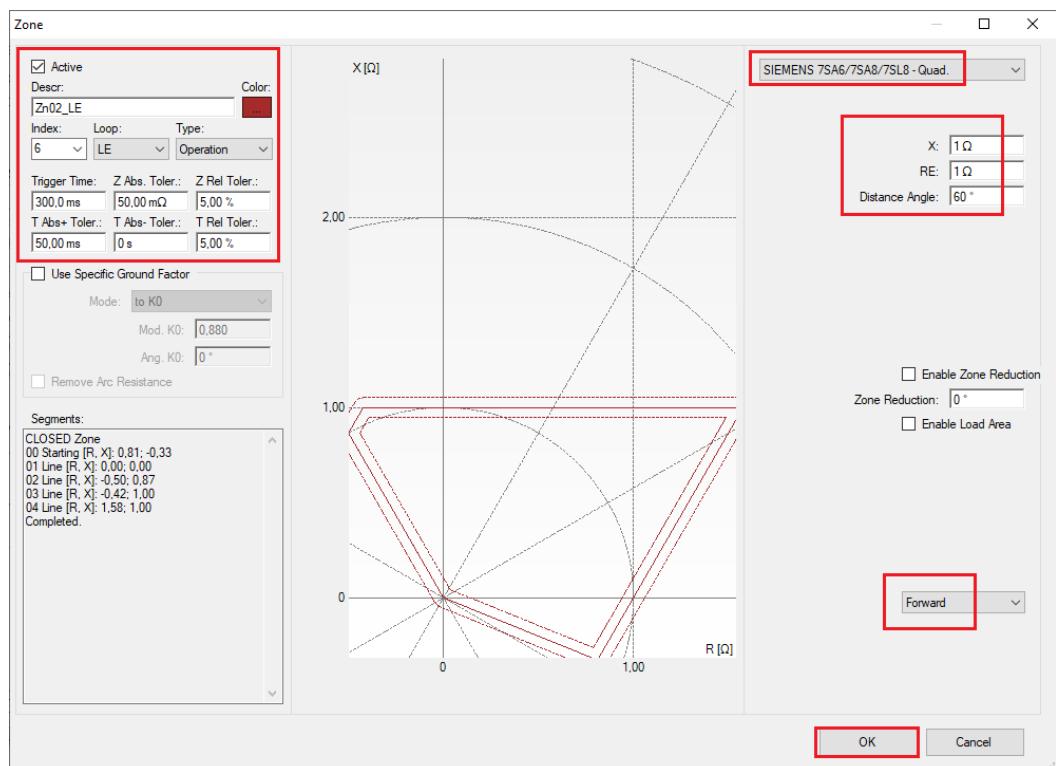


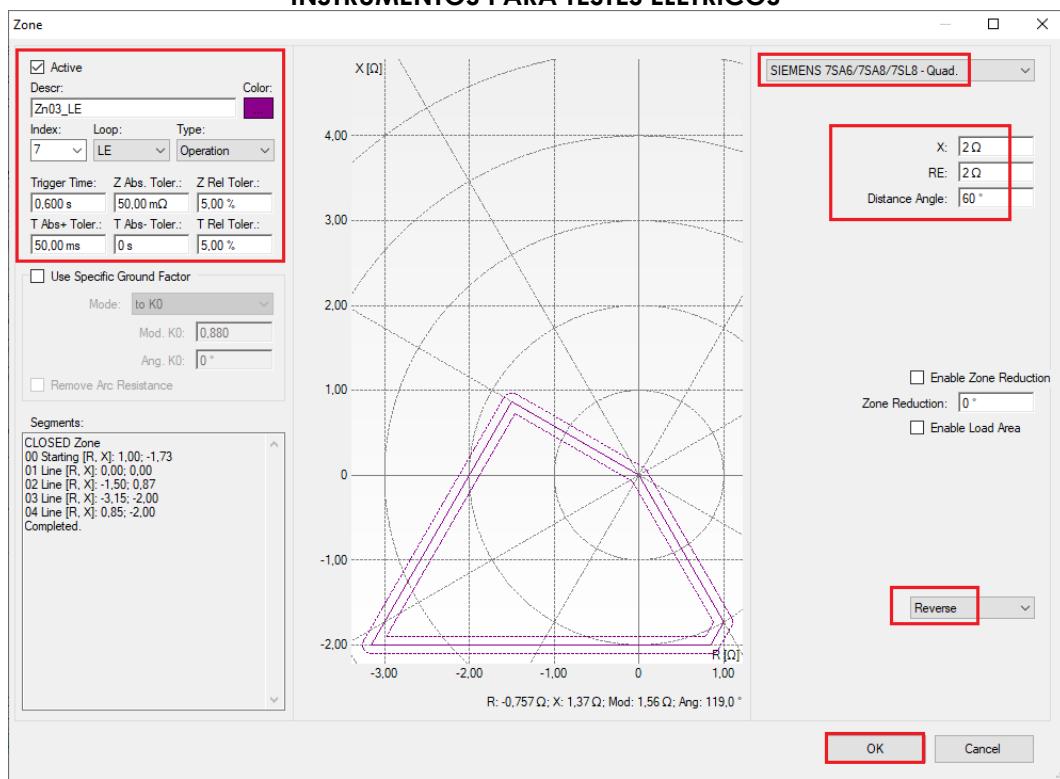
Figure 35

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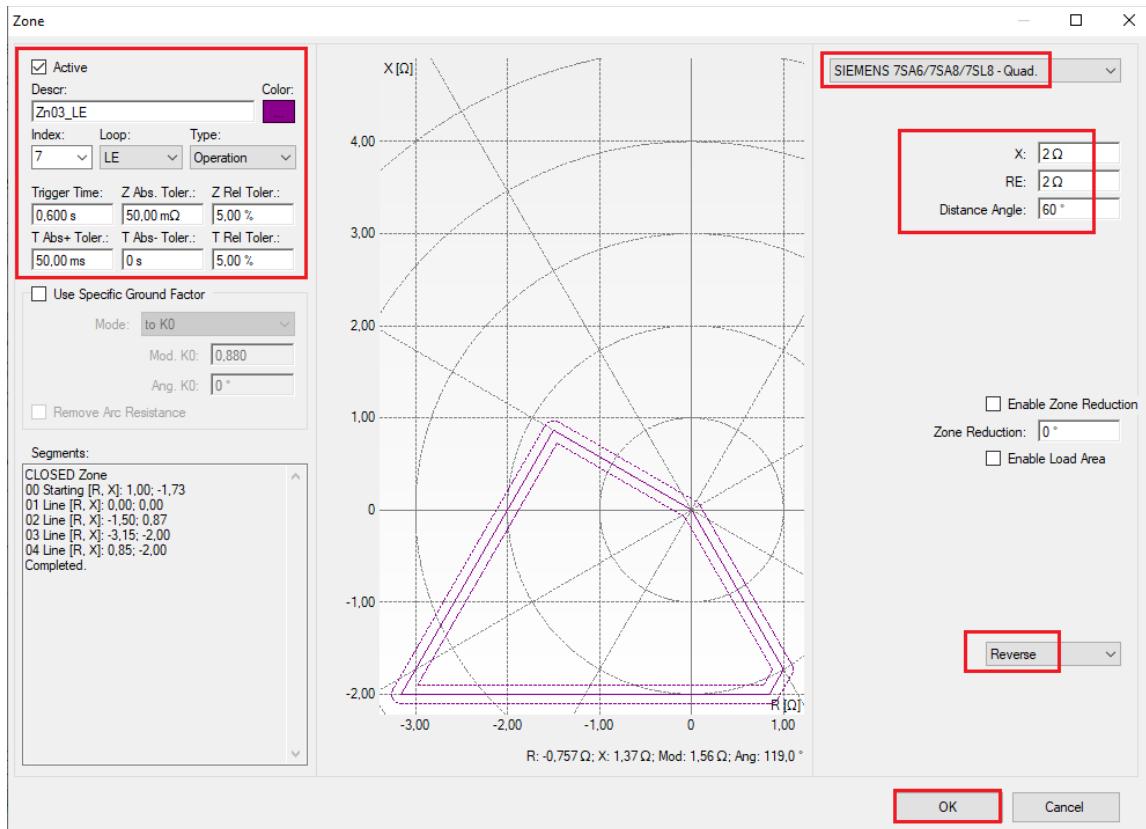
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**Figure 36**



**Figure 37**

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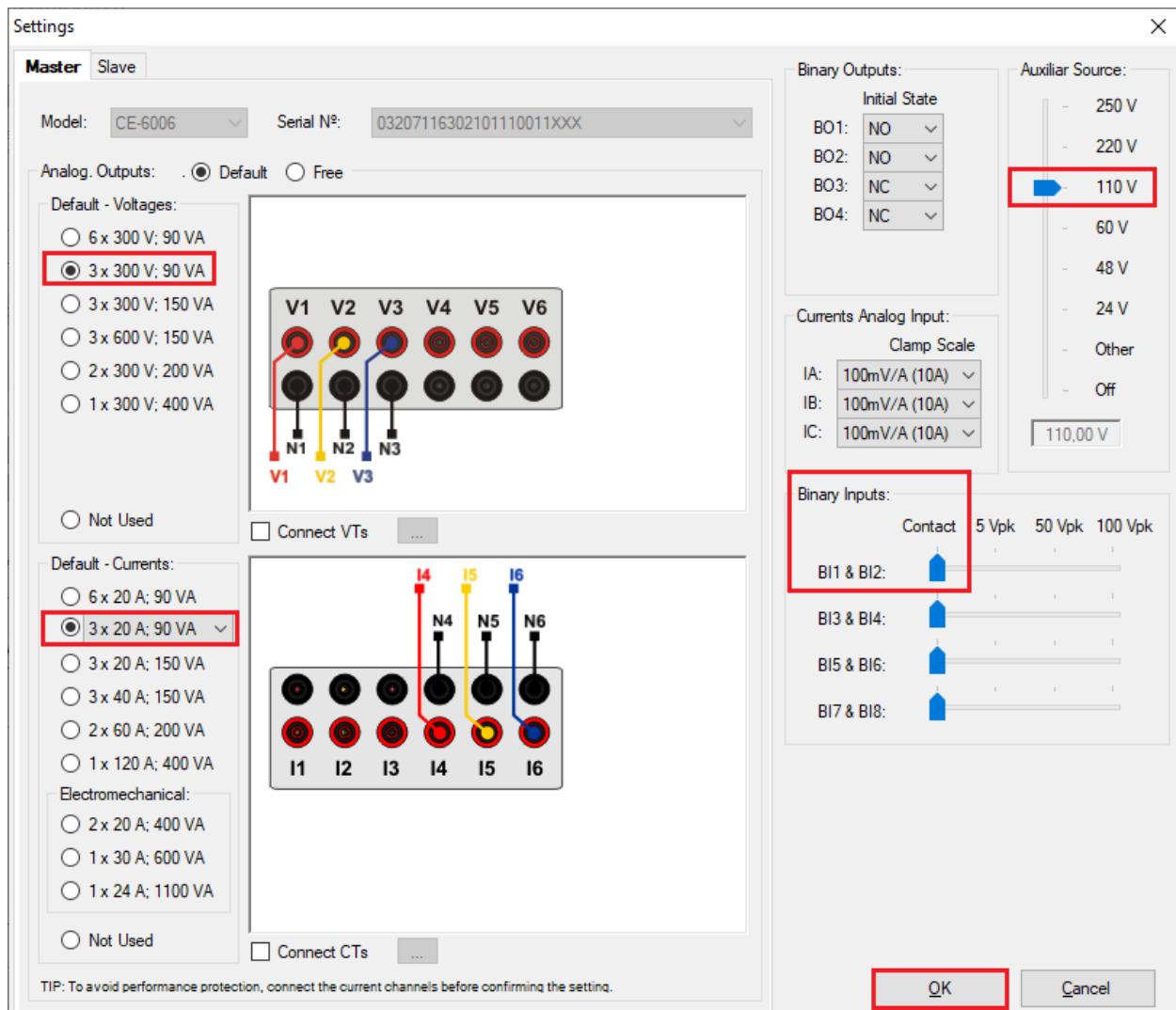
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### 5. Hardware Settings

In the “Home” menu click on the “Hrd Config” button to configure the power supply, stipulate the configuration of the generation channels and the stopping method of the input binaries.



**Figure 38**

### 6. Channels Direct

After performing the hardware configuration, click on the highlighted icon to automatically associate the created channels with the nodes. Choose the “Basic” option for this.

## INSTRUMENTOS PARA TESTES ELÉTRICOS

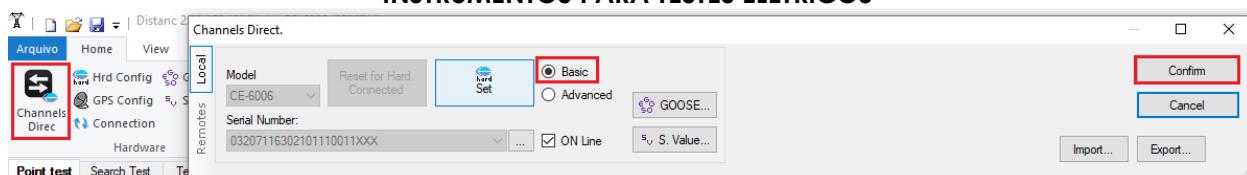


Figure 39

### 7. Restore Layout

Due to the great flexibility that the software presents allowing the user to choose which windows are displayed and in which position, the *Restore Layout* command is used to restore the default settings. Click on the “*Layout*” button and then on “*Recreate Charts*” repeat the process by clicking on “*Layout*” and “*Restore Layout*”. During the test, windows that are not relevant are excluded.

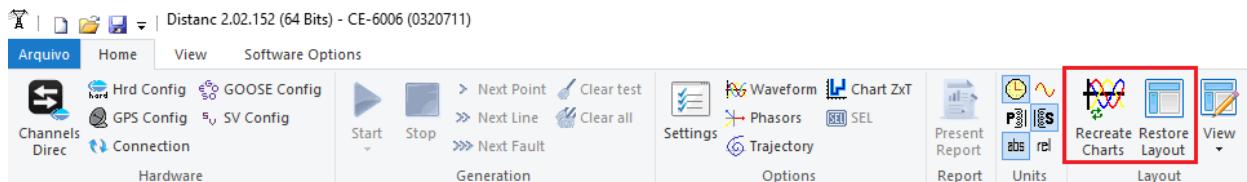


Figure 40

### 8. Function 21 test structure

#### 8.1 Test Settings

By clicking on the Test Settings tab set the test mode to “*Intelligent*” and use binary input 1 for stop interface. Insert a pre-fault with nominal voltage and current equal to zero.

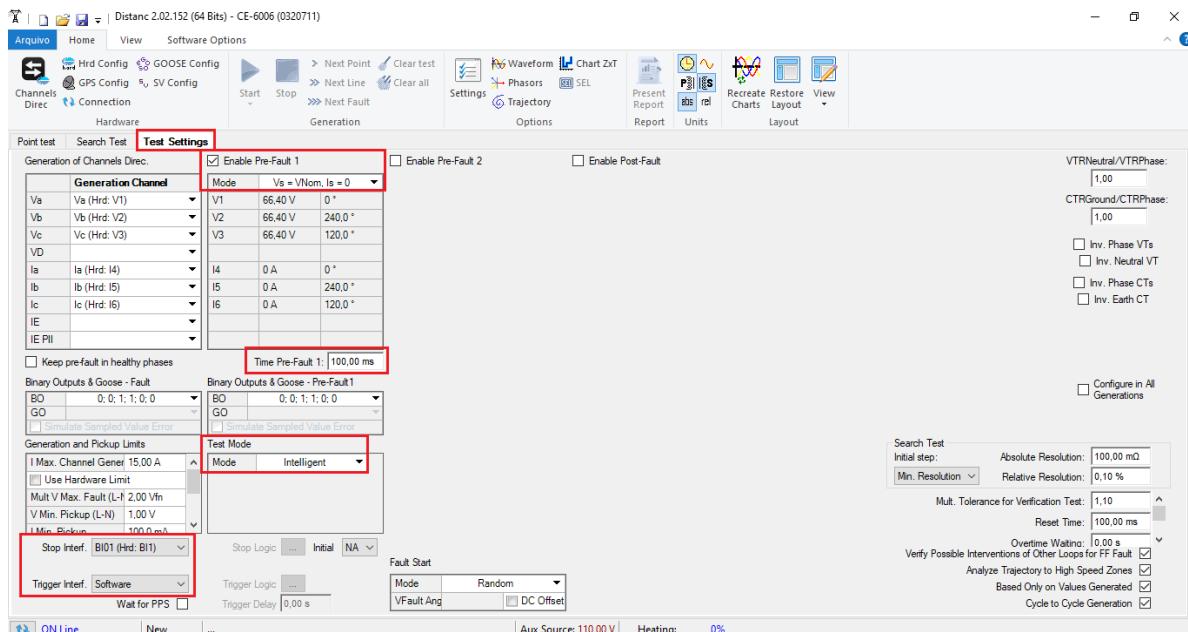


Figure 41

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## 8.2 Point Test for Zones 1,2,3 and 4

### 8.2.1 Two-Phase and Three-Phase Loop

Click on the “Point Test” tab and then “Sequence” and choose the types of faults, in this case only three-phase and two-phase faults, that is, ABC, AB, BC and CA.

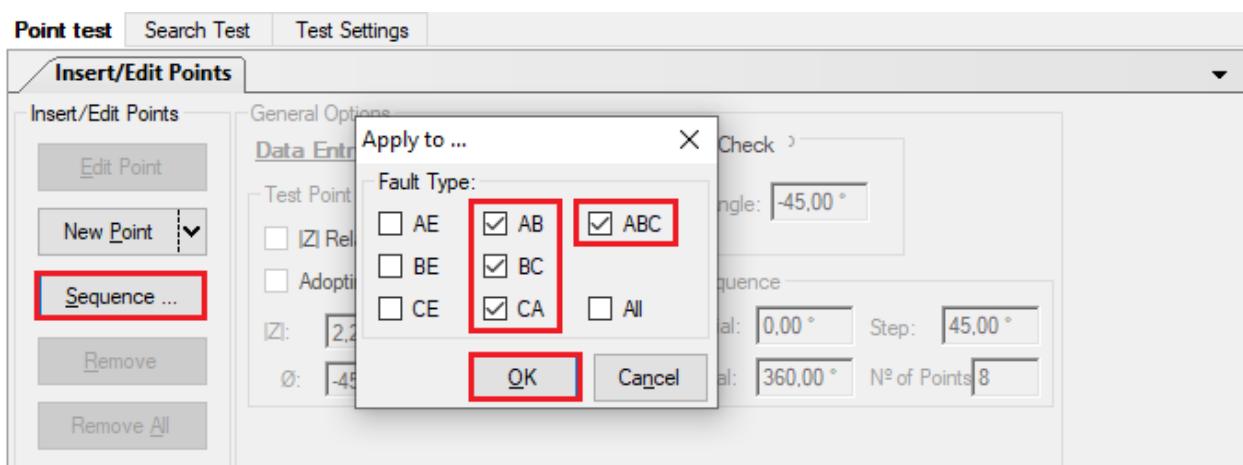


Figure 42

Choose a starting angle, ending angle and pitch. In this way the points are determined automatically.

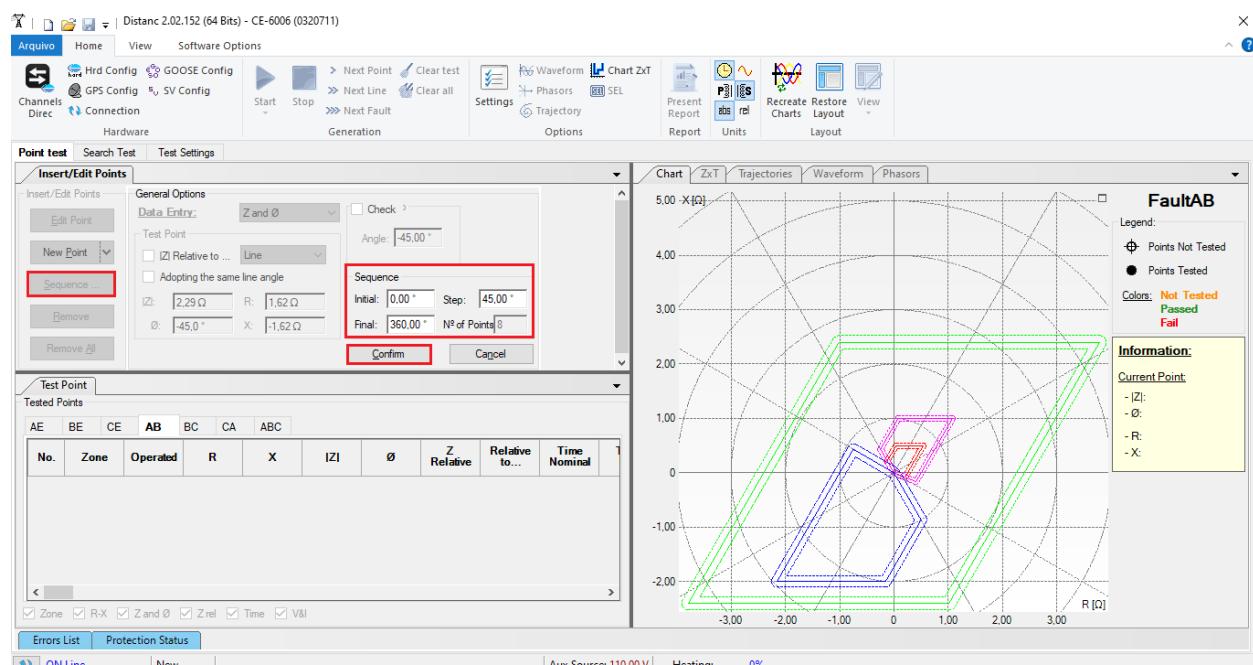


Figure 43

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By clicking on the “*Confirm*” button the following points are created.

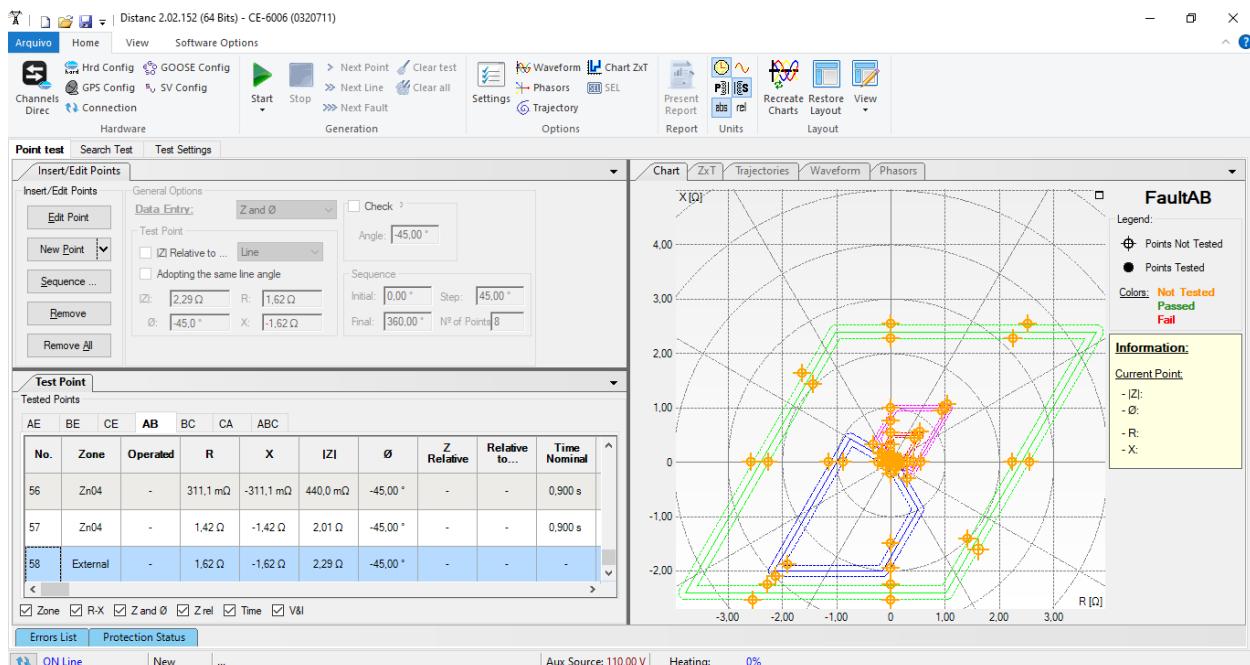


Figure 44

Start the generation by clicking on the icon highlighted below or through the shortcut “*Alt + G*”.

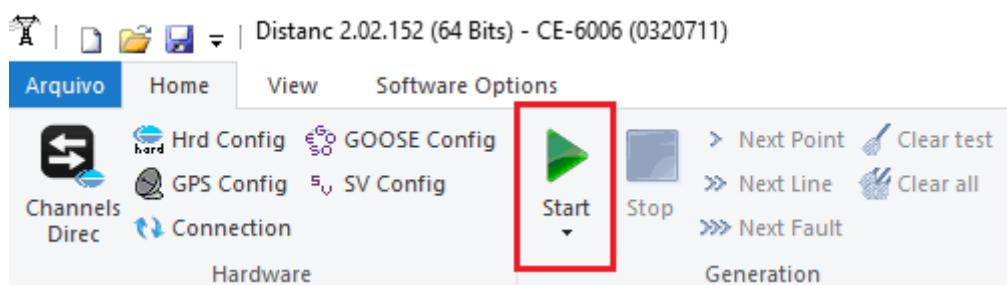


Figure 45

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.

### 8.2.2 Final Result A-B-C faults

By clicking on the “ABC” tab, the final result is verified. Note that all points are within the tolerances given by the manufacturer so that the test is approved.

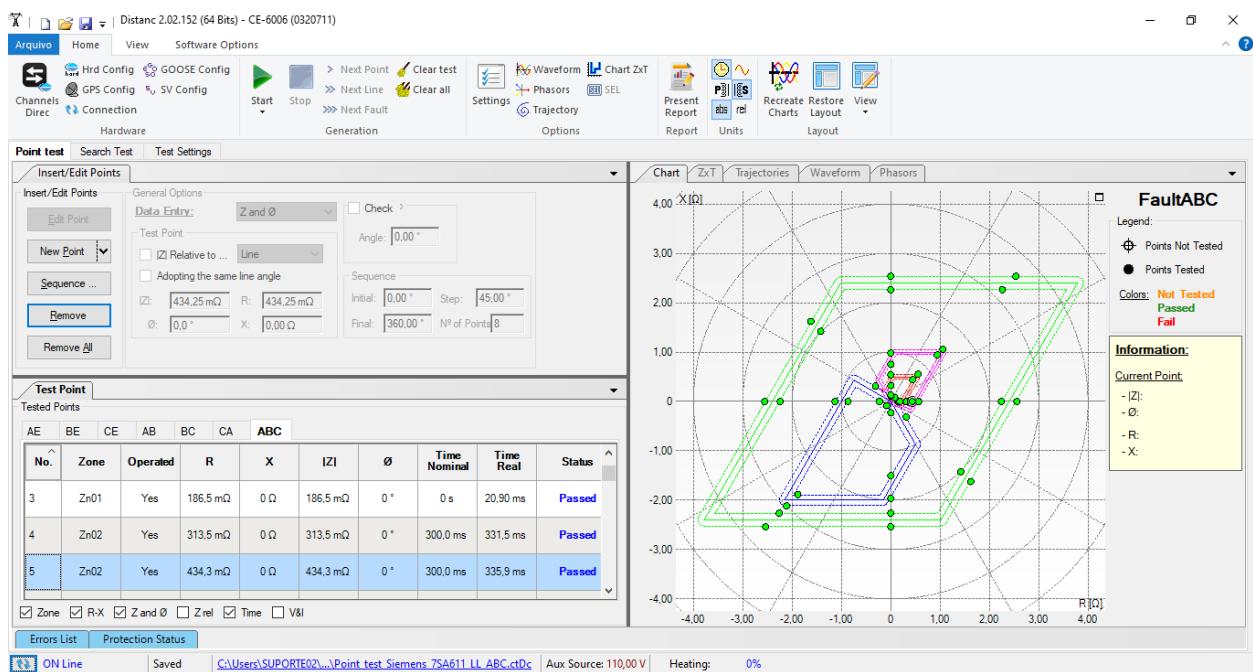


Figure 46

### 8.2.3 Single-phase Loop

Click on the “Point Test” tab and then “Sequence” and choose the fault types, in this case only single-phase faults, that is, AE, BE and CE.

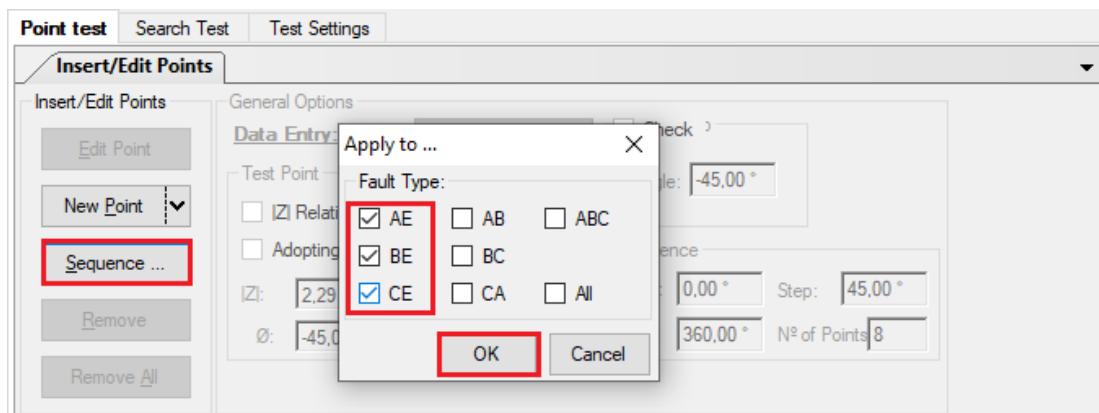


Figure 47

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## INSTRUMENTOS PARA TESTES ELÉTRICOS

Choose a starting angle, ending angle and pitch. In this way the points are determined automatically.

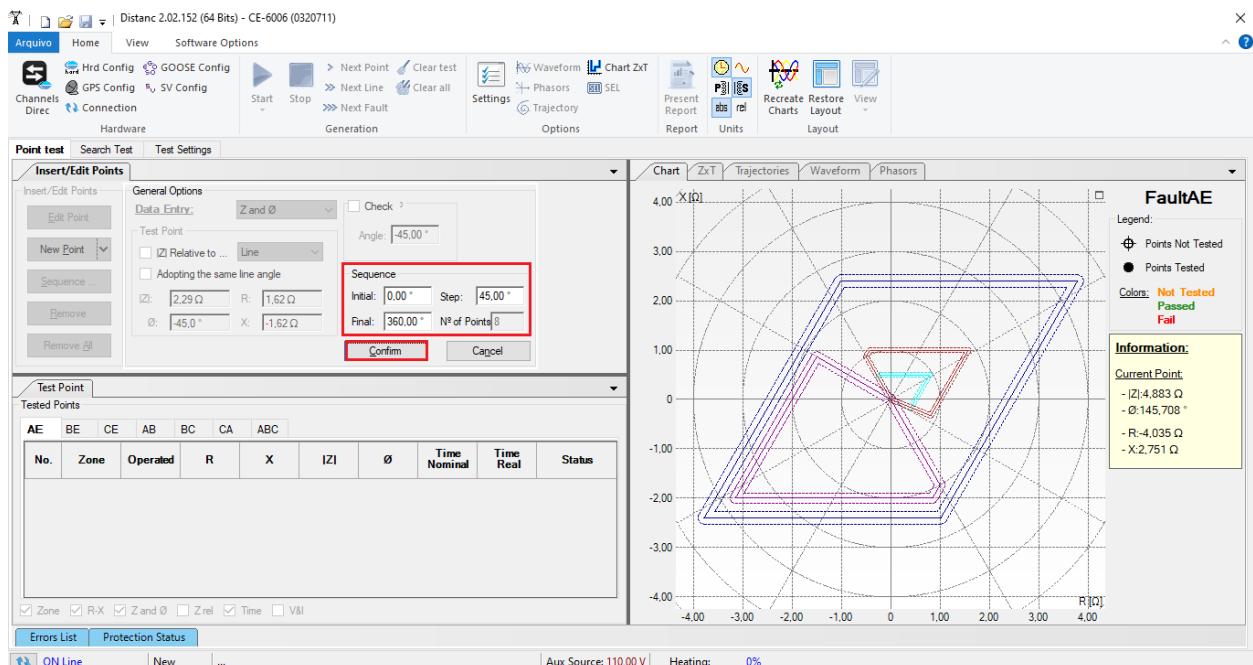


Figure 48

By clicking on the “*Confirm*” button the following points are created.

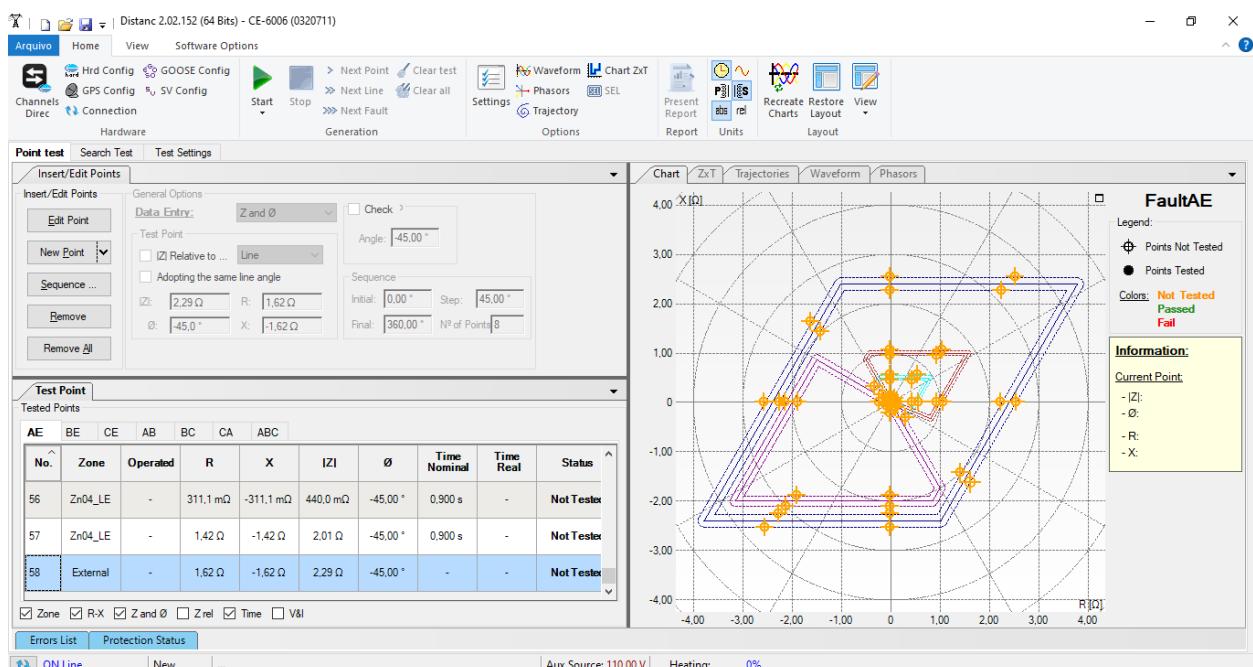


Figure 49

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Start the generation by clicking on the icon highlighted below or through the shortcut “*Alt + G*”.

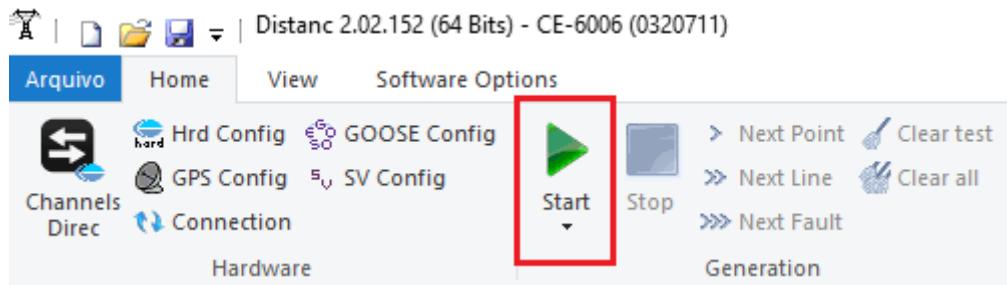


Figure 50

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.

### 8.2.4 Final Result AE Fault

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.

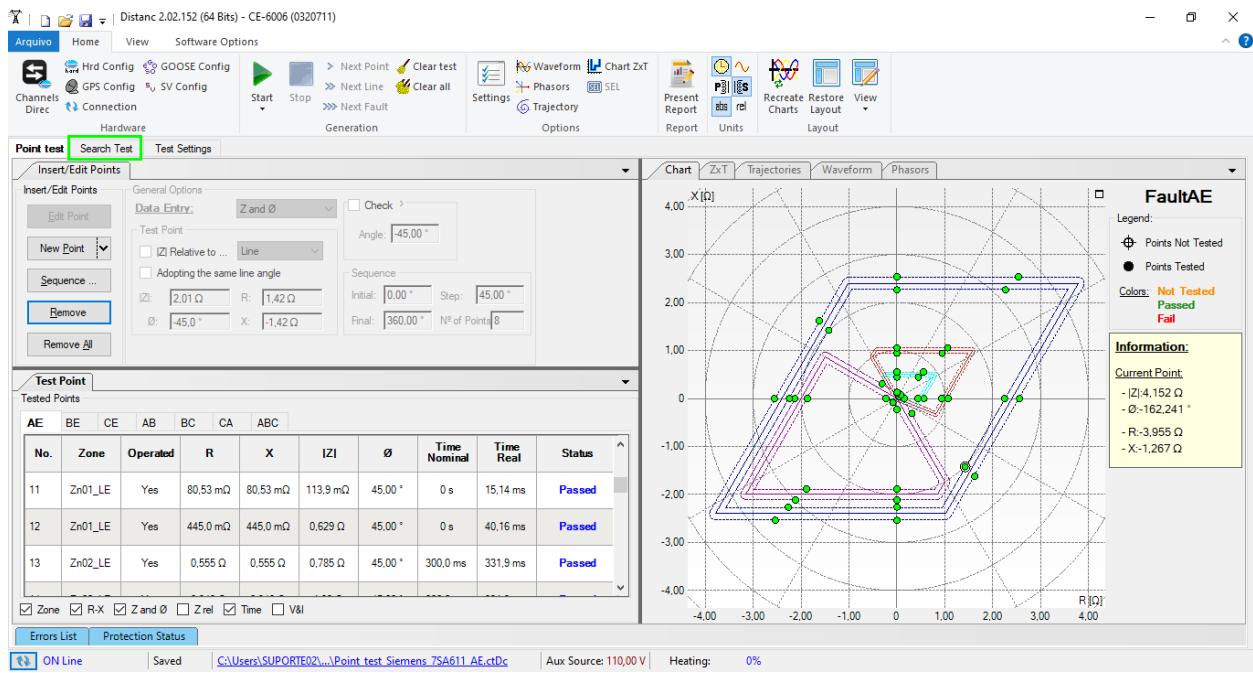


Figure 51

## INSTRUMENTOS PARA TESTES ELÉTRICOS

### 8.3 Search Test for Zones 1,2,3 and 4

#### 8.3.1 Two-Phase and Three-Phase Loop

Click on the “Search Test” tab highlighted in green 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 and two-phase faults, or ABC, AB, BC and CA.

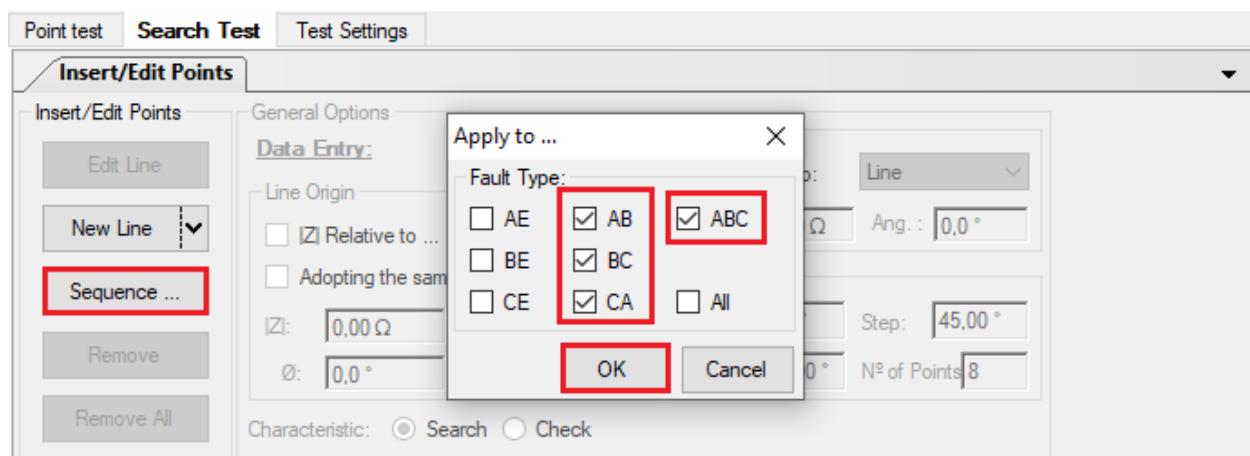


Figure 52

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

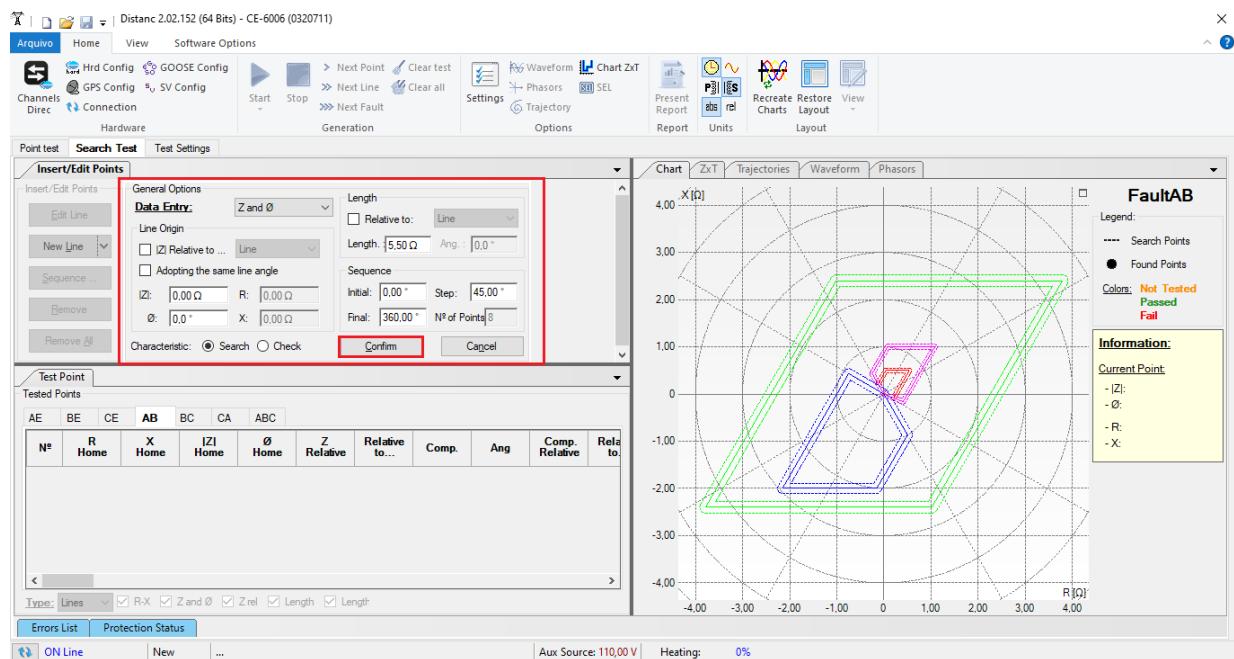


Figure 53

By clicking on the “Confirm” button the following search lines are created.

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## INSTRUMENTOS PARA TESTES ELÉTRICOS

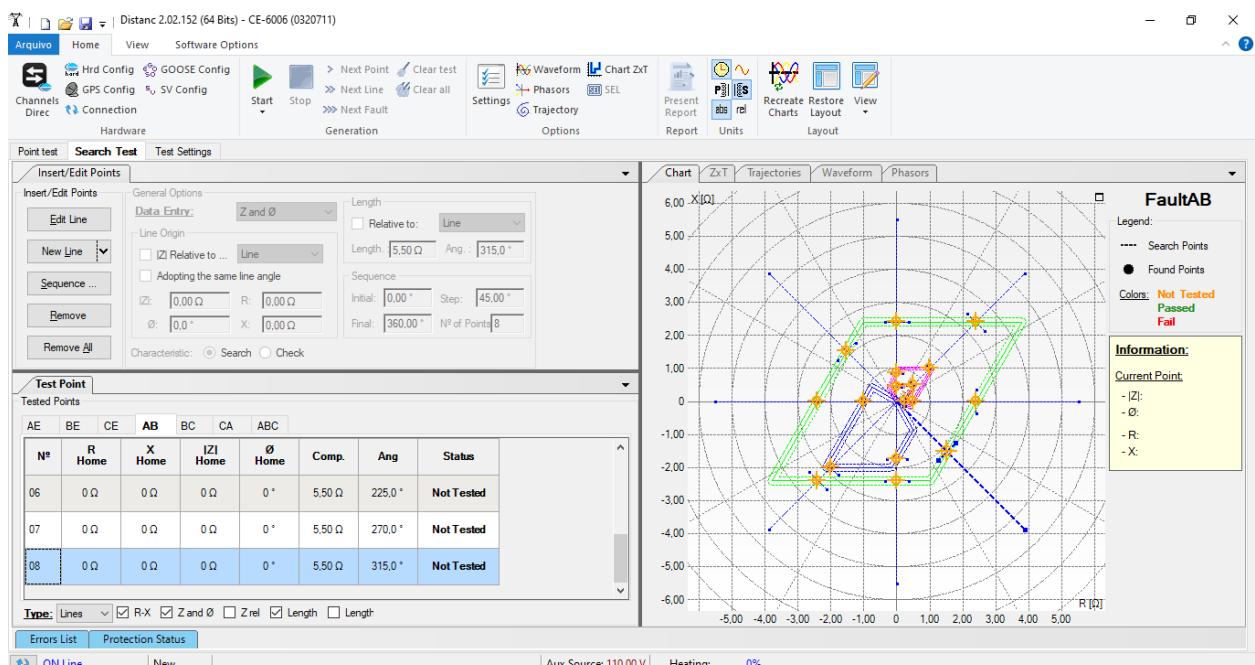


Figure 54

Start the generation by clicking on the icon highlighted below or through the shortcut “Alt + G”.

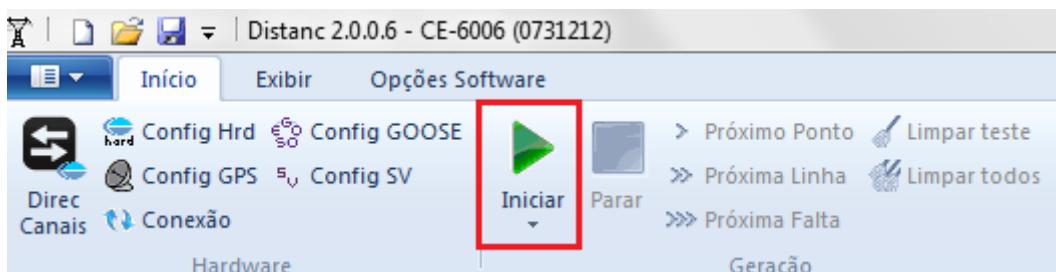


Figure 55

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.

### 8.3.2 Final Result A-B-C Fault

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.

## INSTRUMENTOS PARA TESTES ELÉTRICOS

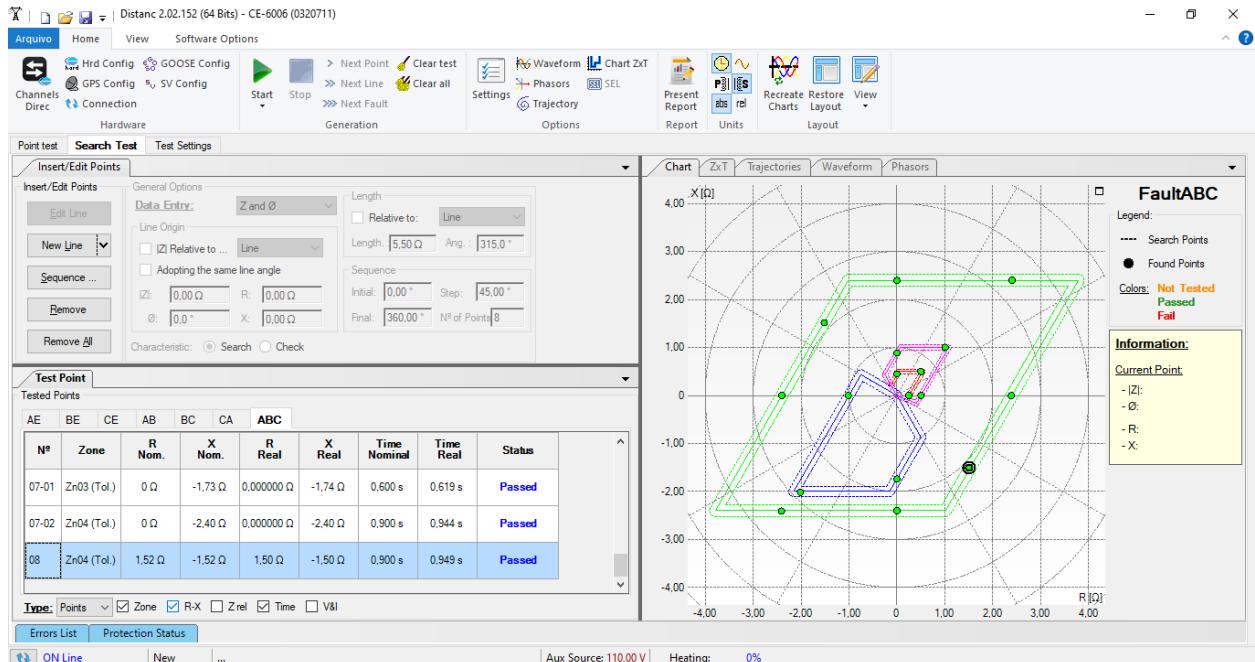


Figure 56

### 8.3.3 Single-phase Loop

Click on the “Point Test” tab and then “Sequence” chooses the fault types in this case only single-phase faults, or AE, BE and CE.

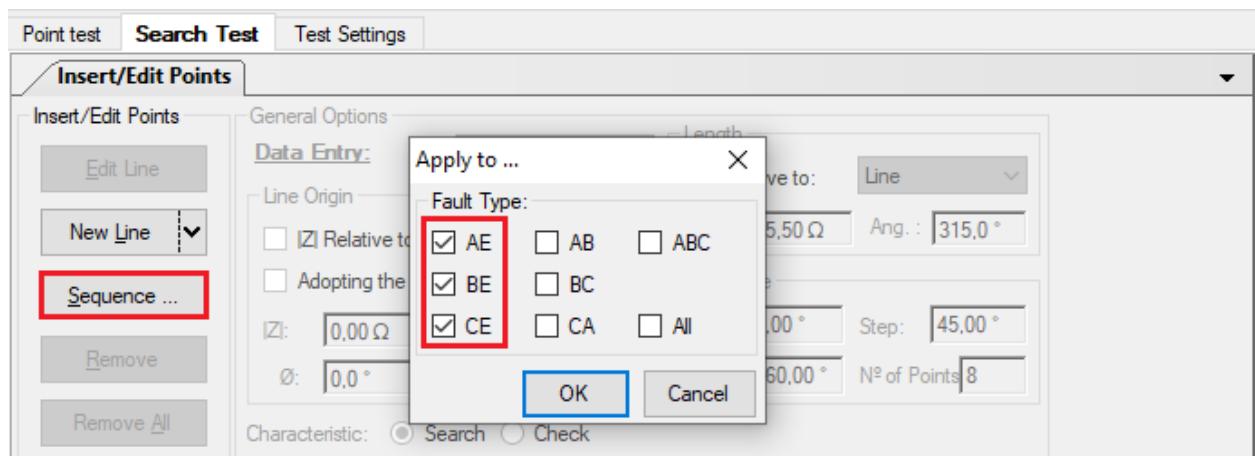


Figure 57

Choose a initial angle, final angle and step. In this way the points are determined automatically.

## INSTRUMENTOS PARA TESTES ELÉTRICOS

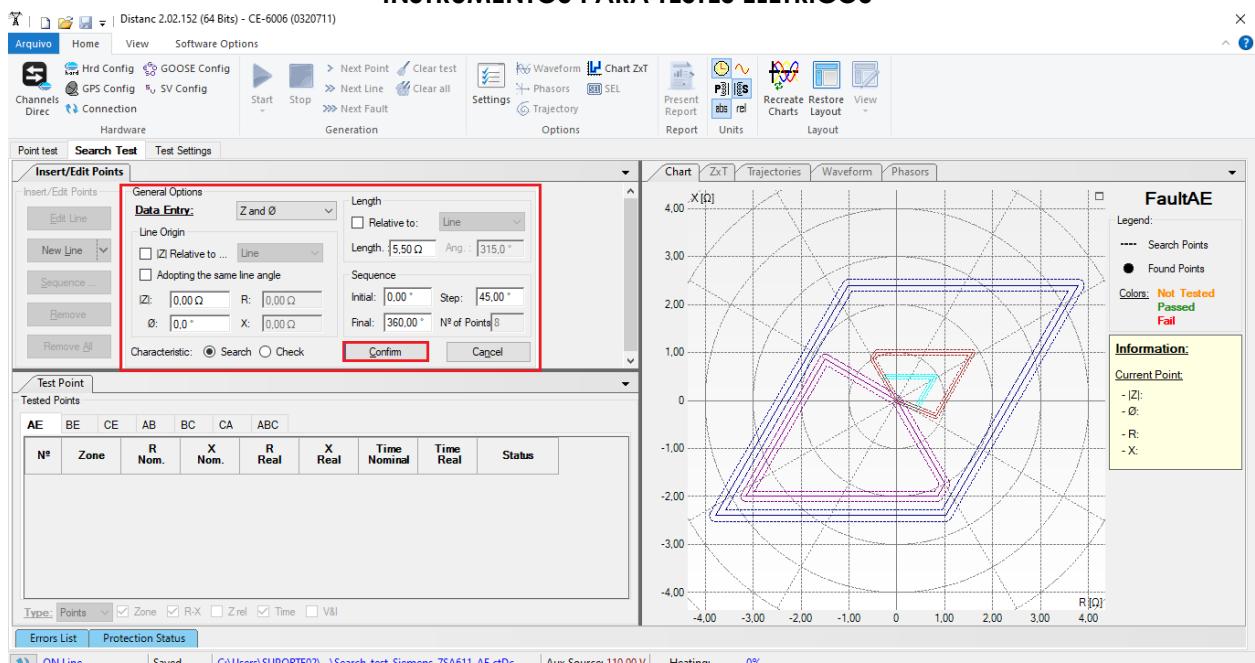


Figure 58

By clicking on the “Confirm” button the following lines are created.

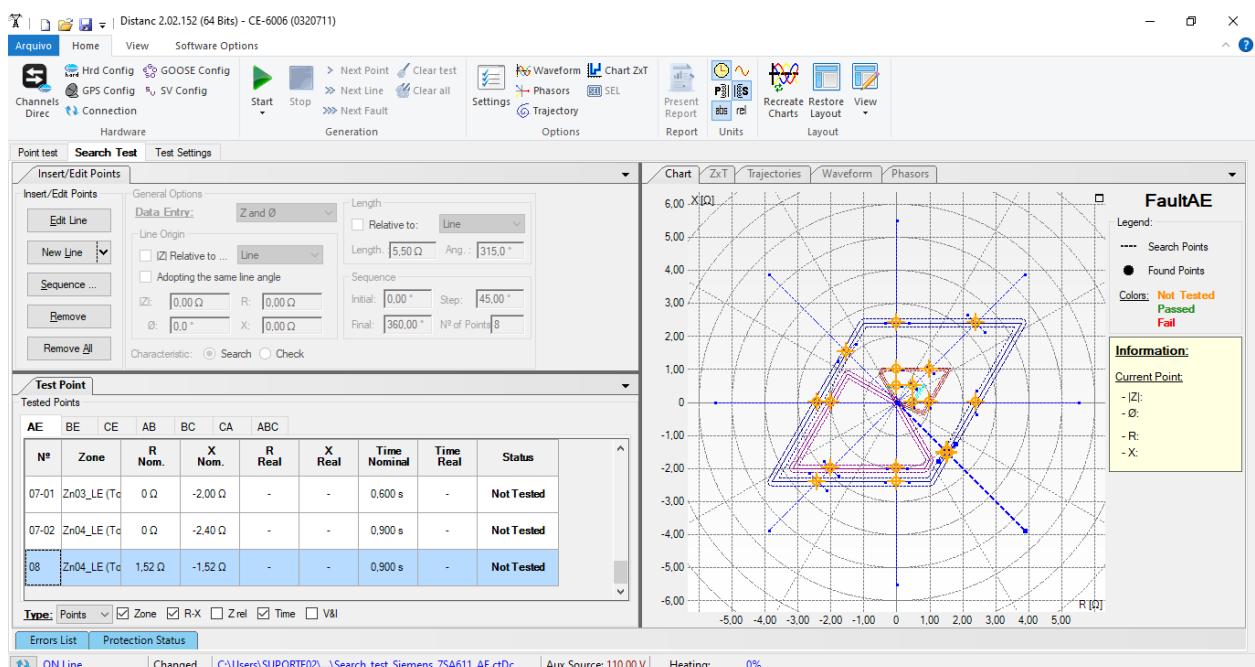


Figure 59

Start the generation by clicking on the icon highlighted below or through the shortcut “Alt + G”.

## INSTRUMENTOS PARA TESTES ELÉTRICOS

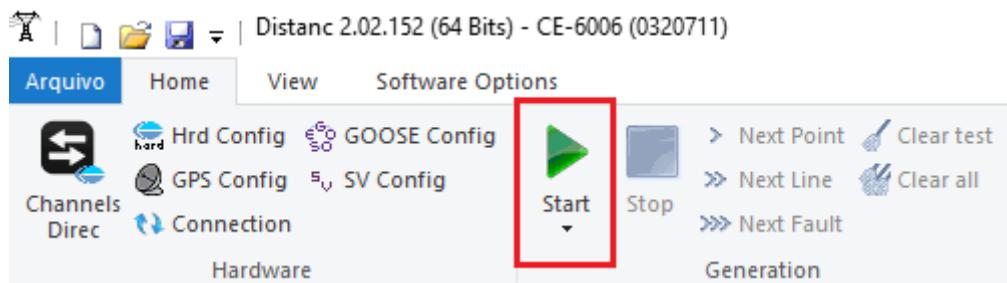


Figure 60

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.

### 8.3.4 Final Result AE Fault

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.

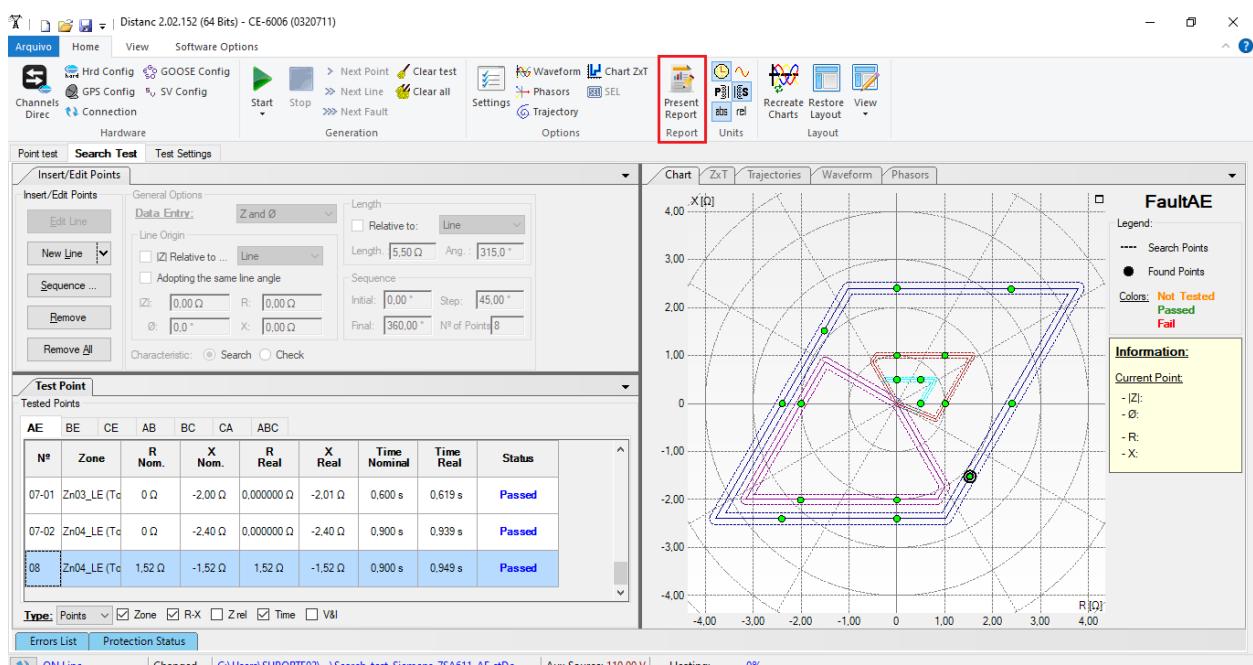


Figure 61

## 9. Report

After finishing the test, click on the icon highlighted in the previous figure 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.



## INSTRUMENTOS PARA TESTES ELÉTRICOS

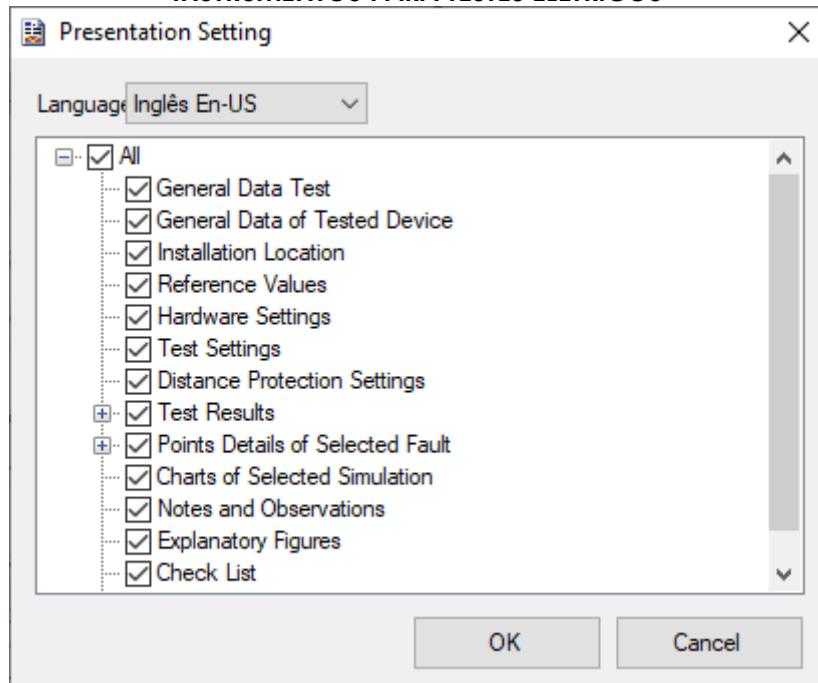


Figure 62

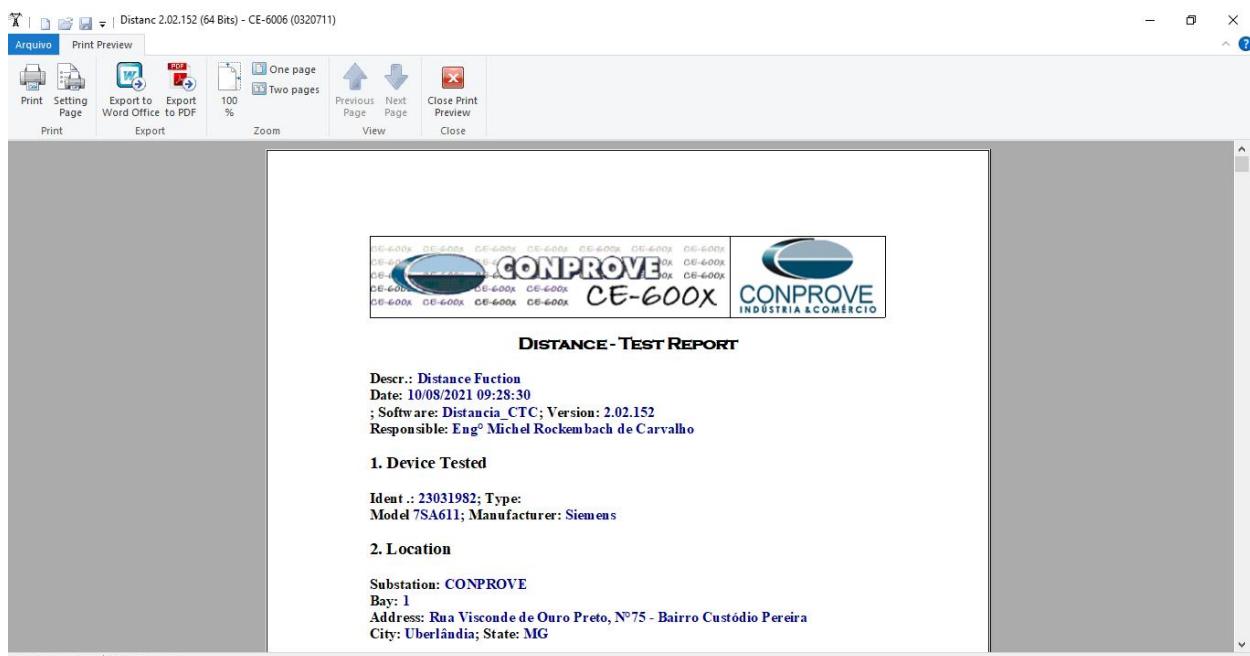
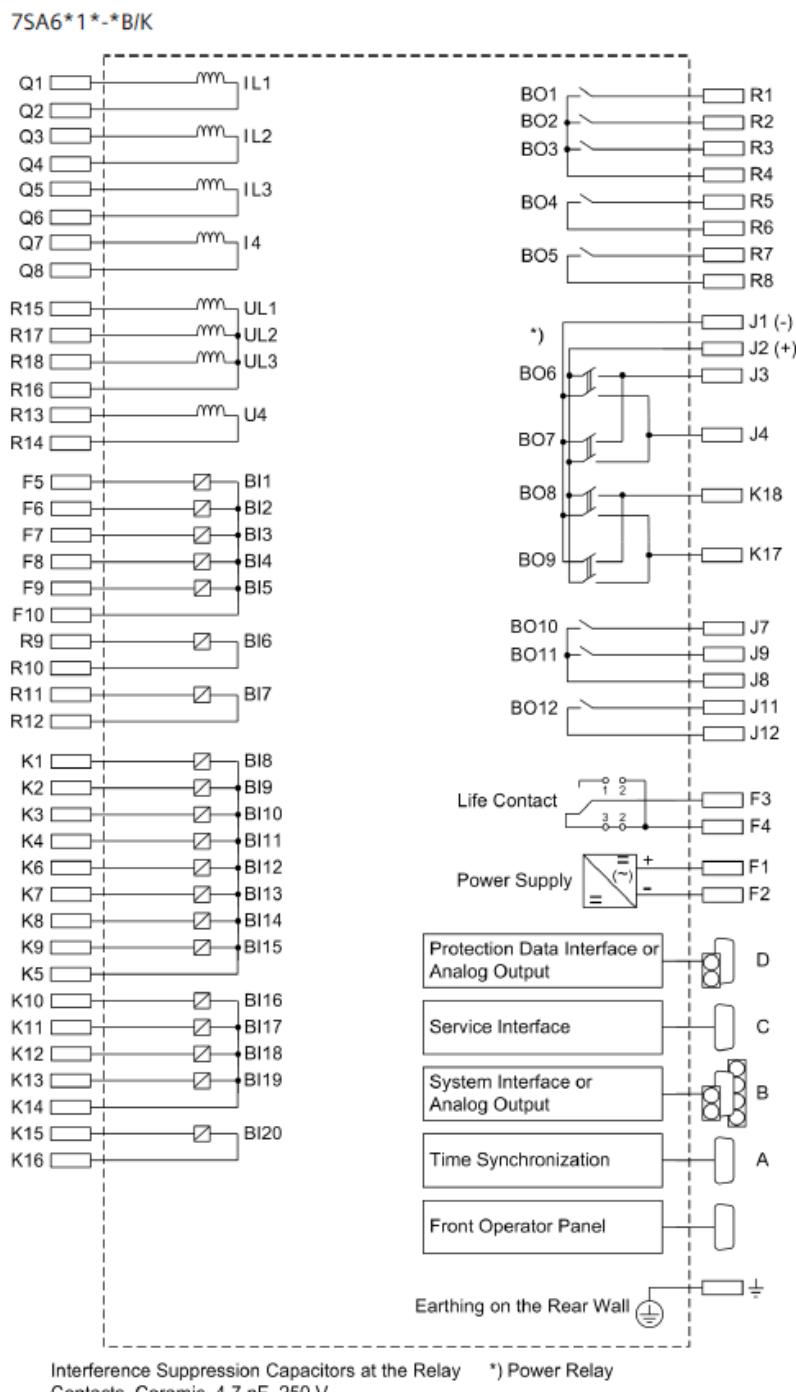


Figure 63

## INSTRUMENTOS PARA TESTES ELÉTRICOS

### APPENDIX A

#### A.1 Terminal Designations



[schrankeinbau-7sa6-1-b-k-oz-050802, 1, en\_GB]  
**Figure B-4** General diagram for 7SA6\*1\*-B/K (panel flush mounting or cubicle mounting)

**Figure 64**

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## INSTRUMENTOS PARA TESTES ELÉTRICOS

### A.2 Technical Data

**Table 1**

|  |                 |   |                    |  |  |
|--|-----------------|---|--------------------|--|--|
| $\alpha$ = Threshold angle for the increased resistance tolerance                                | 10° to 90°      |   | Increments 1°      |  |  |
| <b>Determination of Direction</b>  |                 |   |                    |  |  |
| For all types of faults  |                 | With phase-true, memorized or cross-polarized voltages  |                    |  |  |
| Directional sensitivity  |                 | Dynamically unlimited<br>Stationary approx. 1 V   |                    |  |  |
| Each zone can be set to operate in forward or reverse direction, non-directional or ineffective. |                 |   |                    |  |  |
| <b>Load trapezoid:</b>   |                 |   |                    |  |  |
| $R_{load}$ = minimum load resistance   | for $I_N = 1$ A | 0.100 Ω to 600.000 Ω; ∞   | Increments 0.001 Ω |  |  |
|  | for $I_N = 5$ A | 0.020 Ω to 120.000 Ω; ∞   |                    |  |  |
| $\Phi_{load}$ = maximum load angle   |                 | 20° to 60°  | Increments 1°      |  |  |
| <b>Dropout to pickup ratio</b>   |                 |   |                    |  |  |
| - Currents   | Approx. 0.95    |   |                    |  |  |
| - Impedances   | Approx. 1.06    |   |                    |  |  |
| <b>Measured value correction</b>   |                 | Mutual impedance matching for parallel lines (ordering option)  |                    |  |  |
| Measuring tolerances for sinusoidal measured values  |                 | $\left  \frac{\Delta X}{X} \right  \leq 5 \% \quad \text{for } 30^\circ \leq \varphi_k \leq 90^\circ$ $\left  \frac{\Delta R}{R} \right  \leq 5 \% \quad \text{for } 0^\circ \leq \varphi_k \leq 60^\circ$ $\left  \frac{\Delta Z}{Z} \right  \leq 5 \% \quad \text{for } 0^\circ \leq \varphi_k \leq 90^\circ$ |                    |  |  |

**Table 2**

#### Times

|   |   |                   |
|---|---|-------------------|
| Shortest trip time  | Approx. 17 ms (50 Hz) /15 ms (60 Hz) with fast relay and<br>Approx. 12 ms (50 Hz) /10 ms (60 Hz) with high-speed relay                          |                   |
| Dropout time  | Approx. 30 ms   |                   |
| Stage timers  | 0.00 s to 30.00 s; ∞<br>for all zones; separate time setting possibilities for single-phase and multiphase faults for the zones Z1, Z2, and Z1B | Increments 0.01 s |
| Time expiry tolerances  | 1 % of setting value or 10 ms   |                   |
| The set times are pure delay times.<br>The interval from fault inception to trip command is made up of the set delay time plus the measuring time.<br>The minimum measuring time is 10 ms, for faults close to the set zone boundary the maximum measuring time is approximately 40 ms. |   |                   |

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**INSTRUMENTOS PARA TESTES ELÉTRICOS**

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**APPENDIX B**

**Equivalence of software parameters and the relay under test.**

Table 3

| Distance Software               |        | Siemens 7SA611 Relay                     |        |
|---------------------------------|--------|--|--------|
| Parameter                       | Figure | Parameter                                | Figure |
| Mod Z0/Z1                       | 29     | Zero seq. comp. K0 for Z1                | 16     |
| Ang Z0/Z1                       | 29     | Zero seq. comp. Angle for Z1             | 16     |
| Zn1                             |        | Phase Distance Z1                        |        |
| Distance Angle                  | 30     | Angle of inclination, distance charact.  | 16     |
| Forward/Reverse/Non-Directional | 30     | Operating mode Z1                        | 19     |
| R                               | 30     | R(Z1), Resistance for ph-ph faults       | 19     |
| X                               | 30     | X(Z1), Reactance                         | 19     |
| Trigger Time                    | 30     | T1 multi-ph, delay for multiphase faults | 19     |
| Zone Reduction                  | 30     | Zone Reduction Angle                     | 19     |
| Zn2                             |        | Phase Distance Z2                        |        |
| Distance Angle                  | 31     | Angle of inclination, distance charact.  | 16     |
| Forward/Reverse/Non-Directional | 31     | Operating mode Z2                        | 20     |
| R                               | 31     | R(Z2), Resistance for ph-ph faults       | 20     |
| X                               | 31     | X(Z2), Reactance                         | 20     |
| Trigger Time                    | 31     | T2 multi-ph, delay for multiphase faults | 20     |
| Zone Reduction                  | 31     | Zone Reduction Angle                     | 20     |
| Zn3                             |        | Phase Distance Z3                        |        |
| Distance Angle                  | 32     | Angle of inclination, distance charact.  | 16     |
| Forward/Reverse/Non-Directional | 32     | Operating mode Z3                        | 21     |
| R                               | 32     | R(Z3), Resistance for ph-ph faults       | 21     |
| X                               | 32     | X(Z3), Reactance                         | 21     |
| Trigger Time                    | 32     | T3 multi-ph, delay for multiphase faults | 21     |
| Zone Reduction                  | 32     | Zone Reduction Angle                     | 21     |
| Zn4                             |        | Phase Distance Z4                        |        |
| Distance Angle                  | 33     | Angle of inclination, distance charact.  | 16     |
| Forward/Reverse/Non-Directional | 33     | Operating mode Z4                        | 22     |
| R                               | 33     | R(Z4), Resistance for ph-ph faults       | 22     |
| X                               | 33     | X(Z4), Reactance                         | 22     |
| Trigger Time                    | 33     | T4 multi-ph, delay for multiphase faults | 22     |
| Zone Reduction                  | 33     | Zone Reduction Angle                     | 22     |

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**INSTRUMENTOS PARA TESTES ELÉTRICOS**

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| Software Distance                      |        | Siemens 7SA611 Relay                           |        |
|--|--------|--|--------|
| Parameter                              | Figure | Parameter                                      | Figure |
| <b>Zn1_LE</b>                          |        | <b>Ground Distance Z1</b>                      |        |
| <b>Distance Angle</b>                  | 34     | <b>Angle of inclination, distance charact.</b> | 16     |
| <b>Forward/Reverse/Non-Directional</b> | 34     | <b>Operating mode Z1</b>                       | 19     |
| RE                                     | 34     | <b>RG(Z1), Resistance for ph-gnd faults</b>    | 19     |
| X                                      | 34     | <b>X(Z1), Reactance</b>                        | 19     |
| <b>Trigger Time</b>                    | 34     | <b>T1 1-ph, delay for multiphase faults</b>    | 19     |
| <b>Zone Reduction</b>                  | 34     | <b>Zone Reduction Angle</b>                    | 19     |
| <b>Zn2_Terra</b>                       |        | <b>Ground Distance Z2</b>                      |        |
| <b>Distance Angle</b>                  | 35     | <b>Angle of inclination, distance charact.</b> | 16     |
| <b>Forward/Reverse/Non-Directional</b> | 35     | <b>Operating mode Z2</b>                       | 20     |
| RE                                     | 35     | <b>RG(Z2), Resistance for ph-gnd faults</b>    | 20     |
| X                                      | 35     | <b>X(Z2), Reactance</b>                        | 20     |
| <b>Trigger Time</b>                    | 35     | <b>T2 1-ph, delay for multiphase faults</b>    | 20     |
| <b>Zone Reduction</b>                  | 35     | <b>Zone Reduction Angle</b>                    | 20     |
| <b>Zn3_LE</b>                          |        | <b>Ground Distance Z3</b>                      |        |
| <b>Distance Angle</b>                  | 36     | <b>Angle of inclination, distance charact.</b> | 16     |
| <b>Forward/Reverse/Non-Directional</b> | 36     | <b>Operating mode Z3</b>                       | 21     |
| RE                                     | 36     | <b>RG(Z3), Resistance for ph-gnd faults</b>    | 21     |
| X                                      | 36     | <b>X(Z3), Reactance</b>                        | 21     |
| <b>Trigger Time</b>                    | 36     | <b>T3 1-ph, delay for multiphase faults</b>    | 21     |
| <b>Zone Reduction</b>                  | 36     | <b>Zone Reduction Angle</b>                    | 21     |
| <b>Zn4_LE</b>                          |        | <b>Ground Distance Z4</b>                      |        |
| <b>Distance Angle</b>                  | 37     | <b>Angle of inclination, distance charact.</b> | 16     |
| <b>Forward/Reverse/Non-Directional</b> | 37     | <b>Operating mode Z4</b>                       | 22     |
| RE                                     | 37     | <b>RG(Z4), Resistance for ph-gnd faults</b>    | 22     |
| X                                      | 37     | <b>X(Z4), Reactance</b>                        | 22     |
| <b>Trigger Time</b>                    | 37     | <b>T4 1-ph, delay for multiphase faults</b>    | 22     |
| <b>Zone Reduction</b>                  | 37     | <b>Zone Reduction Angle</b>                    | 22     |