



INSTRUMENTOS PARA TESTES ELÉTRICOS

Test Tutorial

Equipment Type: Protection Relay

Brand: SIEMENS

Model: 7SA86

Function: 68 or RPSB - Power Swing Blocking (PSB) & 78 or PPAM - Out of step (OoS)

Tool Used: CE-6006, CE-6707, CE6710, CE-7012 or CE7024

Objective: Test of PSB and OoS in Conditions of Synchronous, Asynchronous and Faulted Power Oscillations.

Version Control:

Version	Descriptions	Date	Author	Reviewer
1.0	Initial Version	08/04/2022	M.R.C.	G.C.D.P.

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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 contacts 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 test 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 test and also be aware of safety standards and regulations.

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INSTRUMENTOS PARA TESTES ELÉTRICOS
Sequence for testing the 7SA611 relay in the PSB_OoS software

1. Relay Connection to CE-6710

Appendix A-1 shows the relay terminal designations.

1.1 Auxiliary Source

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

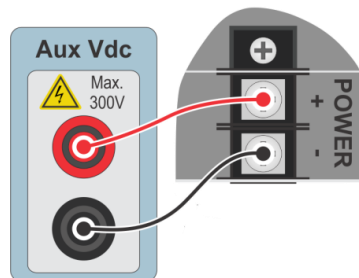


Figure 1

1.2 Current and Voltage Coils

To establish the connection of voltage coils, connect voltage channels V1, V2 and V3 to pins B1, B3 and B5 of slot 1B of the relay respectively, and their common to pins B2, B4 and B6 respectively. If the relay commons are short-circuited, just connect the three commons of the box to that point. To connect the current coils, connect channels I1, I2 and I3 with pins A1, A3 and A5 of slot 1A of the relay terminal and common to pins A2, A4 and A6. If these last three points are short-circuited, connect all commons to this point.

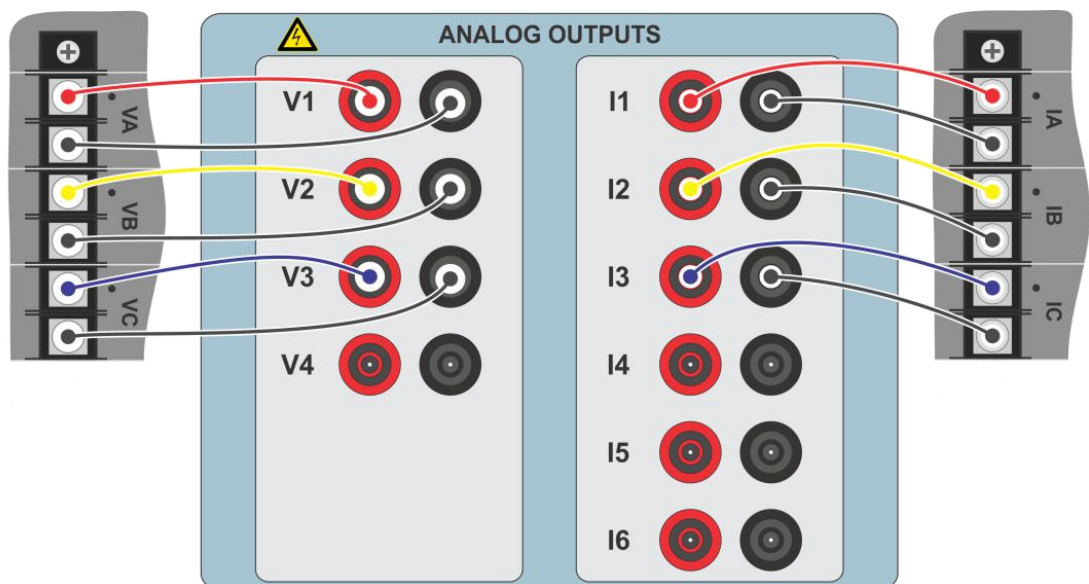


Figure 2

1.3 Binary Inputs

Connect the binary inputs of the CE-6710 to the binary outputs of the relay.

- BI1 to pin B09 and its common to pin B10;
- BI2 to pin B11 and its common to pin B12.
- BI3 to pin B13 and its common to pin B14.

The following figure shows the details of these connections.

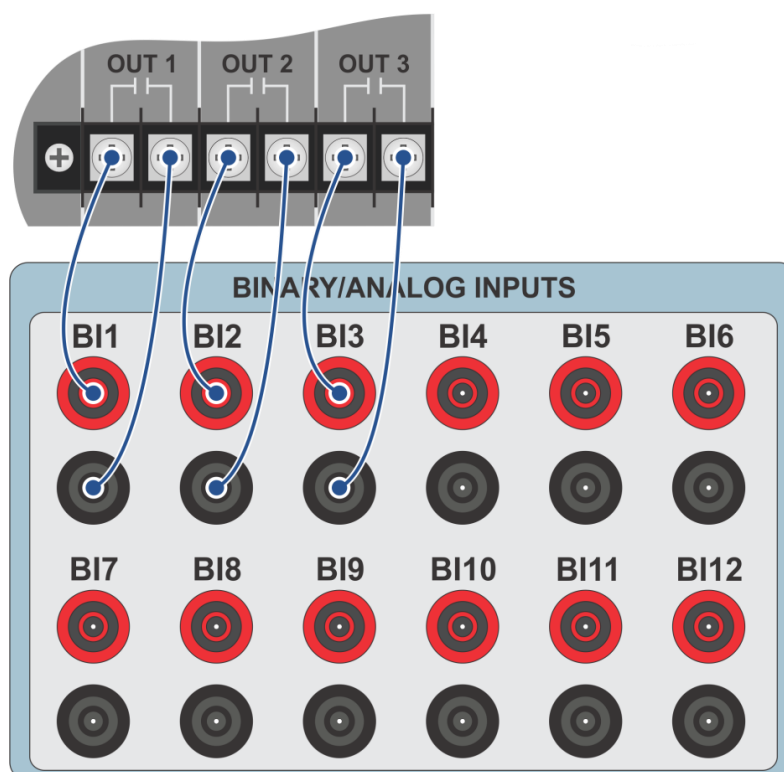


Figure 3

2. Communication with the 7SA86 relay

First, connect a USB cable from the notebook to the relay. Then double click on the relay software icon.



Figure 4

When opening the program, click on the “Project” option and choose the “New” option.

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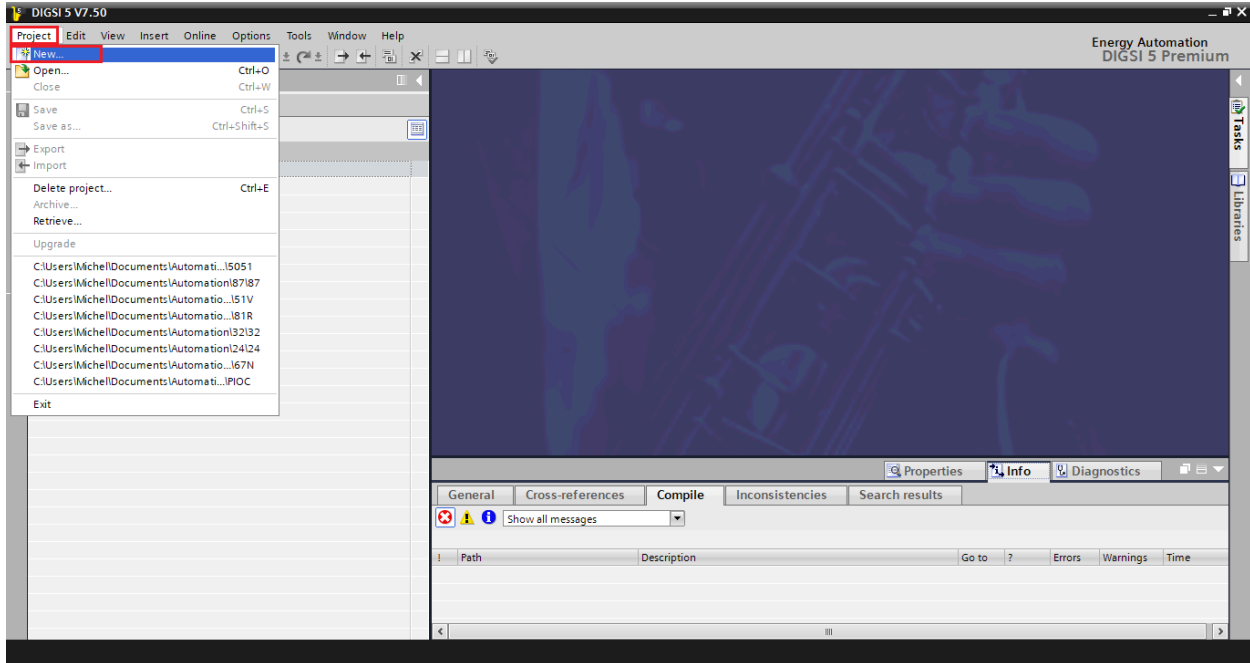


Figure 5

Enter a name for the project and then click on “*Create*”, as highlighted below.

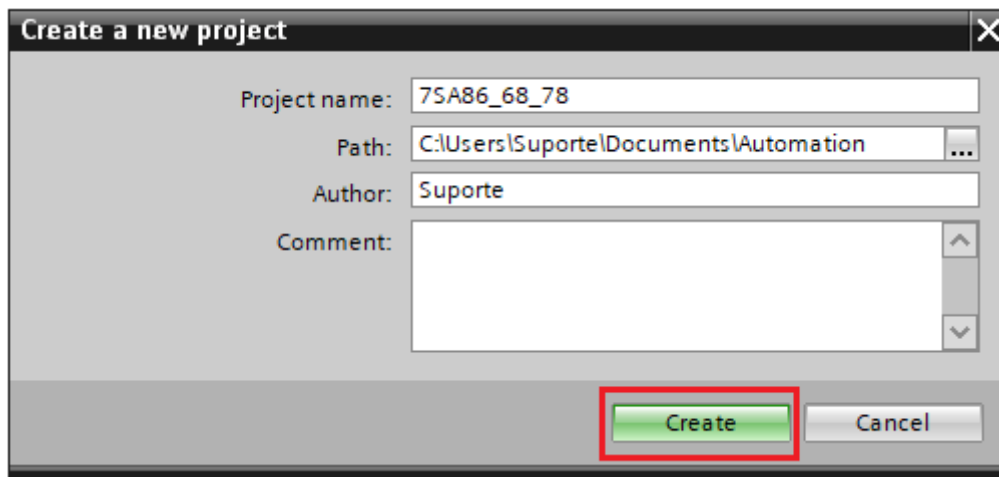


Figure 6

When creating the project, add the relay that will be tested, to do so, double-click on “*Add New Device*” as highlighted below.

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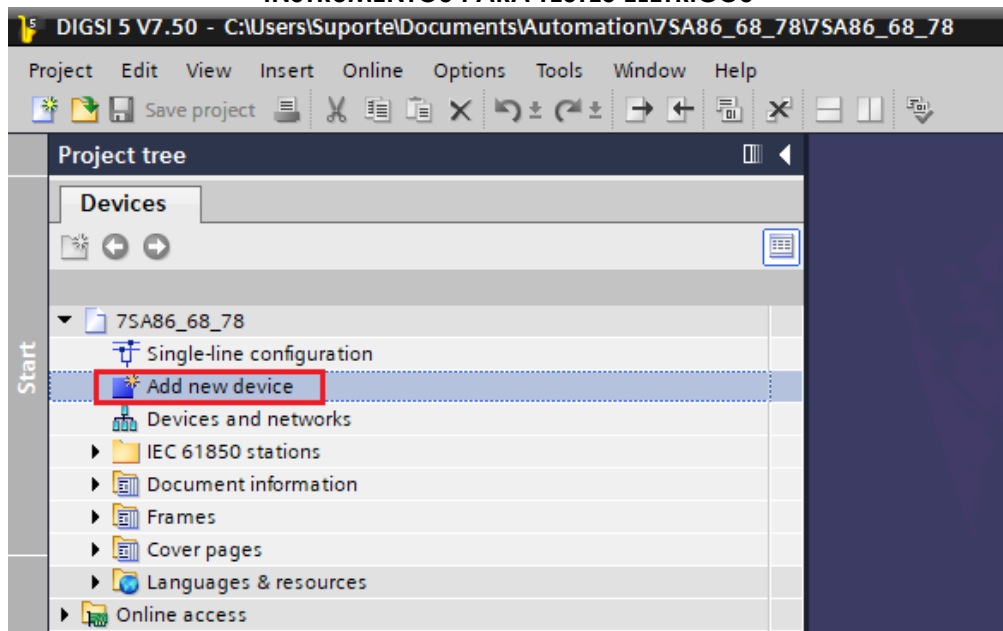


Figure 7

Enter the relay short code located on its side, then click on “*Verify*” as highlighted below.

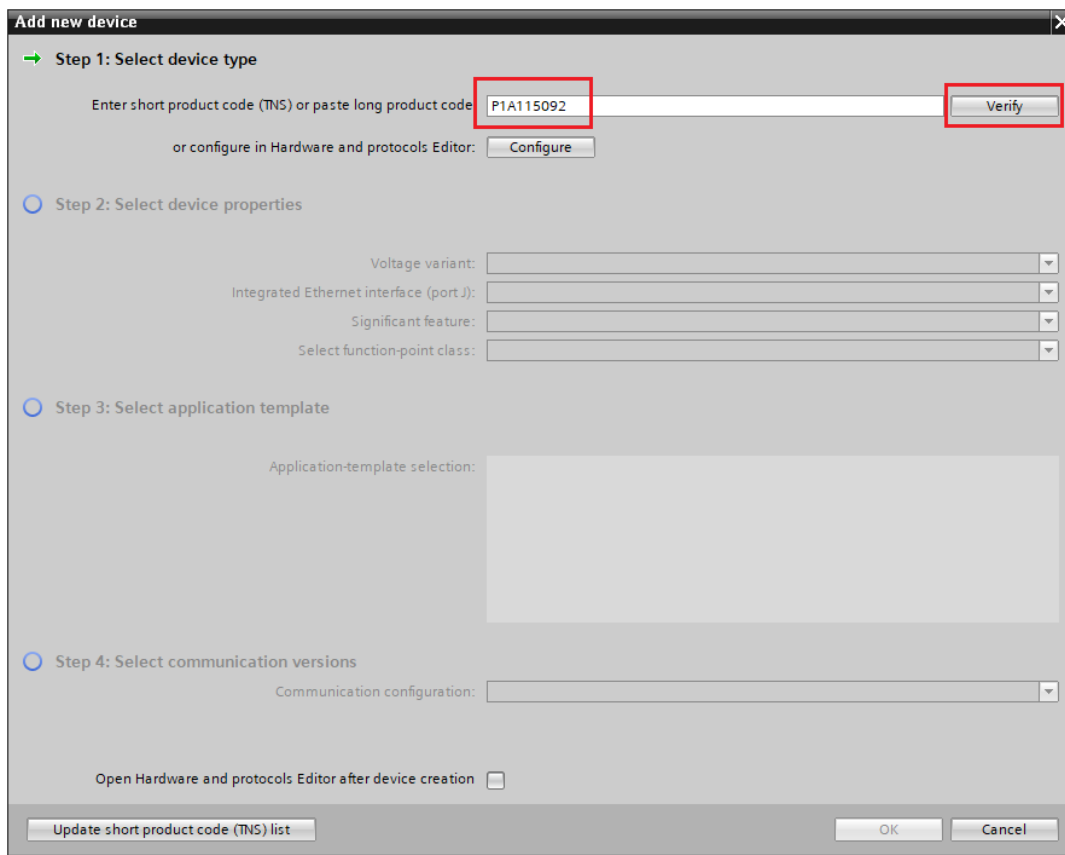


Figure 8

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Select the highlighted “*Template*” whose firmware version is consistent with the relay's (To verify, just look at the relay's HMI when it is turned on). Then click “*OK*”.

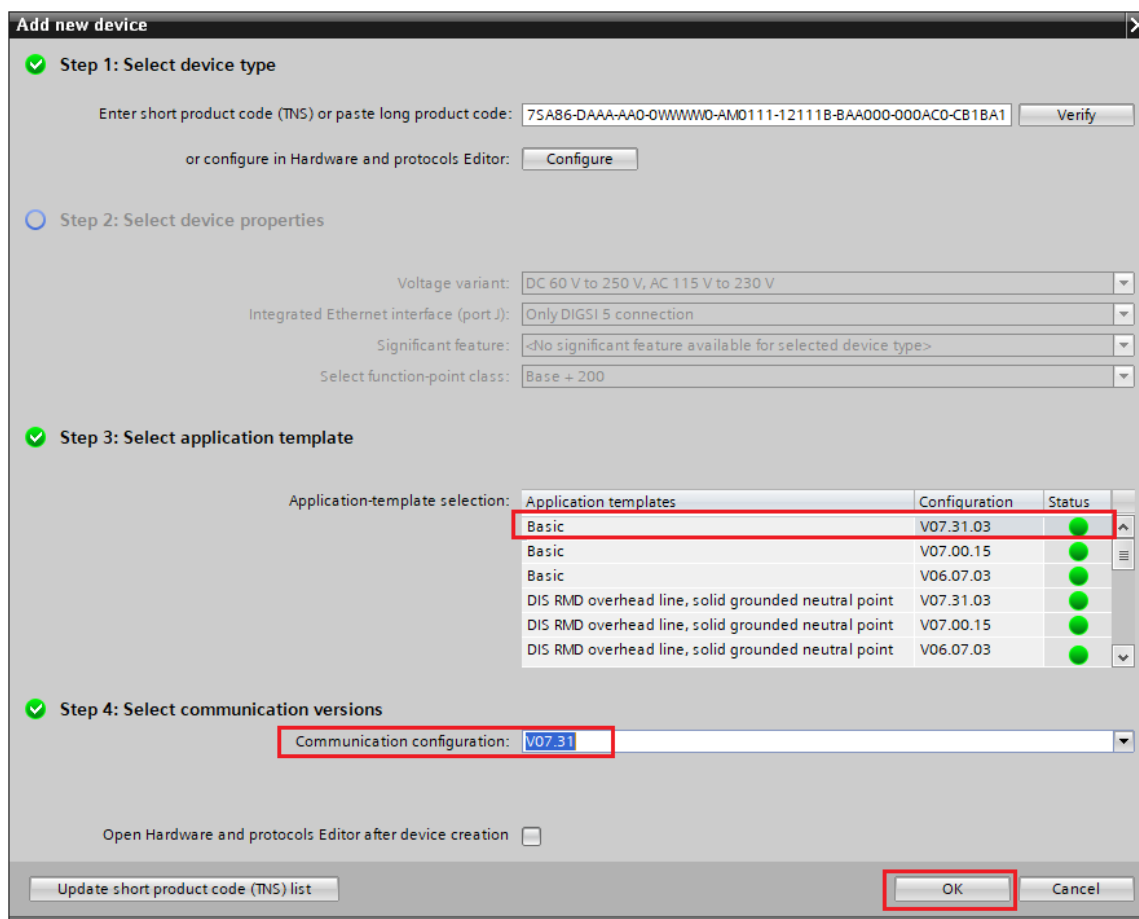


Figure 9

Note that a generic relay has been added (highlighted in green below). The next step is to establish communication with the device, for that, go to the “*Online*” menu and choose the option “*Connect to device and retrieve data*”.

INSTRUMENTOS PARA TESTES ELÉTRICOS

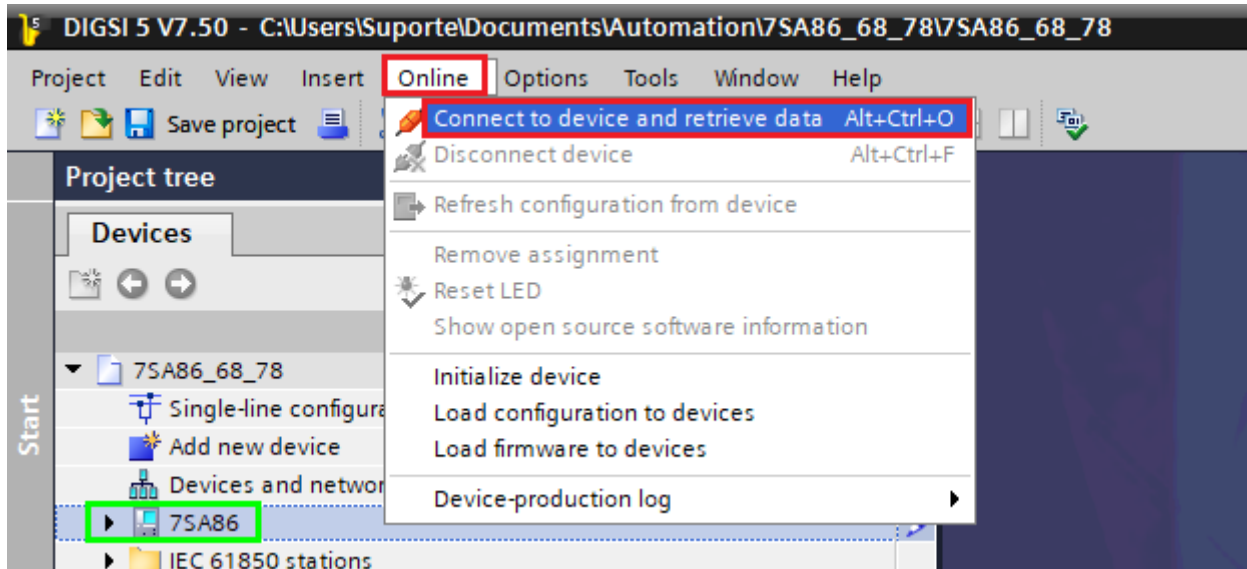


Figure 10

After establishing communication with the relay, it is necessary to read the parameterized settings. Right-click on the relay icon (highlighted in green in the previous figure) and choose the option “*Update configuration from target device*”.

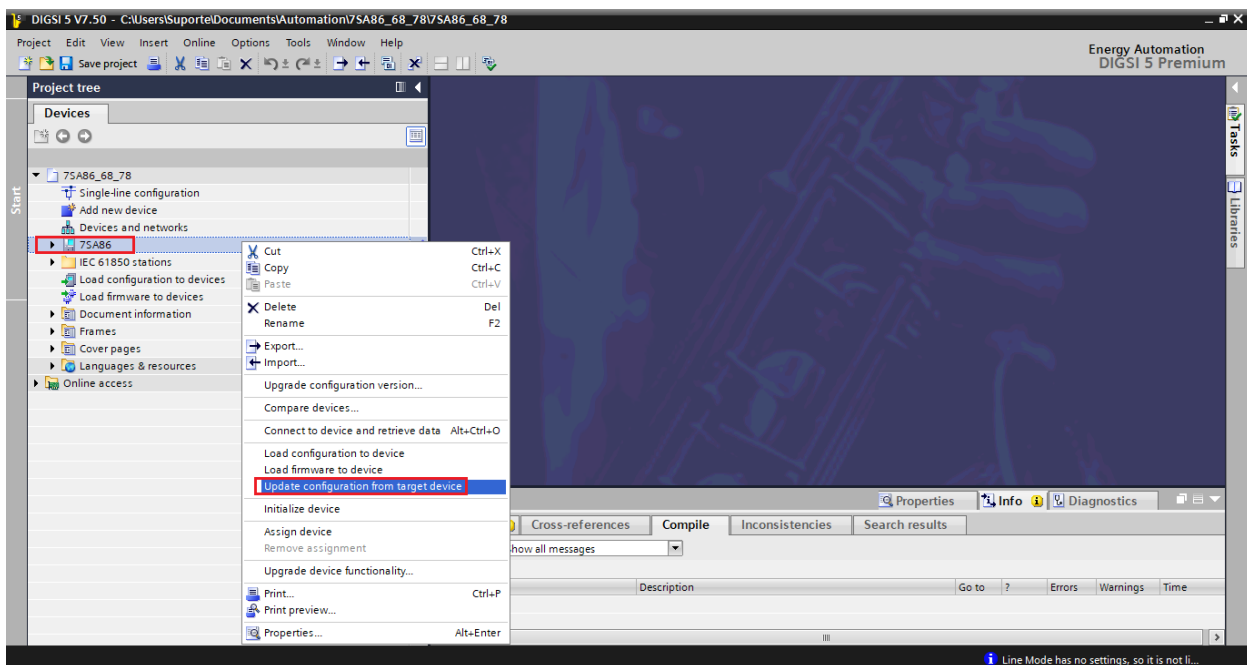


Figure 11

Click “Yes” to the following message:

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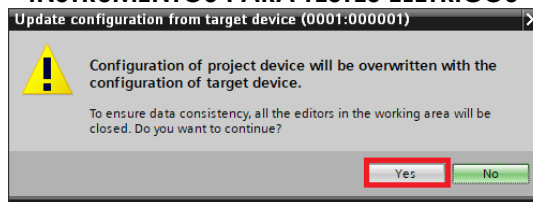


Figure 12

There are other warning messages (not shown), click “Yes” on all. If the procedure is performed properly, the following screen will be reached.



Figure 13

Export the created file in .dex5 format in order to have a backup of the settings. Right-click on the relay icon and choose the “Export...” option.

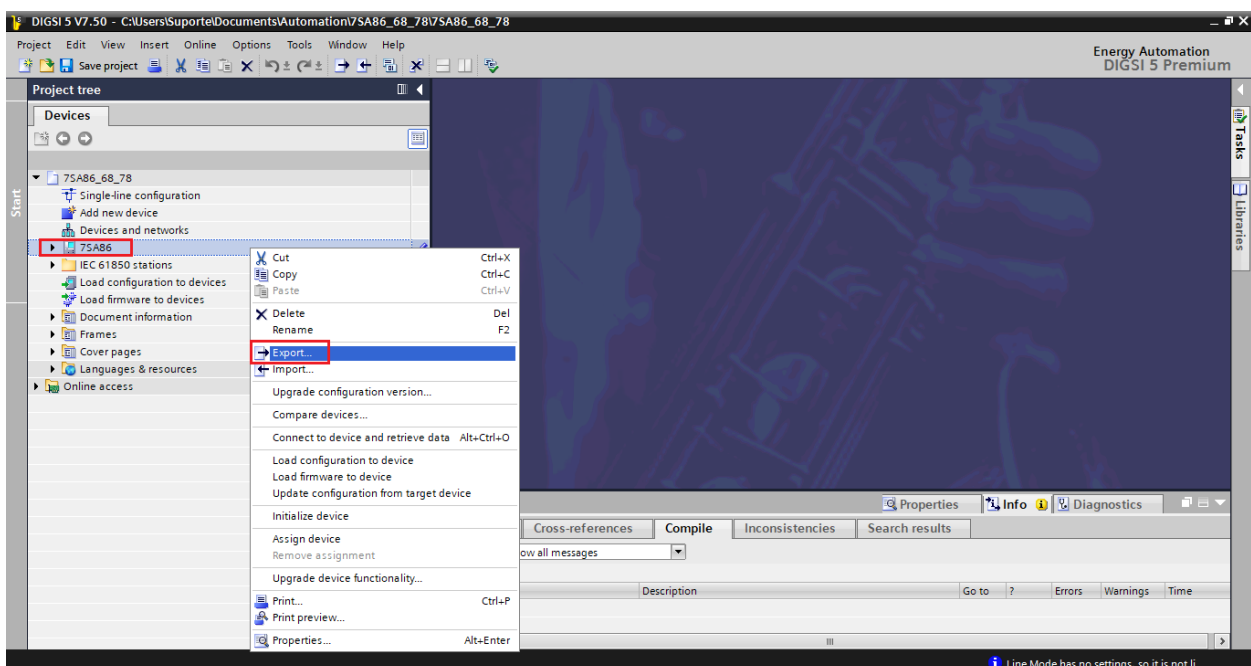


Figure 14

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There are other ways to extract information from Siemens Siprotec 5 relays, however the way shown is practical for those who will commission a relay already parameterized and installed in a panel.

3. Parameterization of relay 7SA86

3.1 Device Settings

After the connection has been established, open the “7SA86” device section. Then open the “Settings” section, finally choose the “Device Settings” option. Check that group 1 is active, the rated frequency is 60Hz and the minimum operating time is zero seconds.

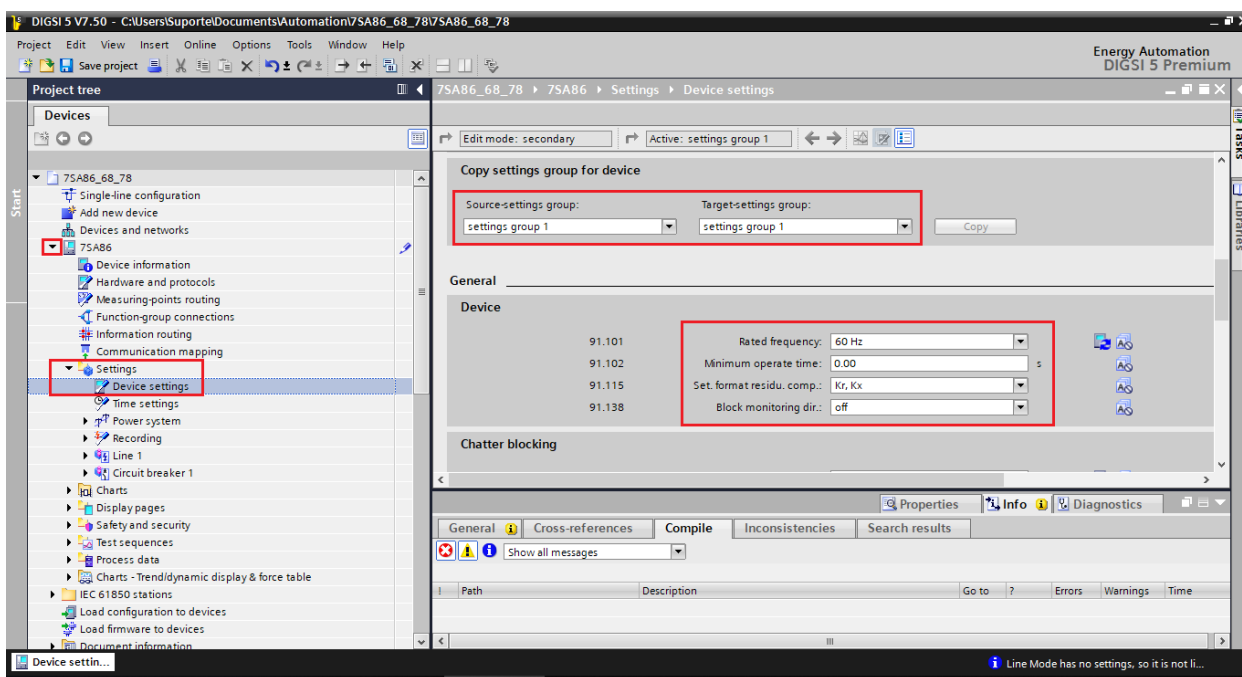


Figure 15

3.2 General

Open the “Power System” section and select the “General” option. Check the parameterized phase sequence.

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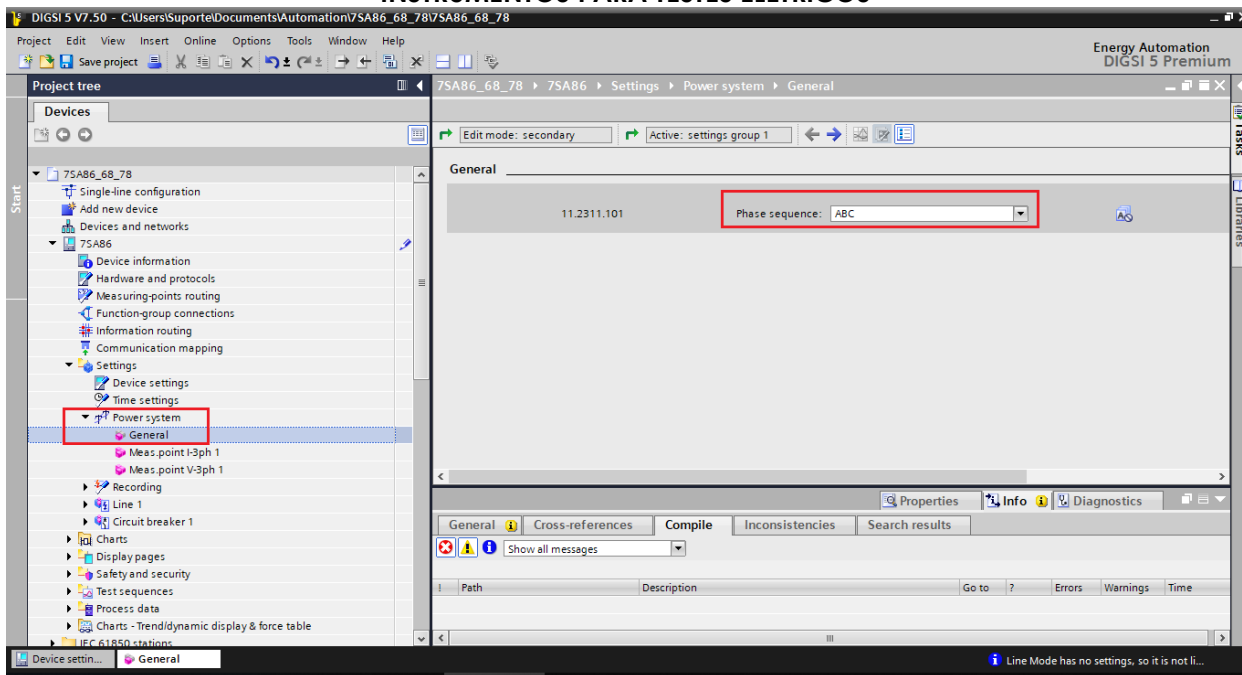


Figure 16

3.3 Meas. Point I-3ph 1

Select the option “Meas. Point I-3ph 1”. Adjust primary and secondary current values, magnitude compensation factors and **disable supervisory functions**.

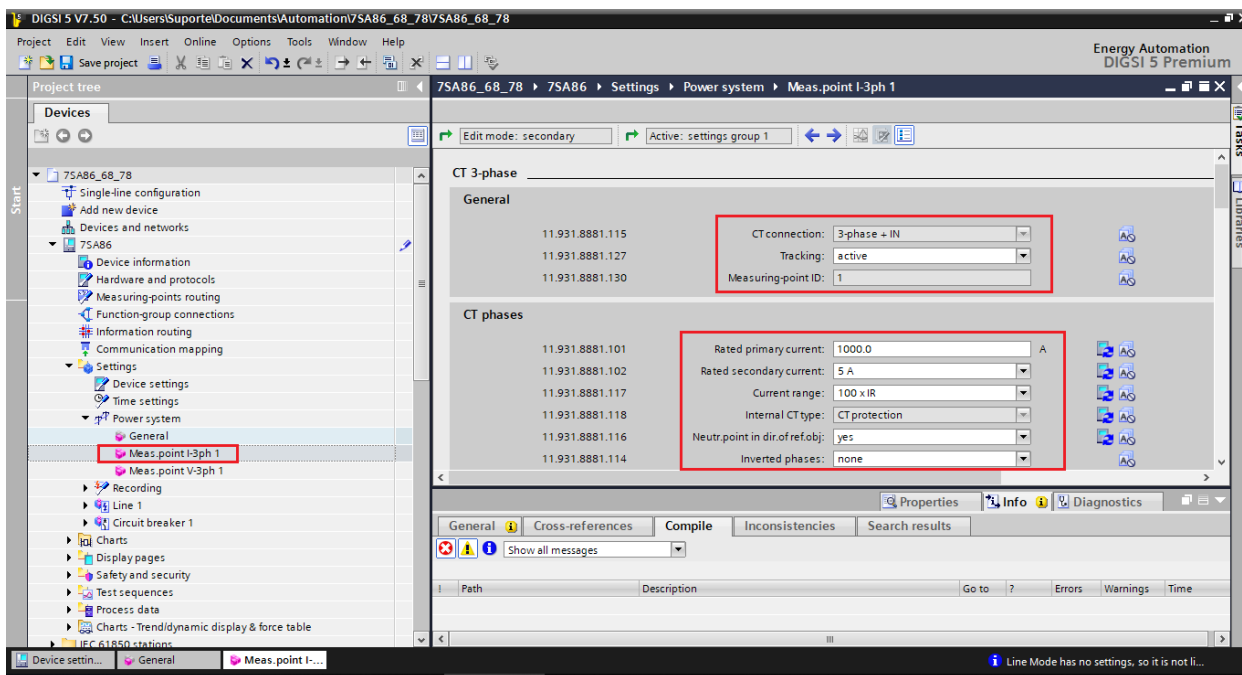


Figure 17

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Click on the “Info” tab to hide it and enlarge the view of the settings.

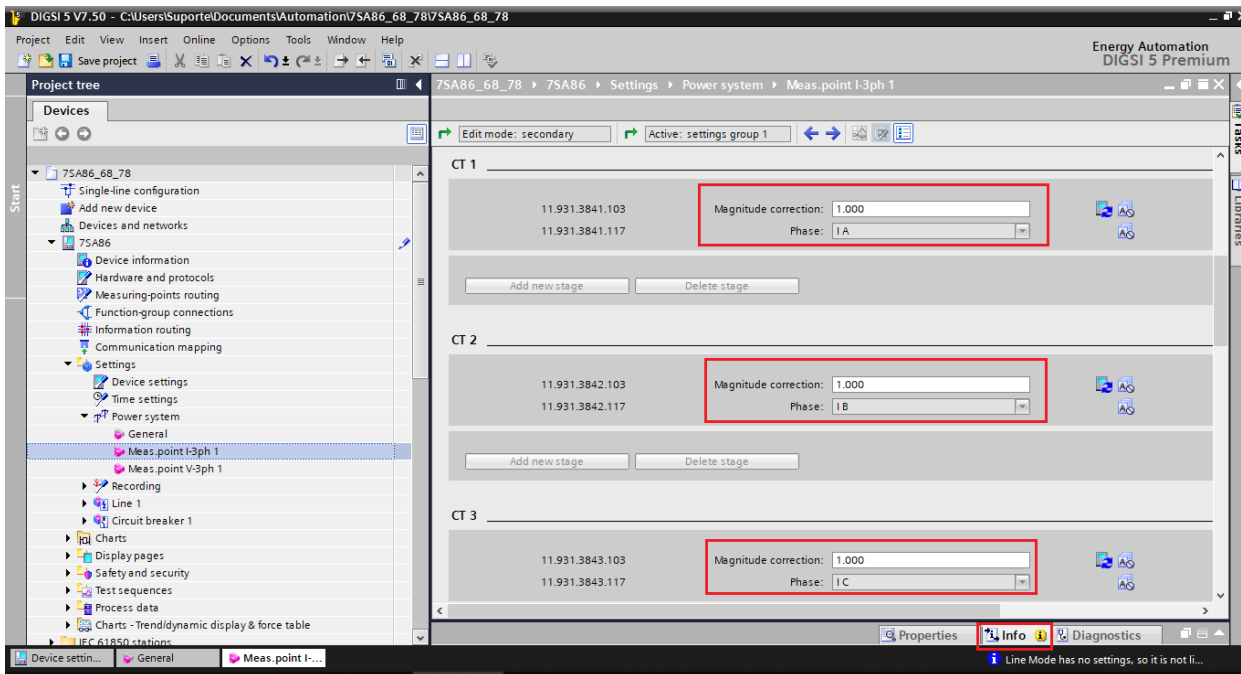


Figure 18

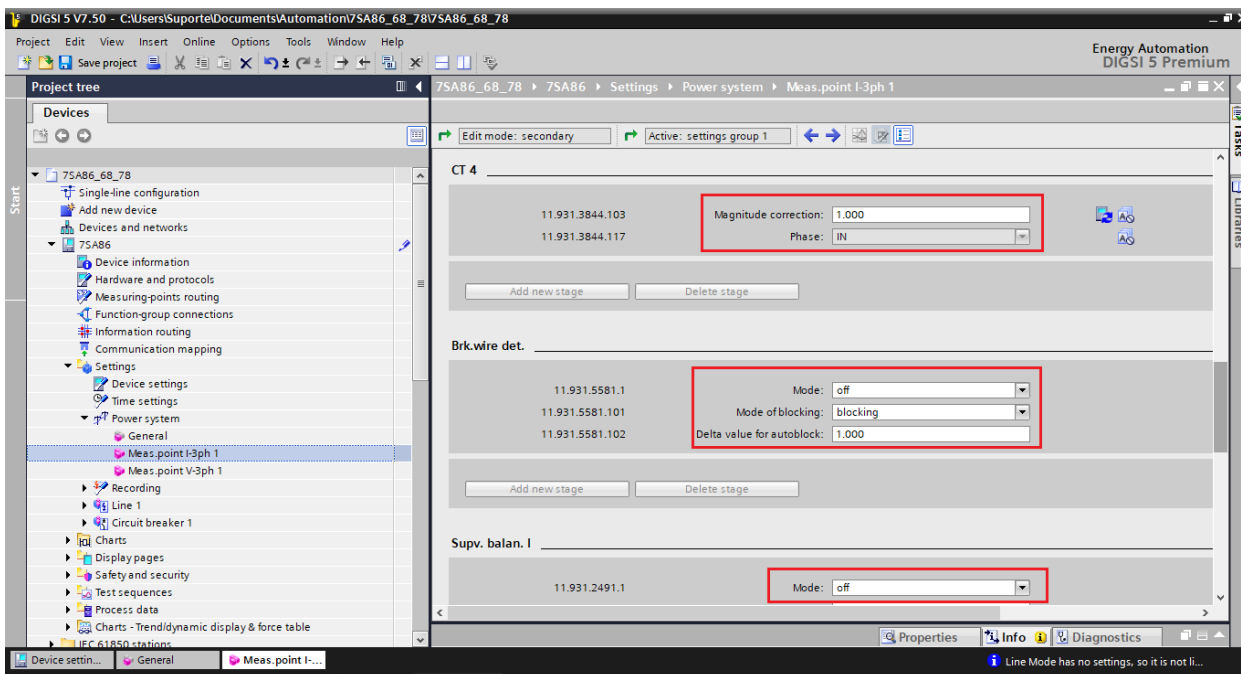


Figure 19

INSTRUMENTOS PARA TESTES ELÉTRICOS

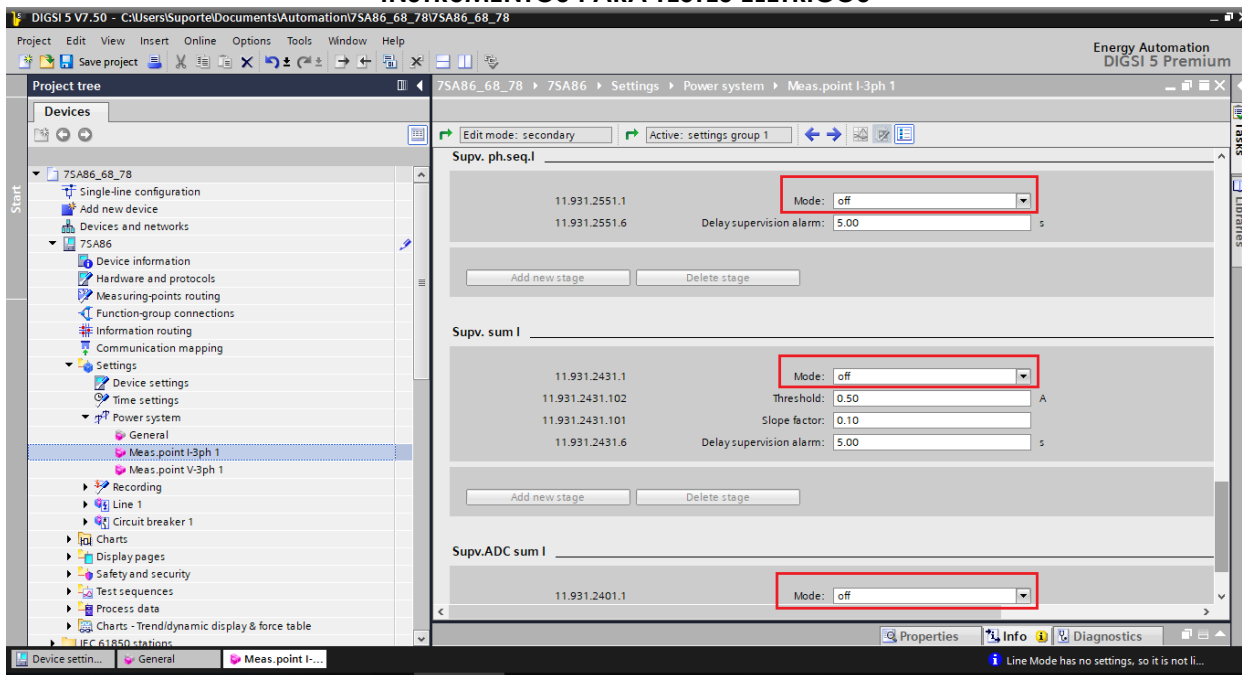


Figure 20

3.4 Meas. Point V-3ph 1

Select the option “*Meas. Point V-3ph 1*”. Set the values of primary, secondary voltages and magnitude compensation factor for the first winding and **disable supervision functions**.

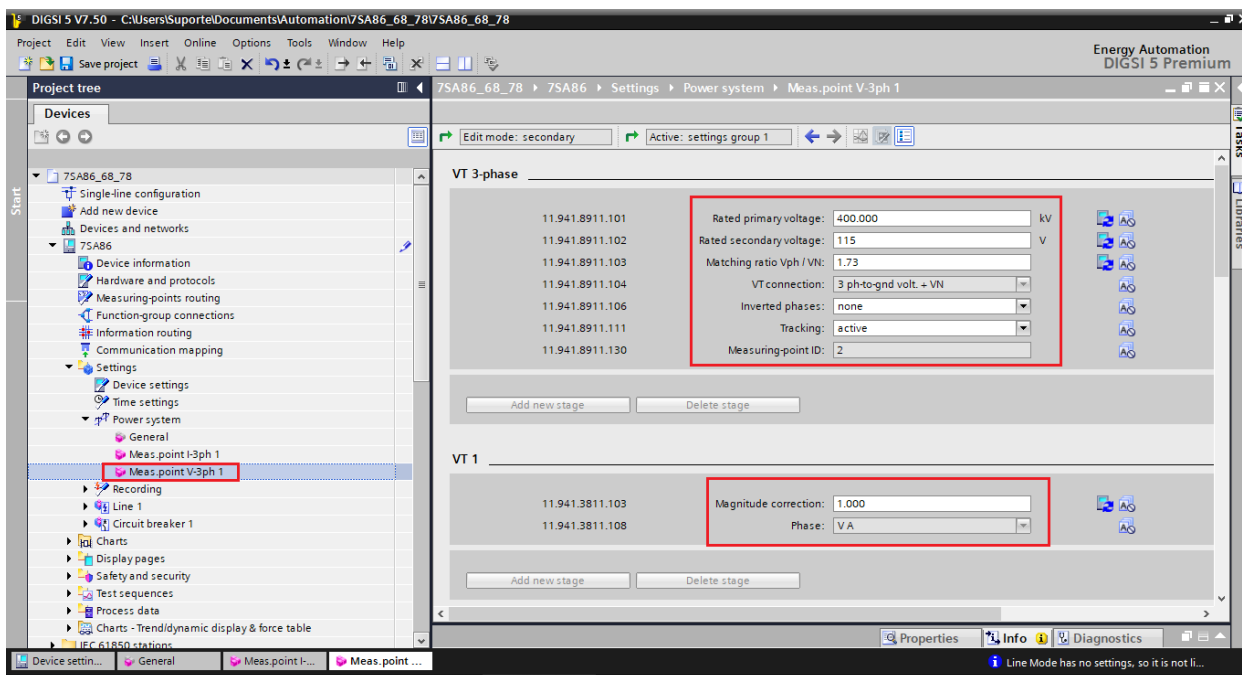


Figure 21

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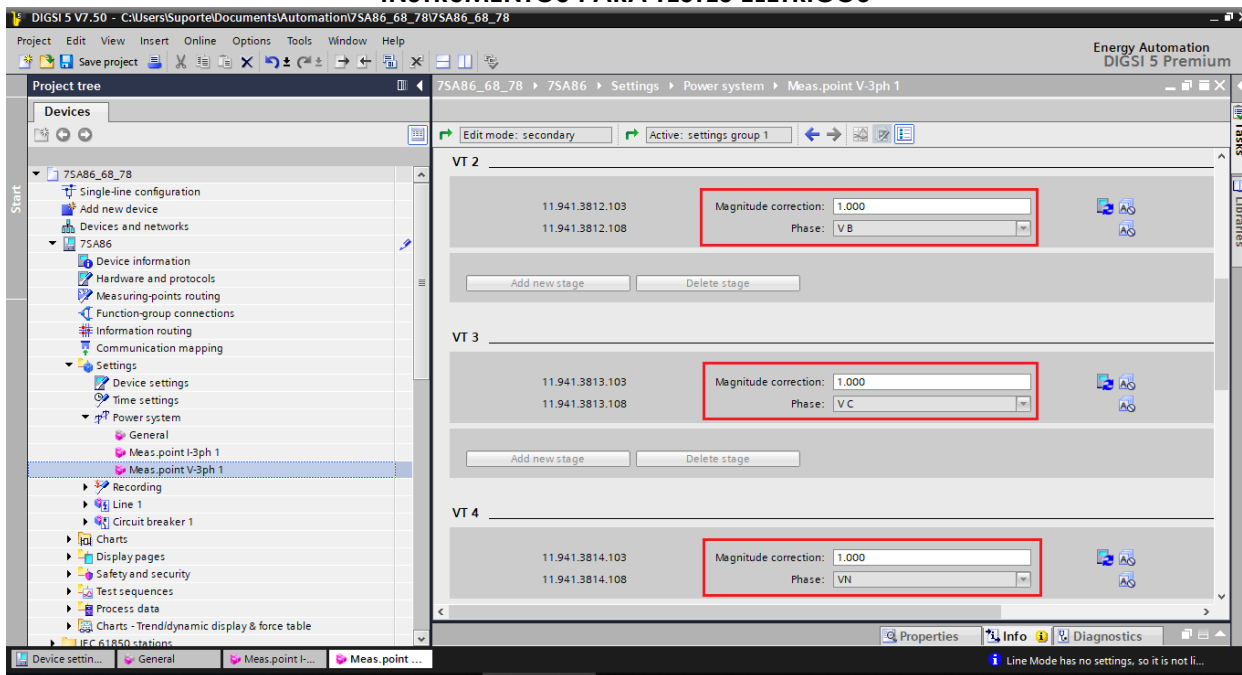


Figure 22

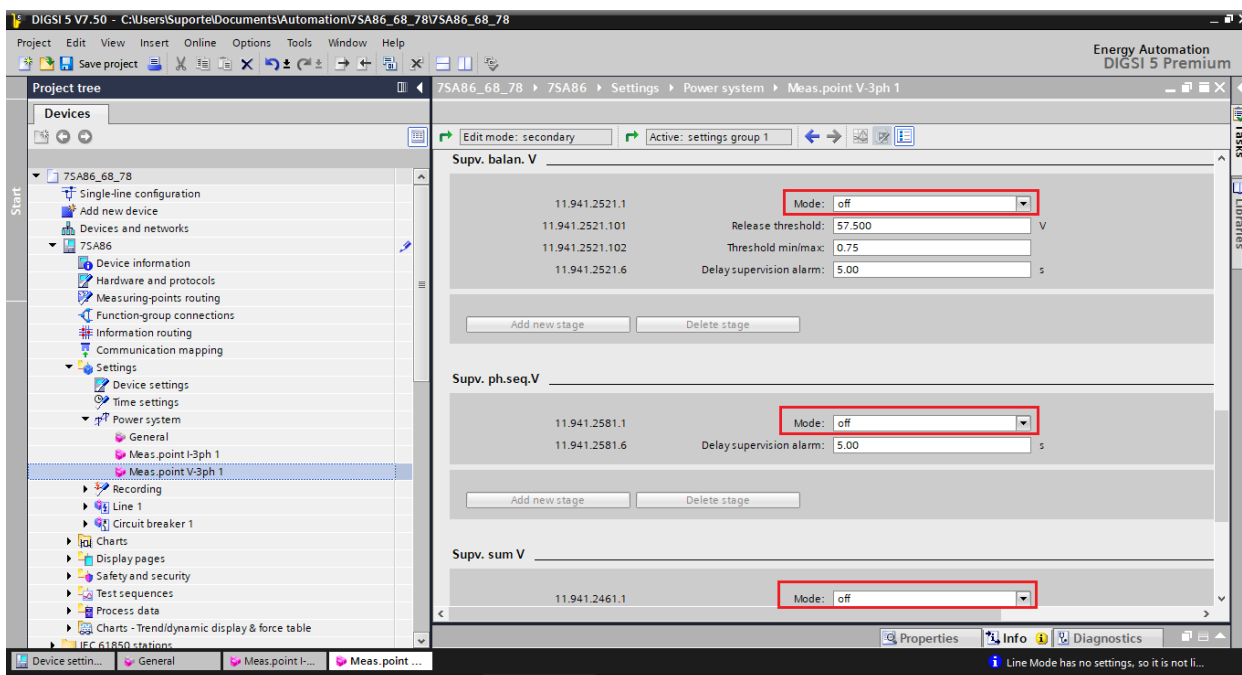


Figure 23

3.5 General

Open the “Line 1” section and select the “General” option. Check voltage, current and general line data settings.

INSTRUMENTOS PARA TESTES ELÉTRICOS

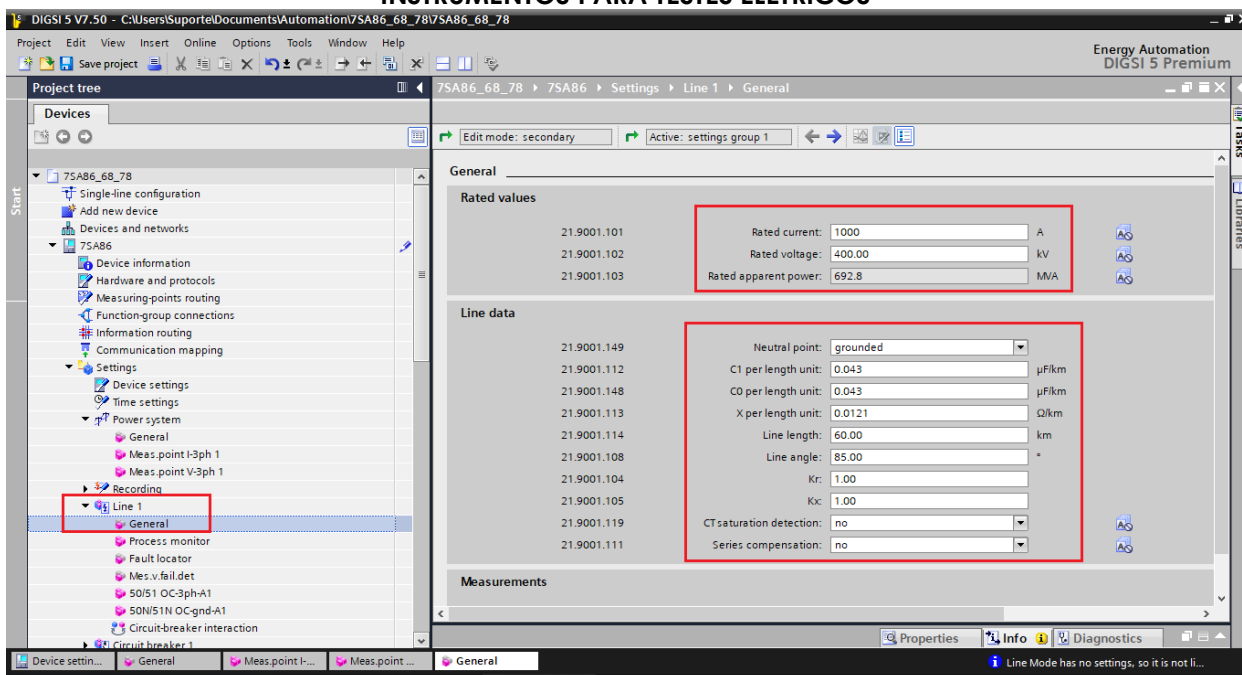


Figure 24

3.6 Inserting function 21

Click on the “Libraries” option and follow the path “Global DIGSI 5 Library > Types > Line protection > 7SA86 Distance prot. 3pole > FG Line > Distance protection”. Drag the “Distance protection [3pol., grounded]” sign over the “Line 1” icon and release.

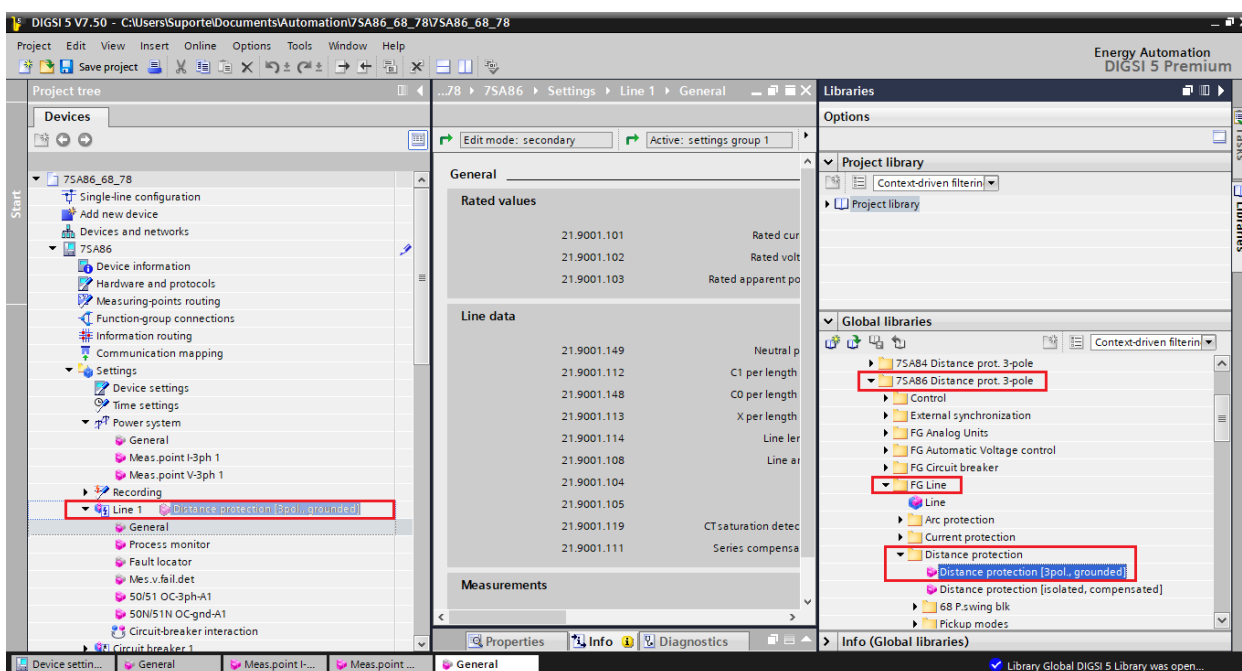


Figure 25

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3.7 21 Distance prot. 1

Double click on “21 Distance prot. 1” to make adjustments to the distance function.

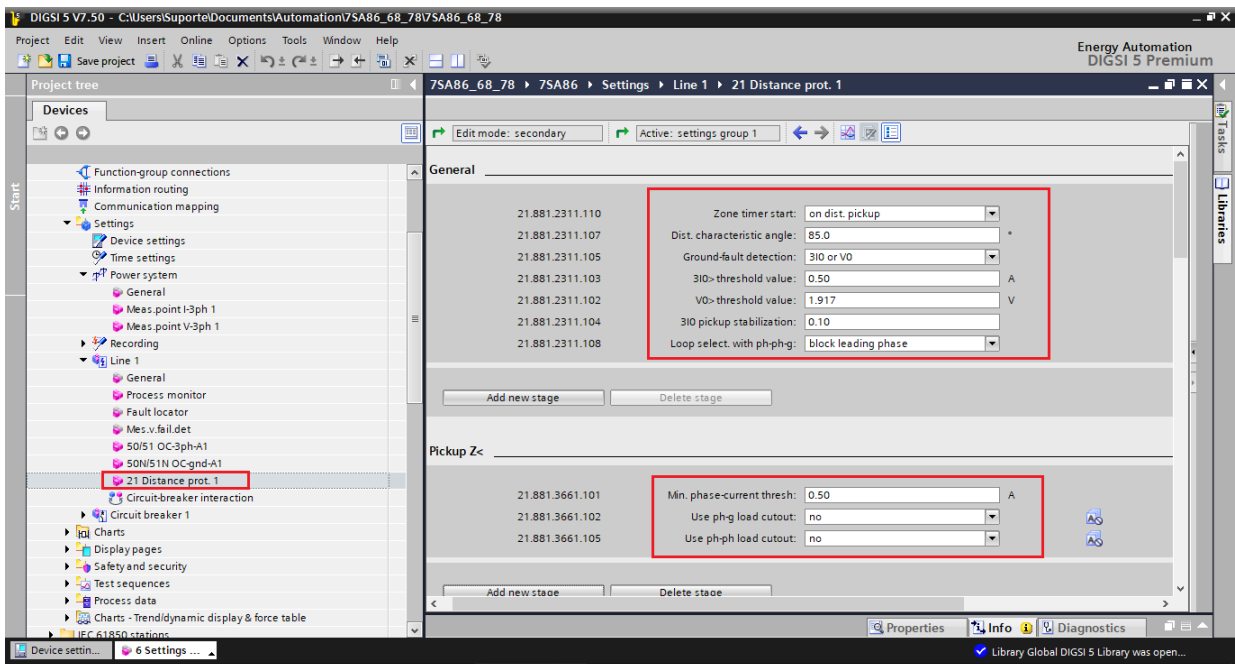


Figure 26

For simplicity, only the first zone will be used.

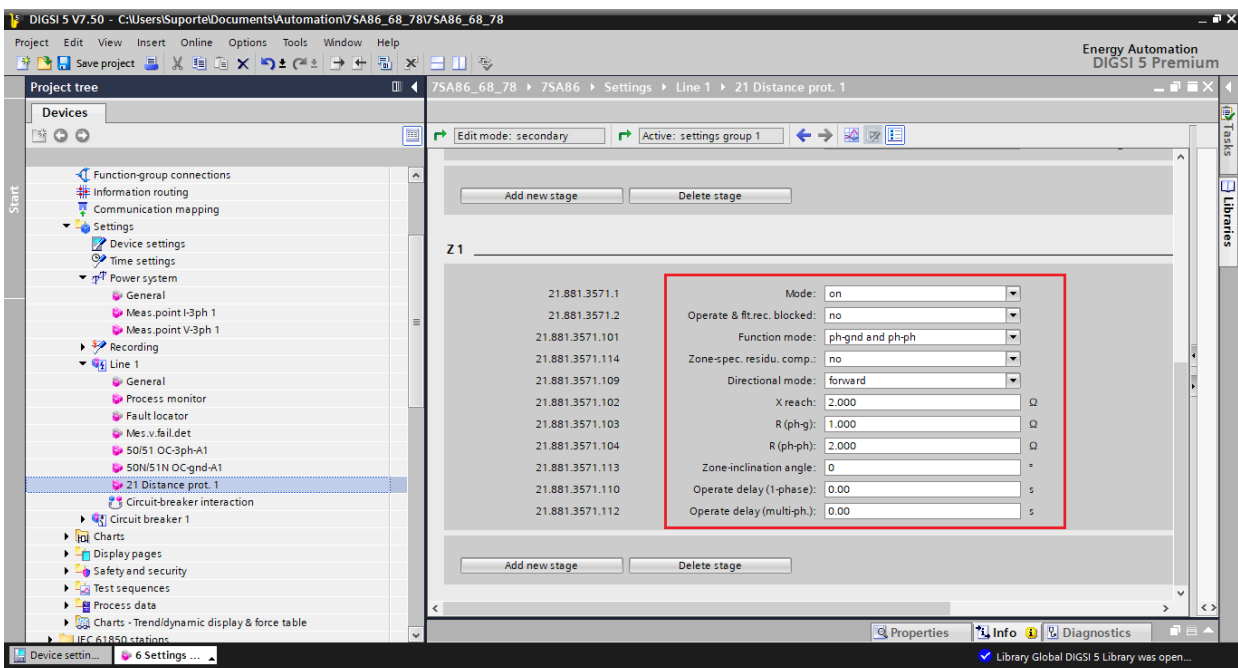


Figure 27

INSTRUMENTOS PARA TESTES ELÉTRICOS

3.8 Inserting function 68

Click on the “*Libraries*” option and follow the path “*Global DIGSI 5 Library > Types > Line protection > 7SA86 Distance prot. 3pole > FG Line > Distance protection > 68 P.swing blk*”. Drag the “*68 P.swing blk*” sign over the “*Line 1*” icon and release.

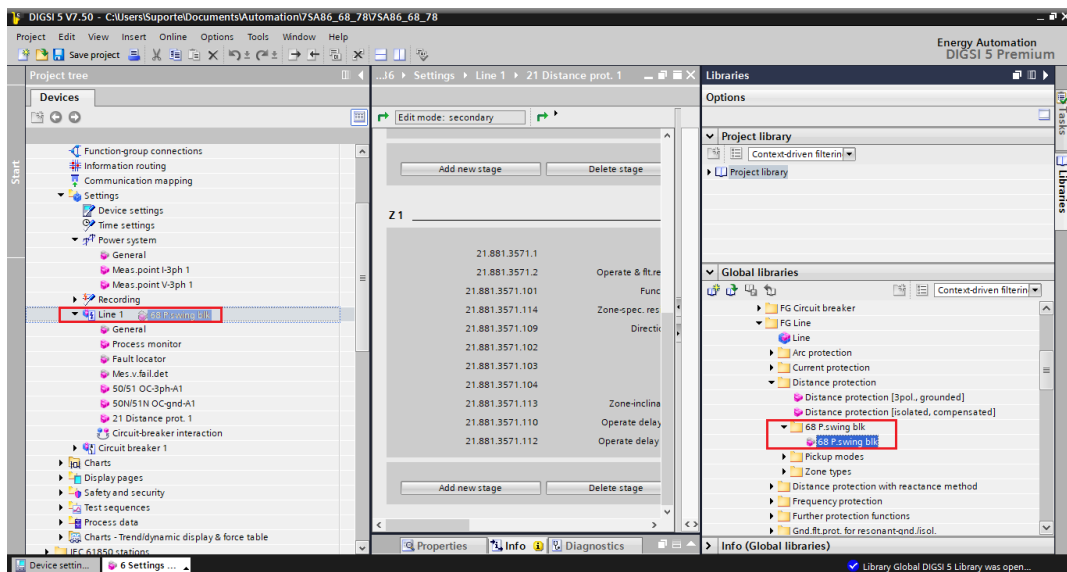


Figure 28

3.9 68 P.swing blk

Double click on “*68 P.swing blk*”, place the block in zone 1 and activate the function.

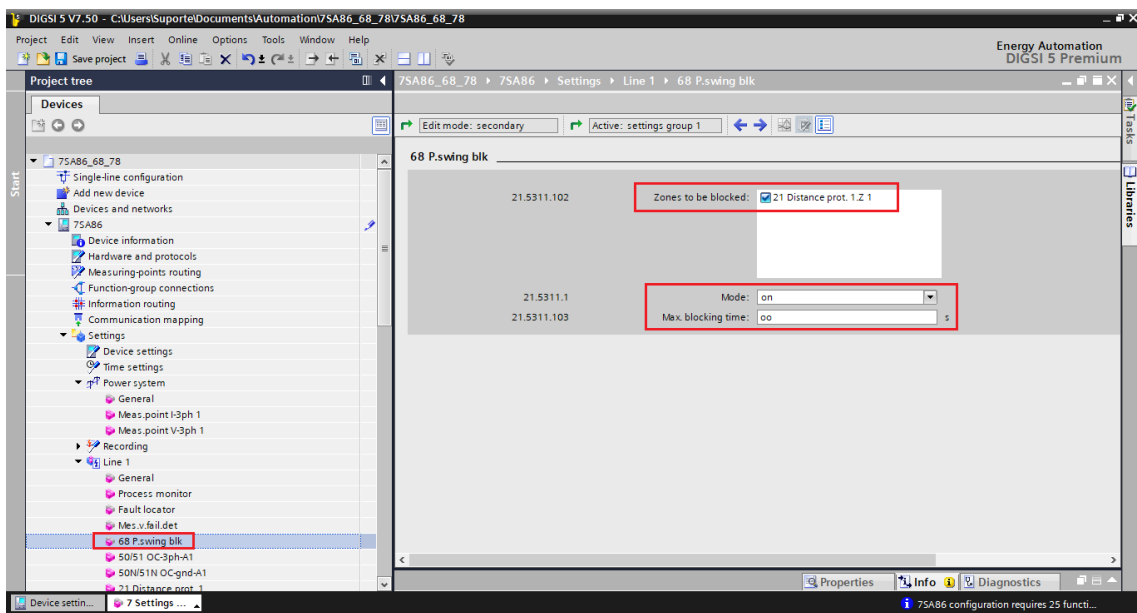


Figure 29

INSTRUMENTOS PARA TESTES ELÉTRICOS

3.10 *Inserting function 78*

Click on the “*Libraries*” option and follow the path “*Global DIGSI 5 Library > Types > Line protection > 7SA86 Distance prot. 3pole > FG Line > Further protection functions > 78 Out-of-step*”. Drag the “*78 Out-of-step*” sign over the “*Line 1*” icon and release.

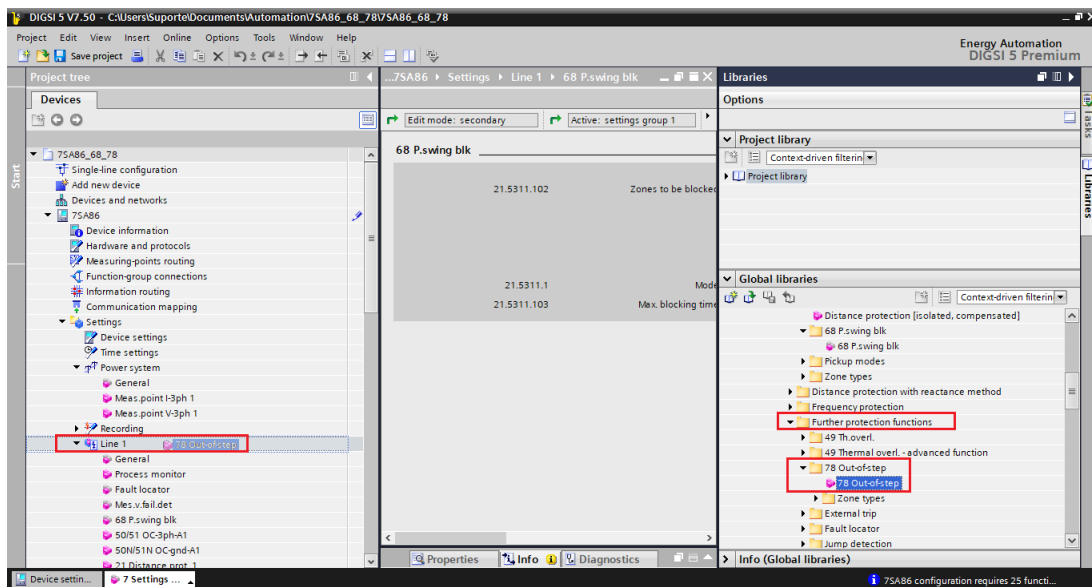


Figure 30

3.11 *78 Out-of-step*

Double-click “*78 Out-of-step*”, and configure detection zone 1.

INSTRUMENTOS PARA TESTES ELÉTRICOS

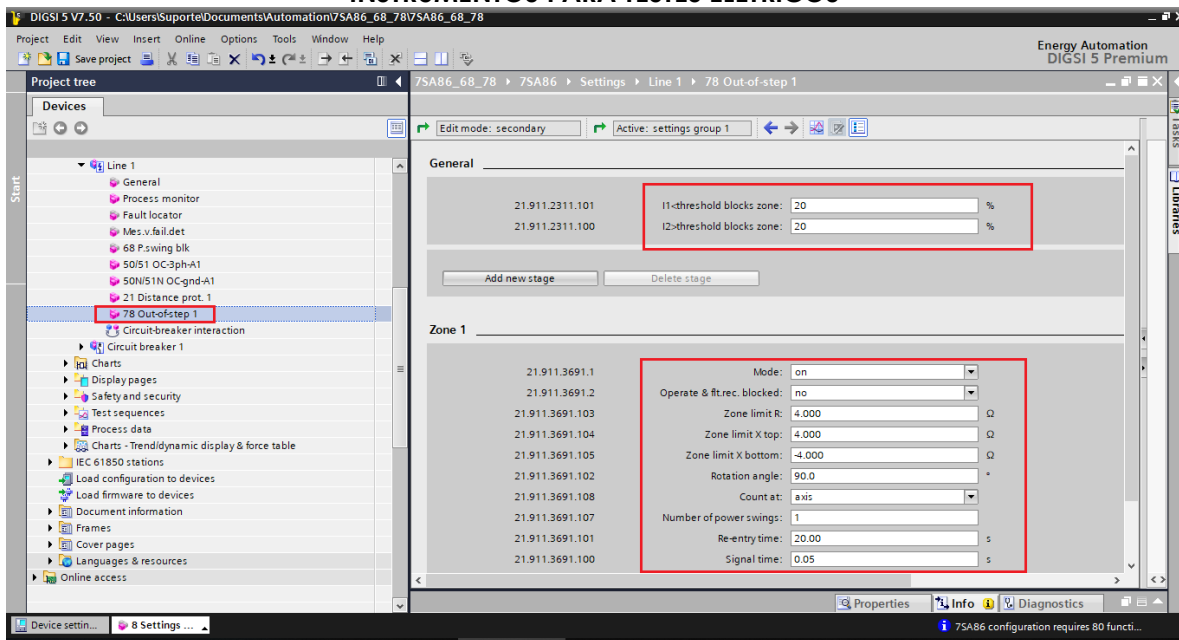


Figure 31

3.12 Information Routing

In the “*Information Routing*” option, the trip signals of the functions are associated with the physical outputs. For easier viewing, maximize the window.

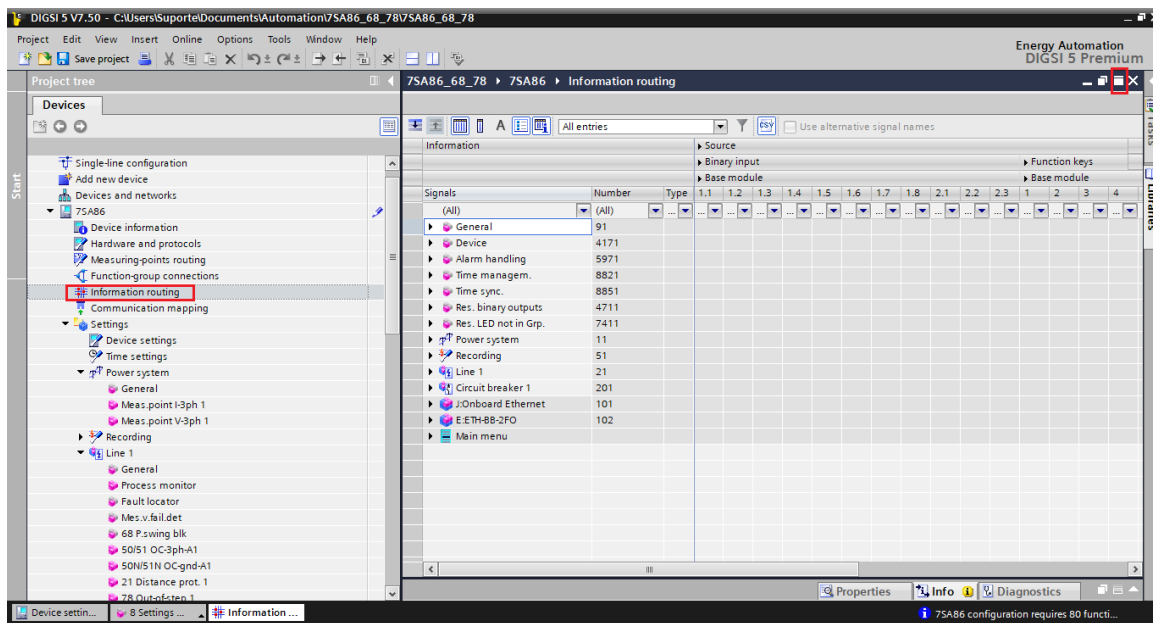


Figure 32

The first columns are associated with the binary inputs of the relay. In that case they will not be used. Double-click the “*Source*” option to hide these settings.

INSTRUMENTOS PARA TESTES ELÉTRICOS

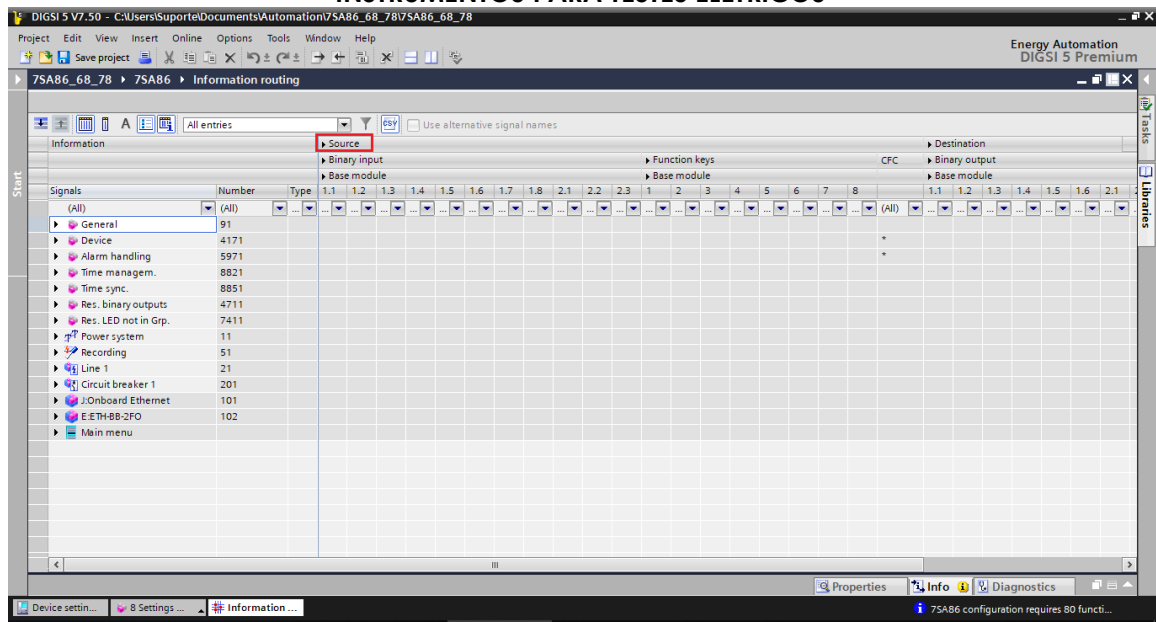


Figure 33

Enter the options “Line 1 > 21 Distance prot. 1 > Z 1”.

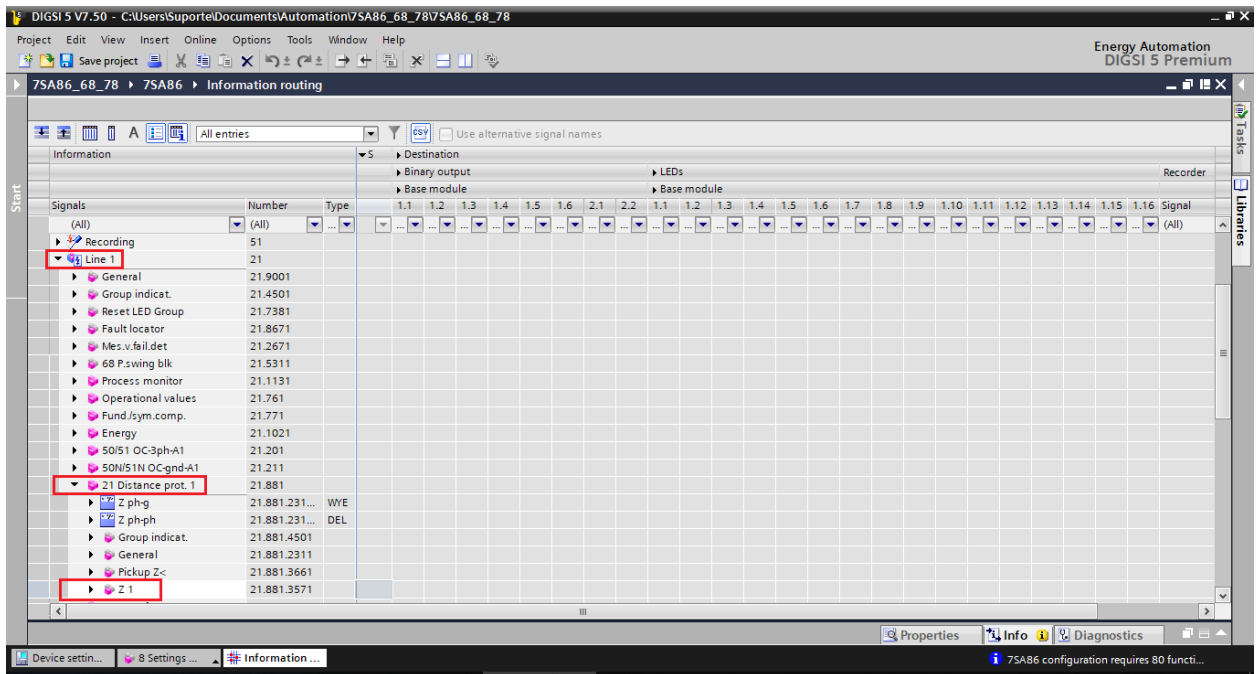


Figure 34

Assign the “general” signal within the “Operate delay expired” to the 1.1 output.
Look at the columns for these signals “Destination > Binary output > Base module”.

INSTRUMENTOS PARA TESTES ELÉTRICOS

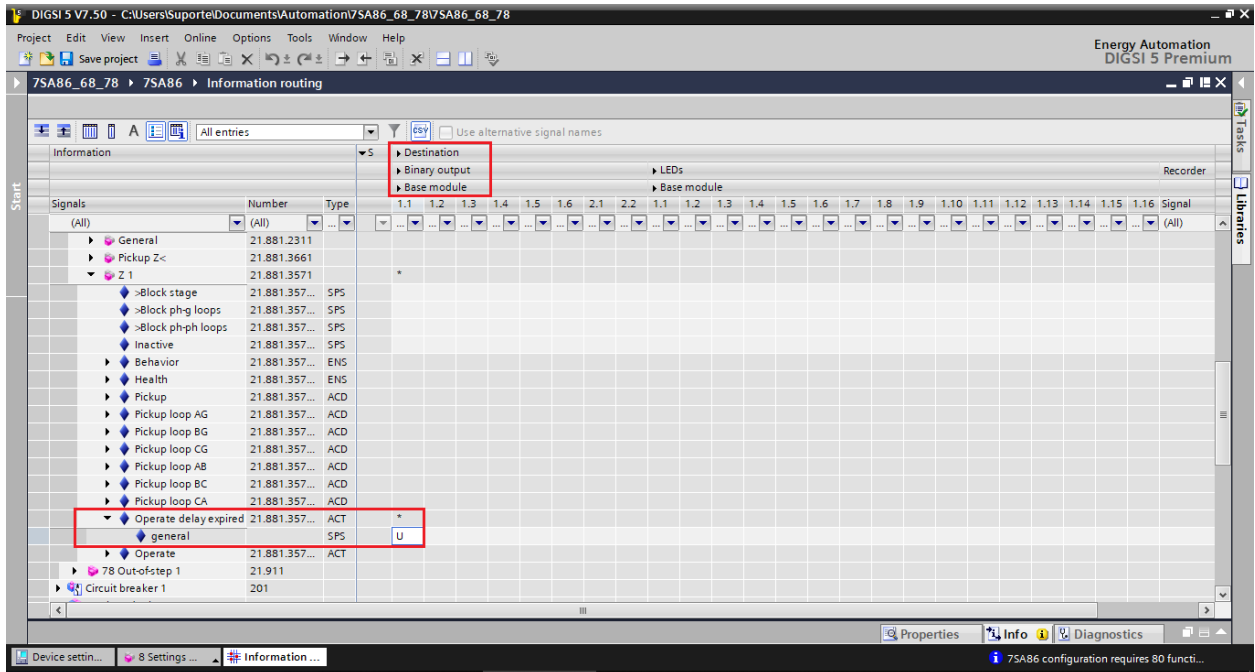


Figure 35

The “U” option must be used, which means “Unlatched” (without seal), that is, the relay activates and when the fault ceases, it automatically returns to the initial state of the binary. If the user chooses the “L” or “Latched” option (with seal) the relay activates and remains activated even if the fault has been extinguished. (This option is not indicated for the test).

Enter the options “68 P.swing blk > Block zones” and associate the “general” signal to the 1.2 output.

INSTRUMENTOS PARA TESTES ELÉTRICOS

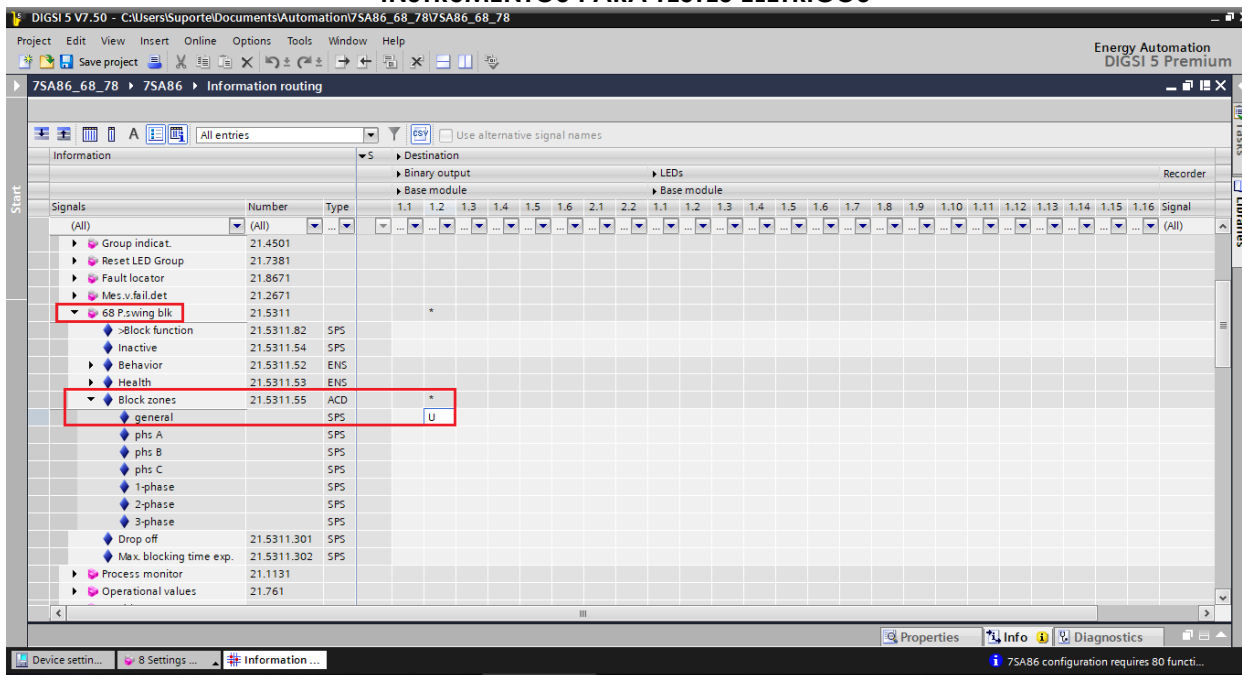


Figure 36

Enter the options “78 Out-of-step > Zone 1” and associate the “Out-of-step condition” signal into output 1.3.

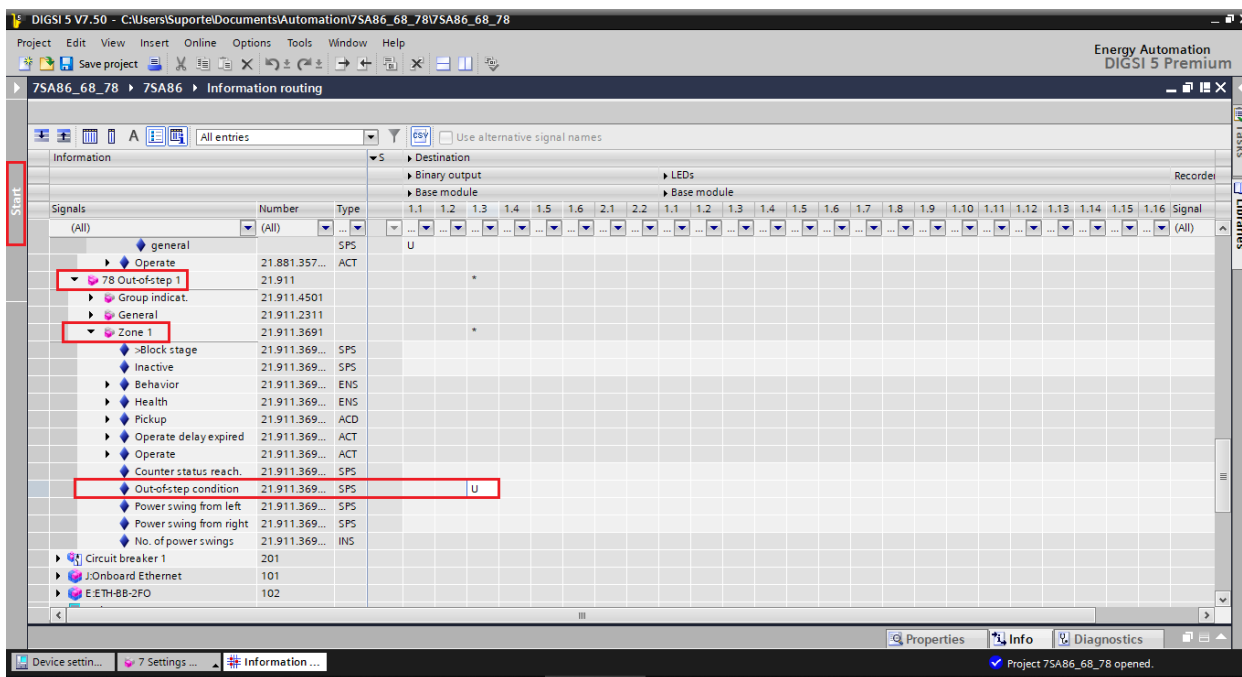


Figure 37

Click on the “Start” option so that the main window is shown again.

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3.13 *Sending adjustments*

To send the changes in the parameterization, right-click on the relay icon “7SA86” and choose the option “Load configuration to device”.

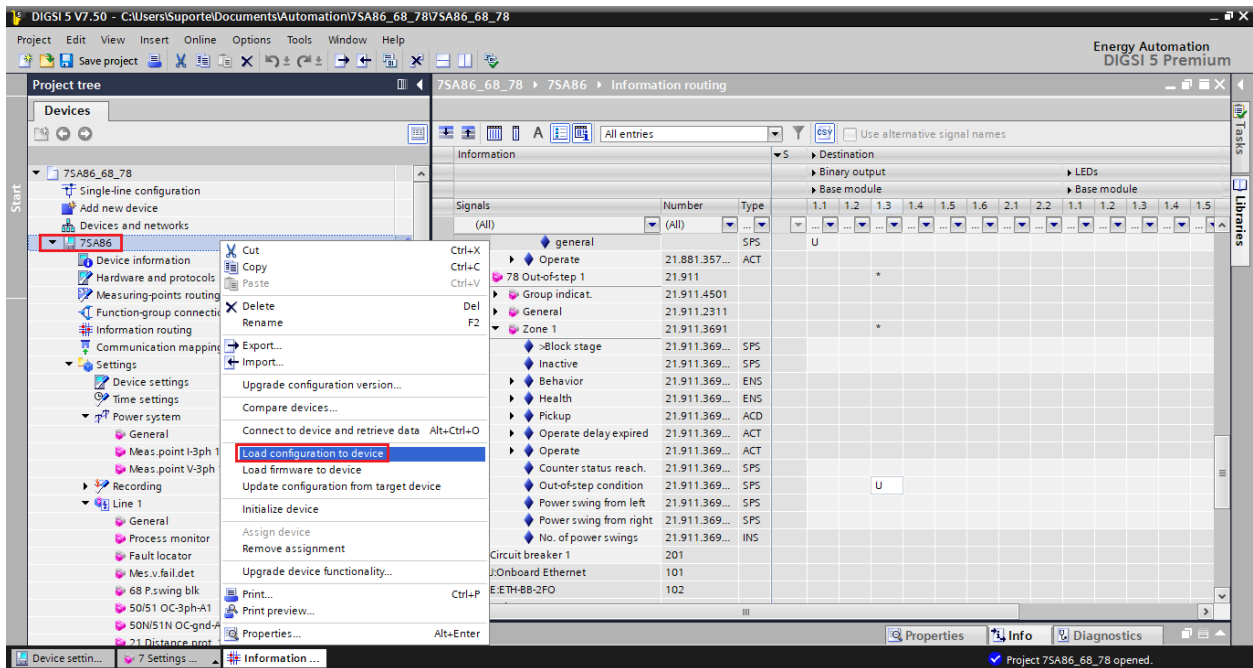


Figure 38

Remembering that the default password Siemens SIPROTE 5: “222222”.

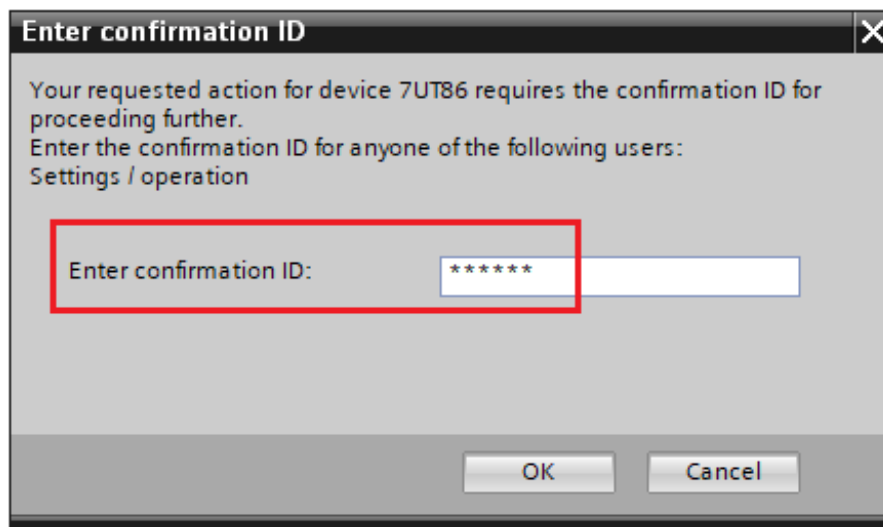


Figure 39

In the next two windows not shown, choose the “Yes” option.

INSTRUMENTOS PARA TESTES ELÉTRICOS

4. PSB OoS software adjustments

4.1 Opening the PSB OoS

Click on the “CTC” application manager icon.



Figure 40

Click the “PSB OoS” software icon.

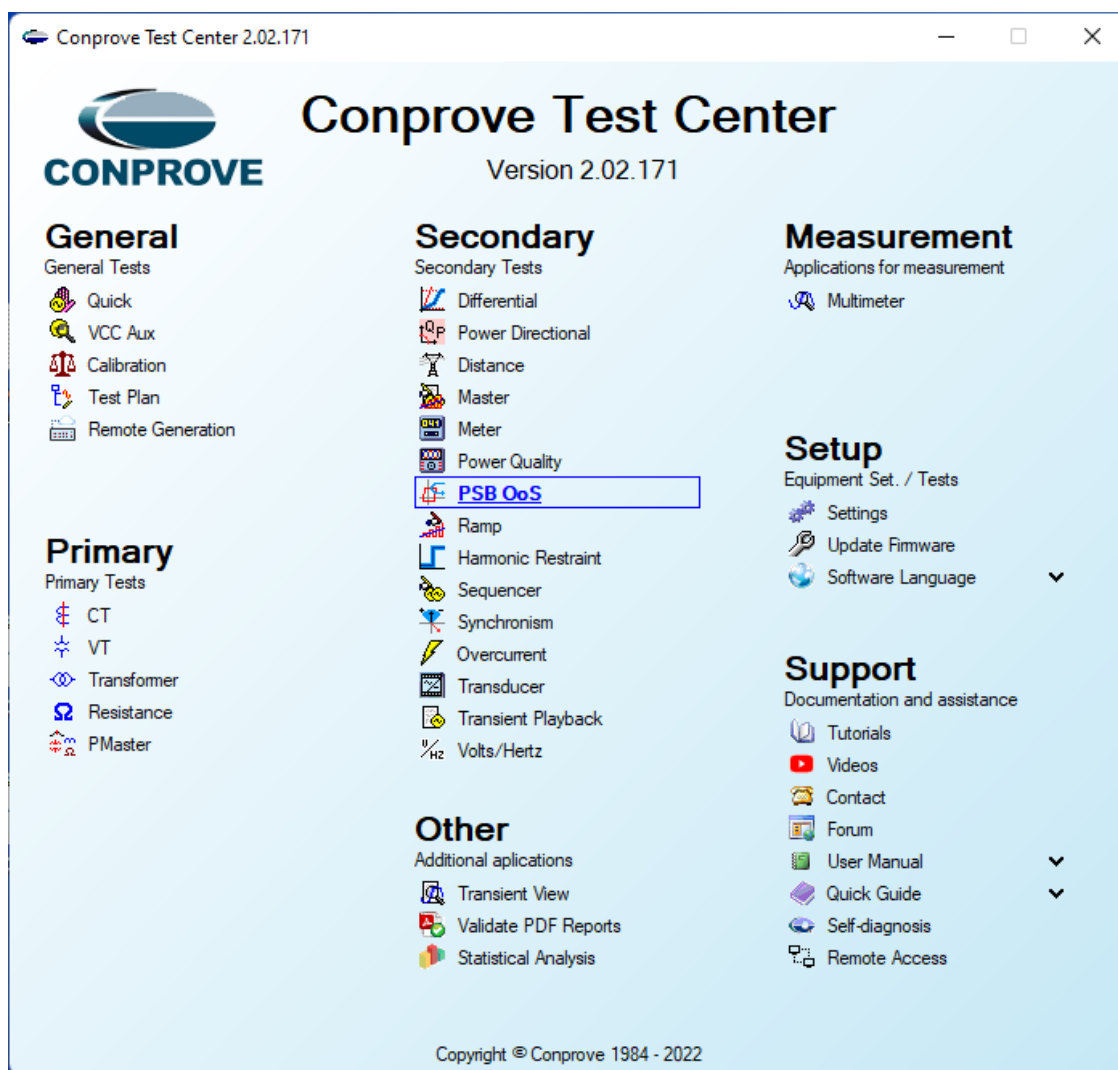


Figure 41

INSTRUMENTOS PARA TESTES ELÉTRICOS

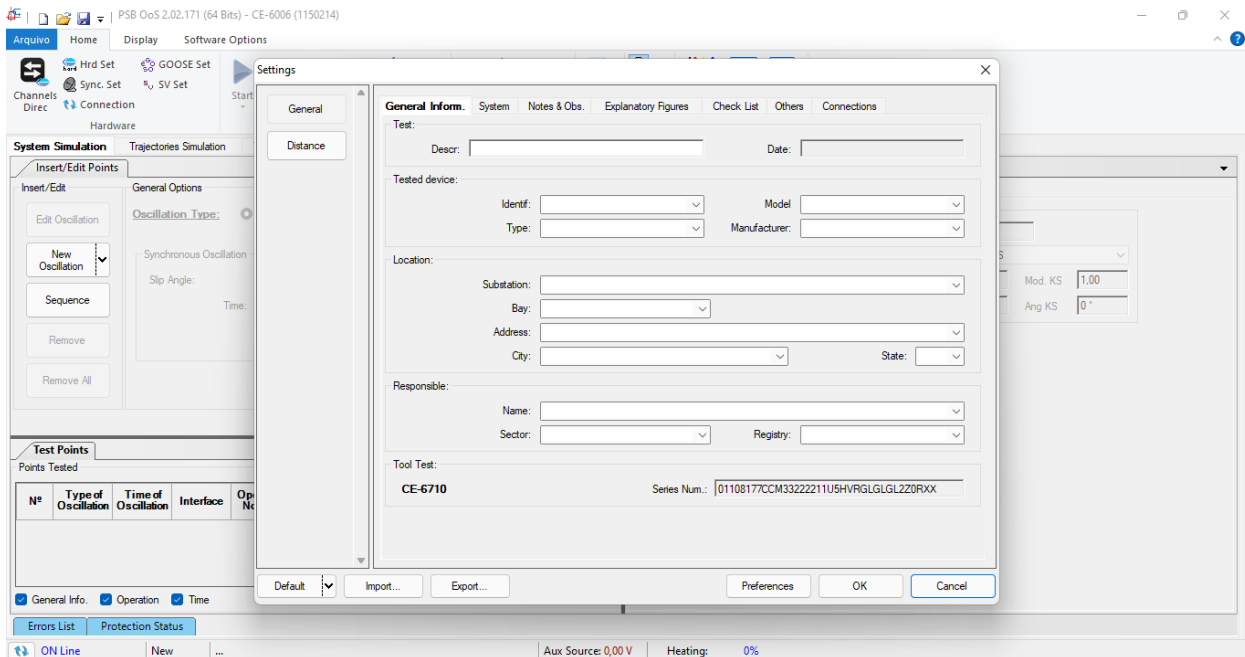


Figure 42

4.2 Configuring the Settings

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

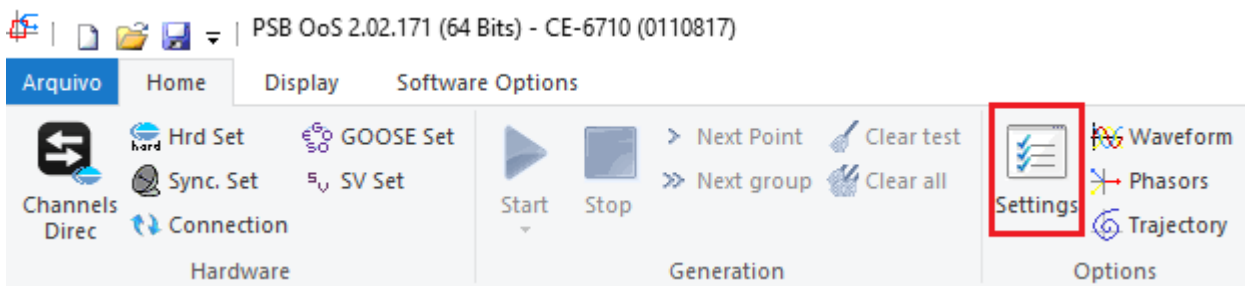


Figure 43

Inside the “*Settings*” screen, fill in the “*General Inform.*” with details of the tested device, installation location and the person responsible. This makes reporting easier, as this tab will be the first to be shown.

INSTRUMENTOS PARA TESTES ELÉTRICOS

Settings

General Inform. System Notes & Obs. Explanatory Figures Check List Others Connections

Test:
 Descr: Power Swing Block and Out of Step Date: 07/04/2022 11:00:34

Tested device:
 Identif: 23031982 Model: 7SA86
 Type: Line Protection Manufacturer: Siemens

Location:
 Substation: Conprove
 Bay: 1
 Address: Visconde de Ouro Preto 75, Custódio Pereira
 City: Uberlândia State: MG

Responsible:
 Name: Michel Rockembach de Carvalho
 Sector: Engineering Registry: 0001

Tool Test:
CE-6710 Series Num.: 01108177CCM3322211U5HVRGLGLL2Z0RXX

Default Export... Preferences OK Cancel

Figure 44

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

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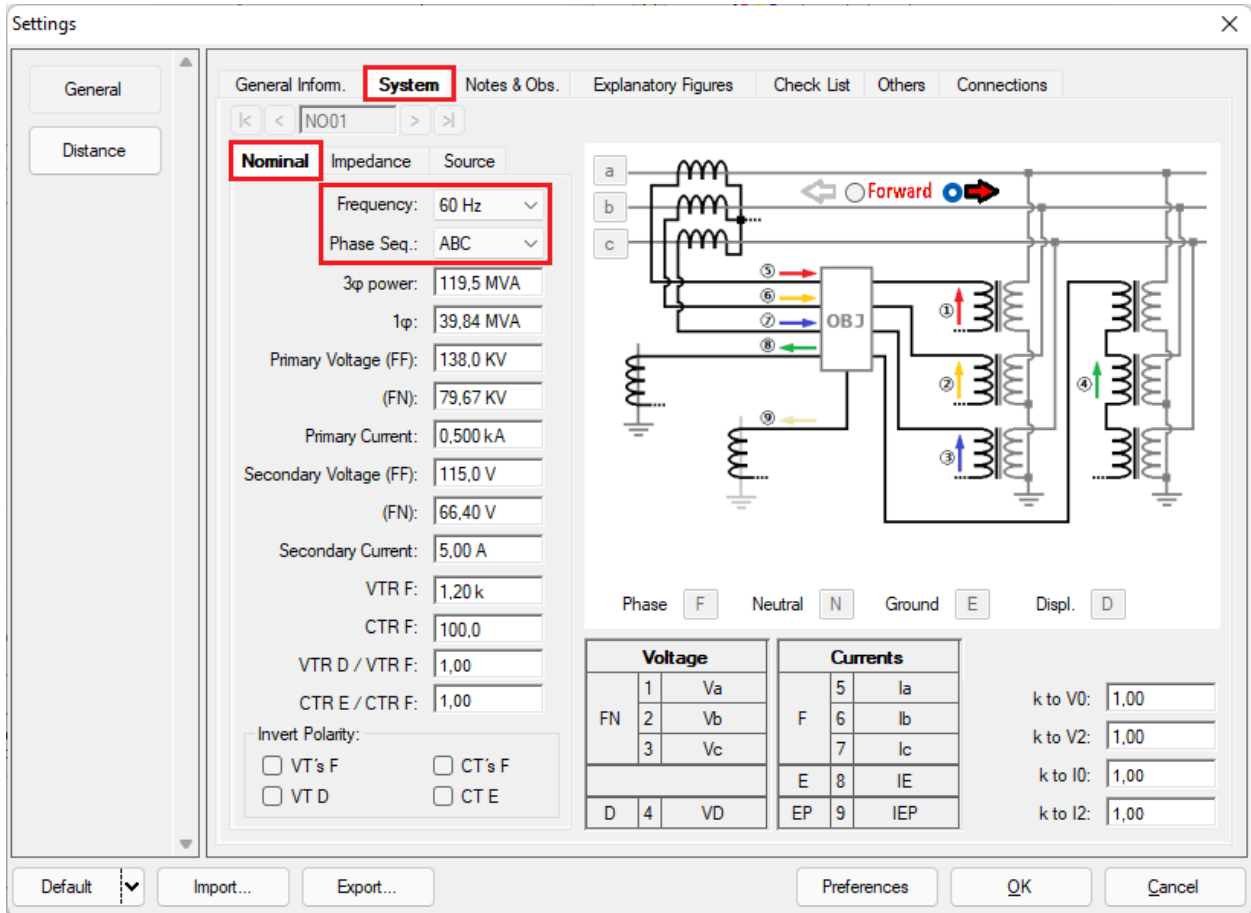


Figure 45

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.

5. Channel Targeting and Hardware Configurations

Click on the icon illustrated below.

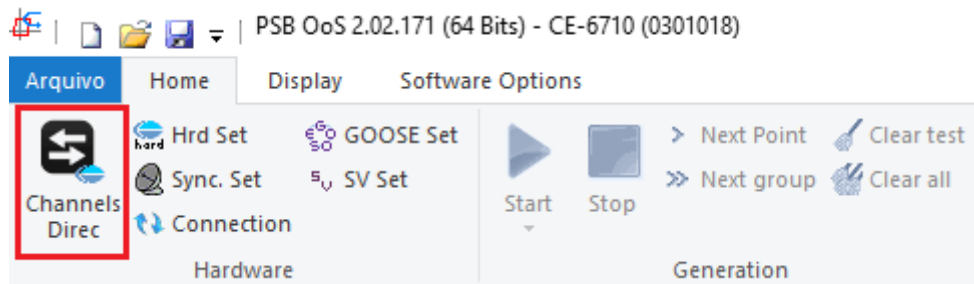


Figure 46

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Then click on the highlighted icon to configure the hardware.

Channels Direct.

Local: Model: CE-6710, Serial Number: 03010187CCM3322211U5HVRGLGL2Z0RX0, ON Line checked.

Hard.: Adapt I/Os, Autoassociate, Clean. Nodes: Autoassociate, Clean. Confirm, Cancel, Import..., Export...

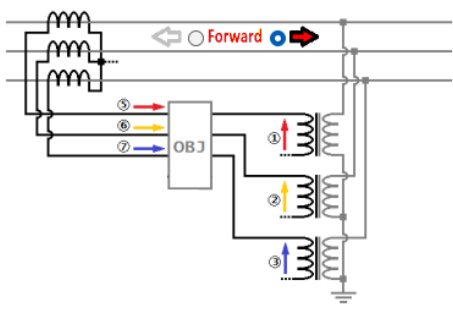
Outputs: Analog. and SV. Inputs: Analog. and SV. Outputs: Binary, GOOSE and Analog DC. Inputs: Binary, GOOSE and Analog. DC. Logical.

1/1

Nominal Line Source

Frequency: 60 Hz
Phase Seq.: ABC
3 ϕ power: 119,5 MVA
1 ϕ : 39,84 MVA
Primary Voltage (FF): 138,0 KV
(FN): 79,67 KV
Primary Current: 0,500 kA
Secondary Voltage (FF): 115,0 V
(FN): 66,40 V
Secondary Current: 5,00 A
VTR F: 1,20 k
CTR F: 100,0
VTR D / VTR F: 1,00
CTR E / CTR F: 1,00

Reverse Polarity:
 VT's F CT's F
 VT D CT E
 Equal Parameters Among Nodes



Forward

Voltage		Channel	Currents		Channel	
1	Va	AO_V01	5	Ia	AO_I01	
2	Vb	AO_V02	6	Ib	AO_I02	
3	Vc	AO_V03	7	Ic	AO_I03	
	Vab		8	IE		
	Vbc		9	IEP		
	Vca					
4	VD					
	k.V0			k.I0		
	k.V2			k.I2		
k	to V0	1,00	to I0	1,00	to I2	1,00

Analog Outputs

Descr.	Hardware	Node	Point
AO_V01	V1	NO01	Va
AO_V02	V2	NO01	Vb
AO_V03	V3	NO01	Vc
AO_V04	V4	NO01	UD

Current Channels

Descr.	Hardware	Node	Point
AO_I01	I1	NO01	Ia
AO_I02	I2	NO01	Ib
AO_I03	I3	NO01	Ic
AO_I04	I4	NO01	UD
AO_I05	I5	NO01	UD
AO_I06	I6	NO01	UD

Figure 47

Choose channel configuration, adjust auxiliary source and stop method of binary inputs. Finally, click on "OK".

INSTRUMENTOS PARA TESTES ELÉTRICOS

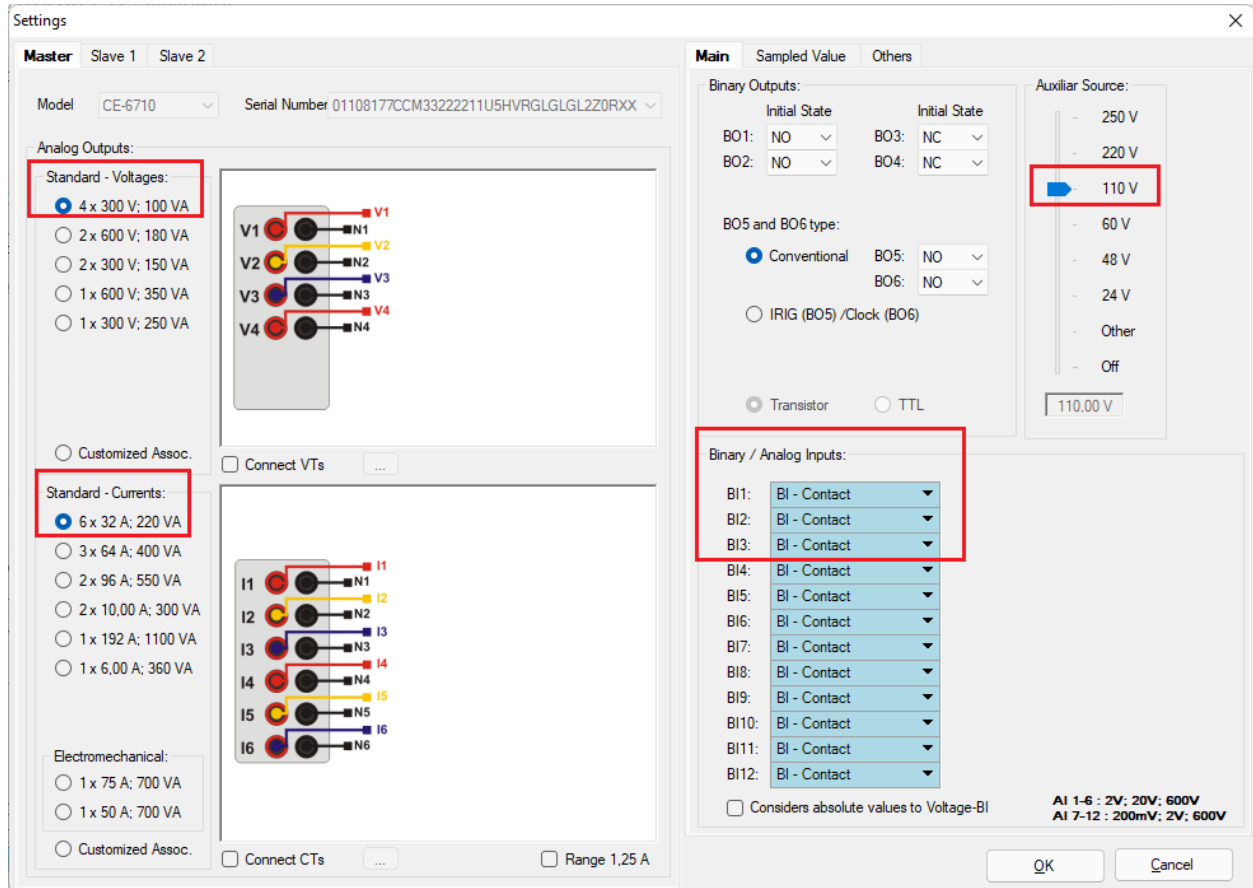


Figure 48

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

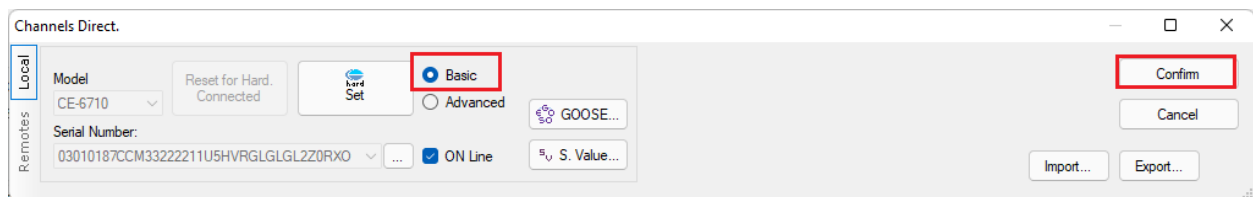


Figure 49

6. Distance Adjustments

6.1 Distance screen > Distance Prot. Settings

Click on the “*Settings*” icon and the “*Distance*” button, and the screen shows the parameters of length, line angle and earth compensation factor. For this specific test there is no need to configure them.

INSTRUMENTOS PARA TESTES ELÉTRICOS

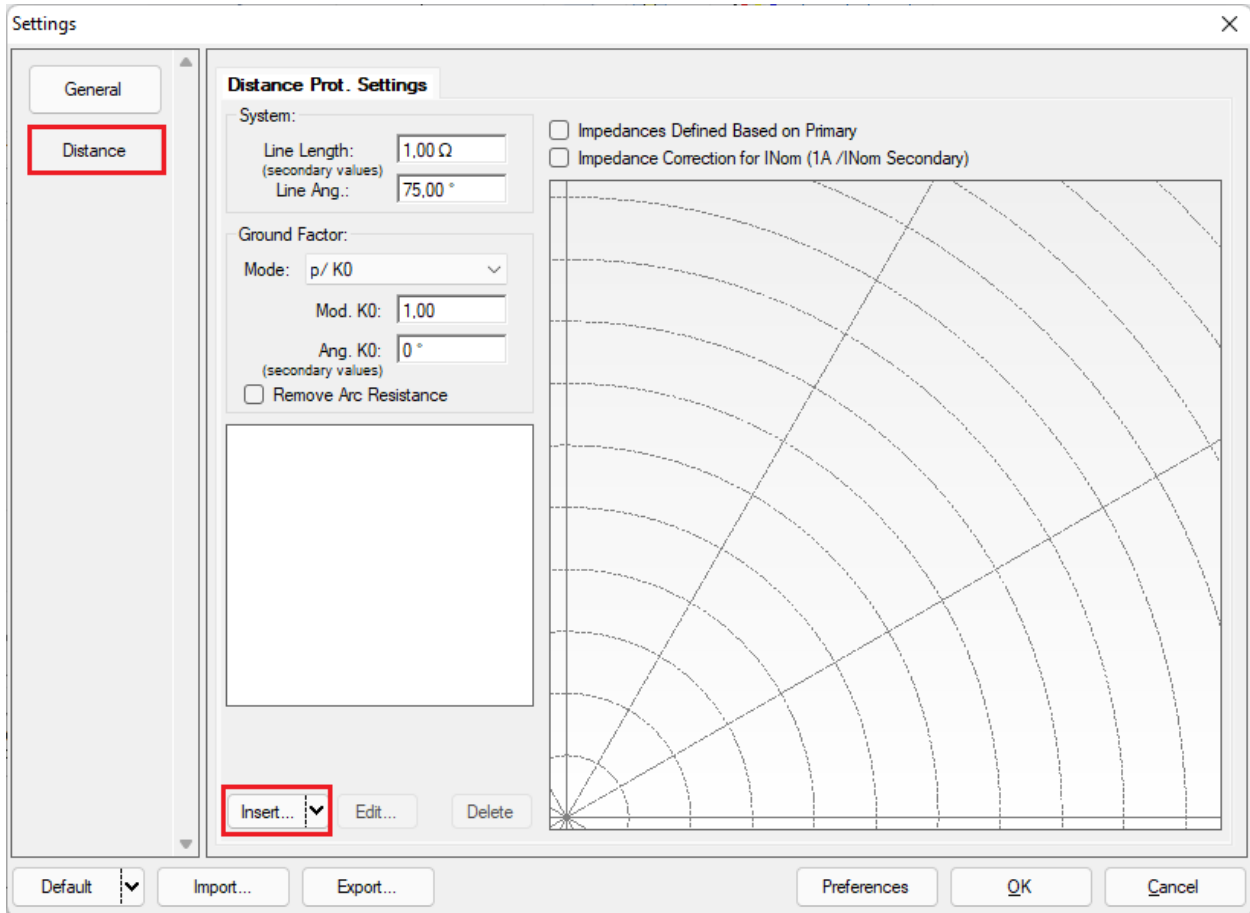


Figure 50

6.2 Entering Zone 1

Note: There is an extremely practical and fast way to import the characteristic of the zones. See Appendix C.

Click on the button “Insert...” choose the mask for the relay “SIEMENS 7SA6/7SA8/7SL8- Quadr.” and configure the settings. Click “OK” then.

INSTRUMENTOS PARA TESTES ELÉTRICOS

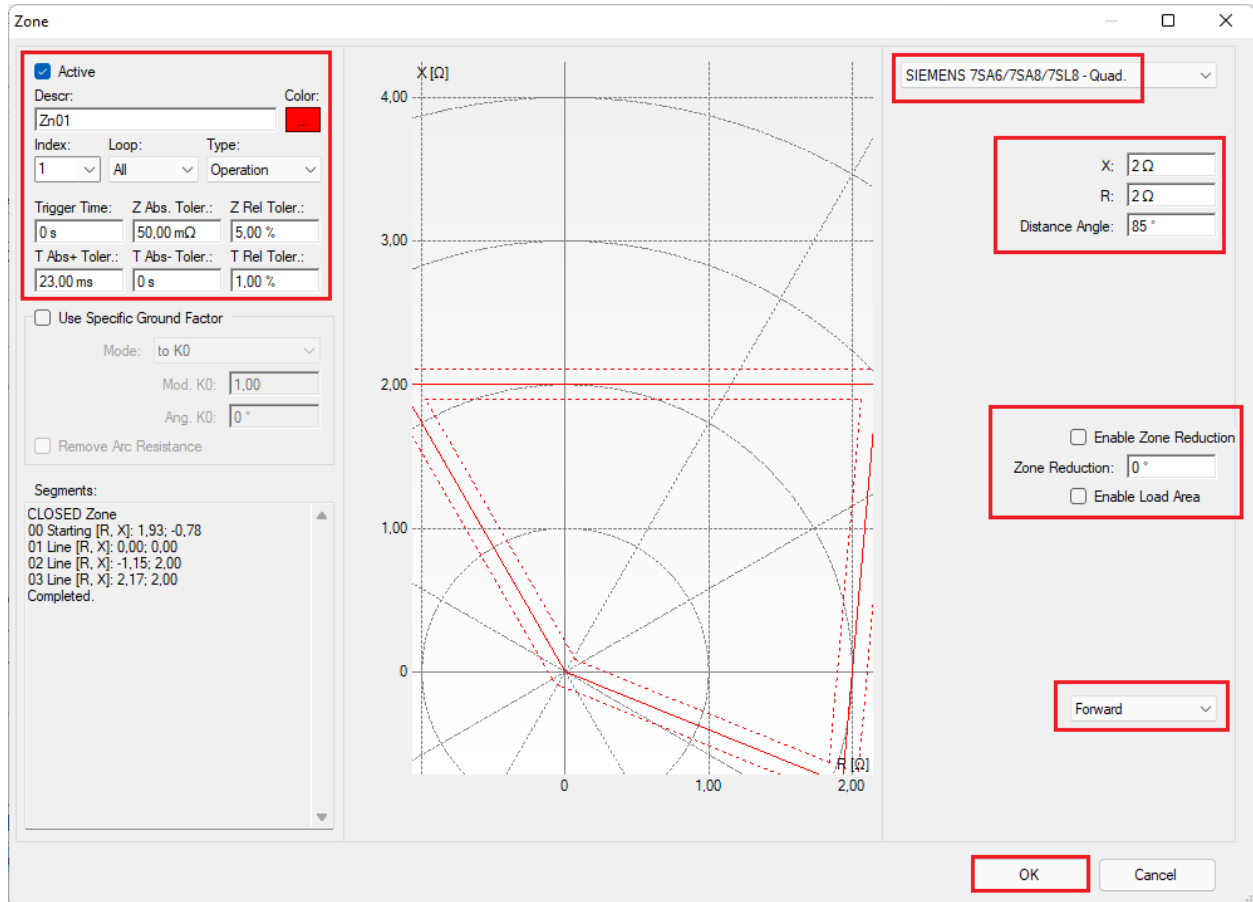


Figure 51

7. Test structure for PSB_OoS functions

7.1 Test Settings

By clicking on the “*Test Settings*” tab, the user must direct the channels and adjust the binary inputs as follows:

- BI01 = Dist Trip;
- BI02 = PSB Alarm;
- BI03 = Trip OoS.

Enable a pre-simulation condition with nominal conditions and 0.1s.

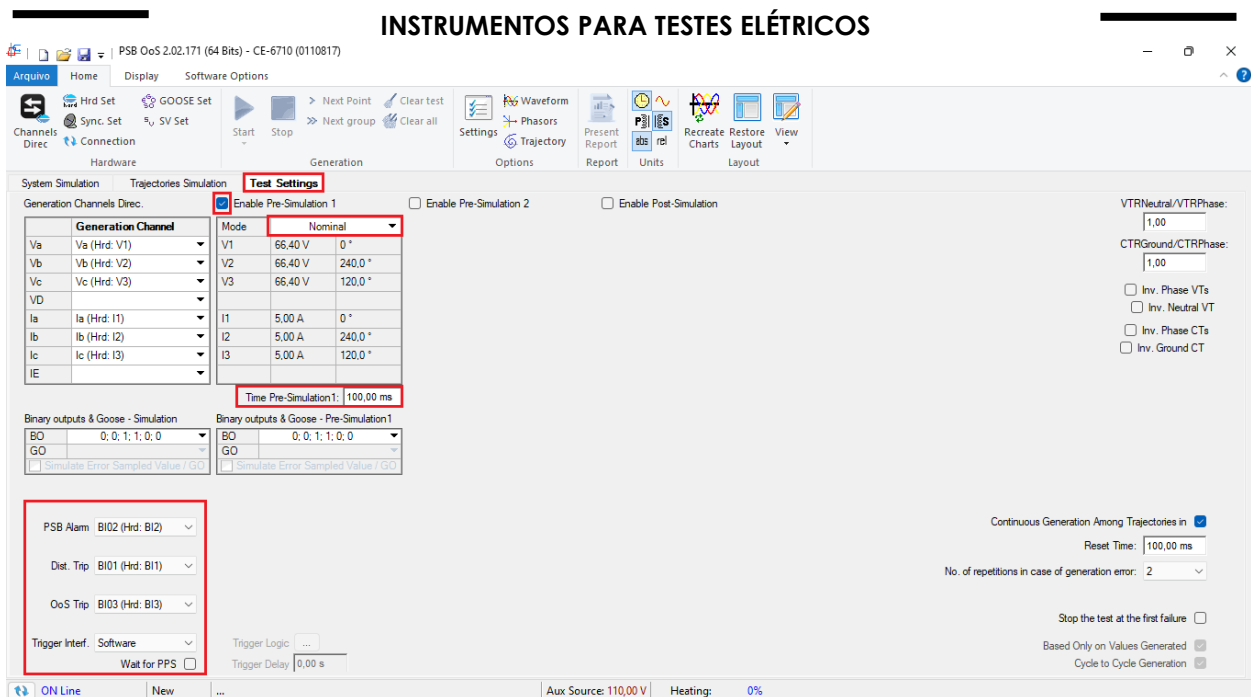


Figure 52

7.2 System Simulation

For the “*System Simulation*” test, a study must be carried out in order to simplify the system to two voltage sources with a line between them so that the power oscillations will occur according to these parameters. As we do not have this study, we chose the option “*Trajectories Simulation*”.

7.3 Trajectories Simulation

The “*Trajectories Simulation*” test makes it possible to create the same tests as the “*System Simulation*” however it has the flexibility of not being tied to the system modeling settings, so that the user has complete freedom to control the impedance trajectory (dZ/dt).

7.4 Synchronous Oscillation Trajectory Simulation

In the following test, a synchronous oscillation is simulated, where the activation of the Power Swing Alarm is expected. To perform the test click on “*New Trajectory*” then choose the number of points, impedance and angle values. The next step is to enter the rate of change of the impedance which must be different from “0”. Choose the value of dZ/dt equal to $20.0\Omega/s$.

INSTRUMENTOS PARA TESTES ELÉTRICOS

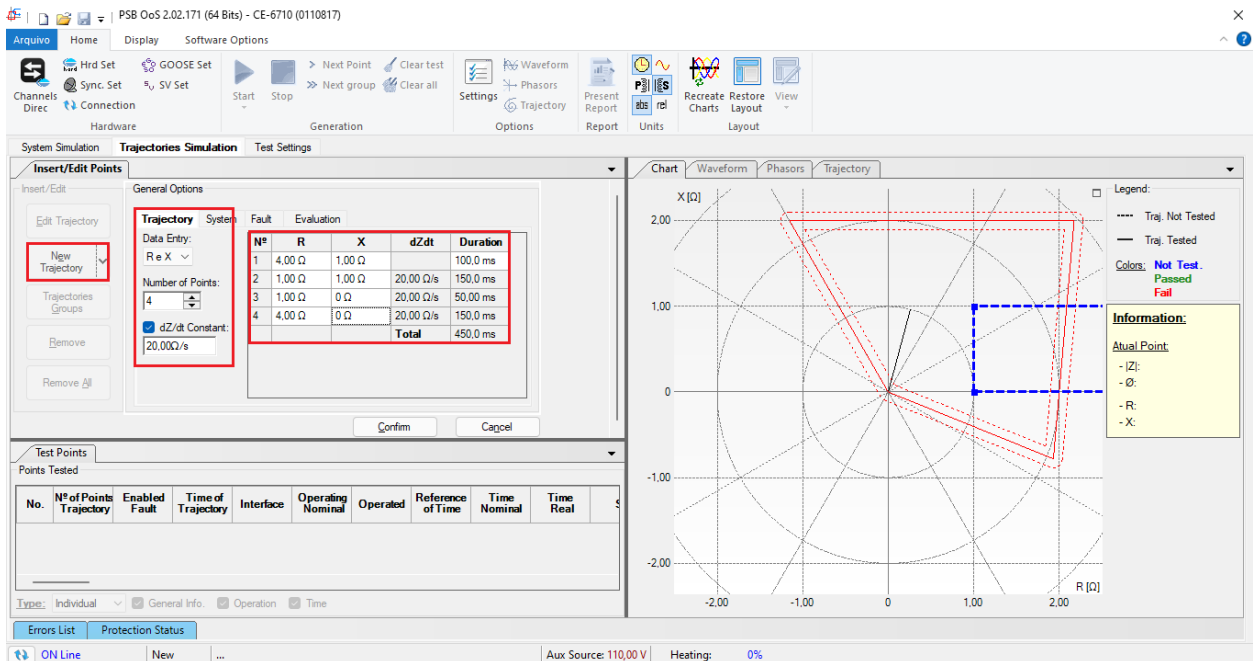


Figure 53

The next step is to configure the “System” tab.

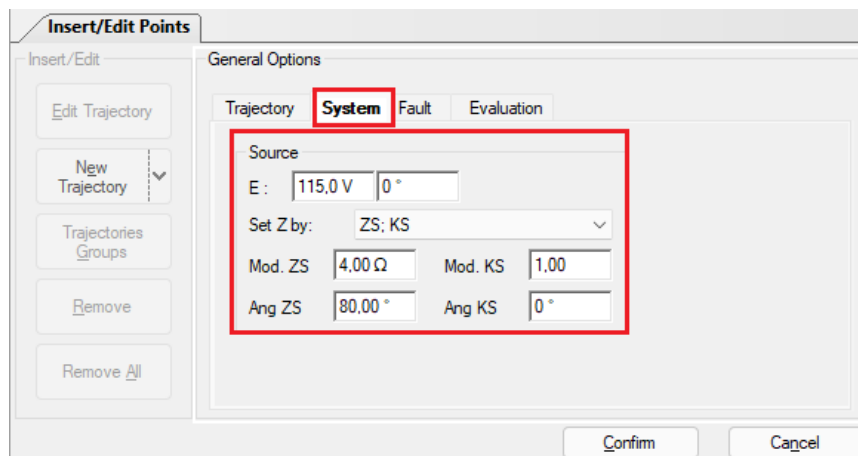


Figure 54

It is not necessary to make any adjustments in the “Fault” tab. The next step in the “Evaluation” tab is to set the “Operation” field to “Yes” and the “Interface” to “PSB Alarm” then click on “Confirm”.

INSTRUMENTOS PARA TESTES ELÉTRICOS

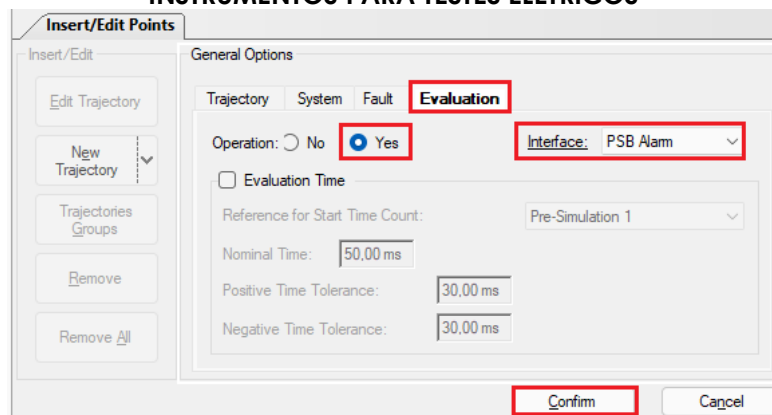


Figure 55

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

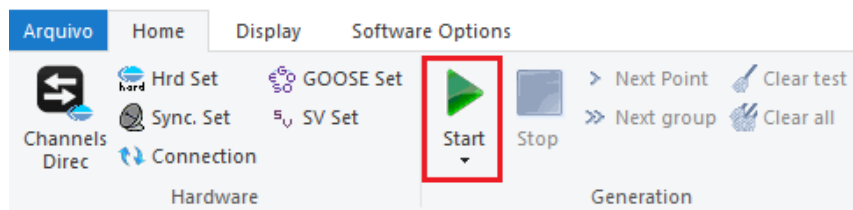


Figure 56

After the end of the test, it is possible to visualize the waveforms, actuation of the binary inputs and the impedance and power trajectories.

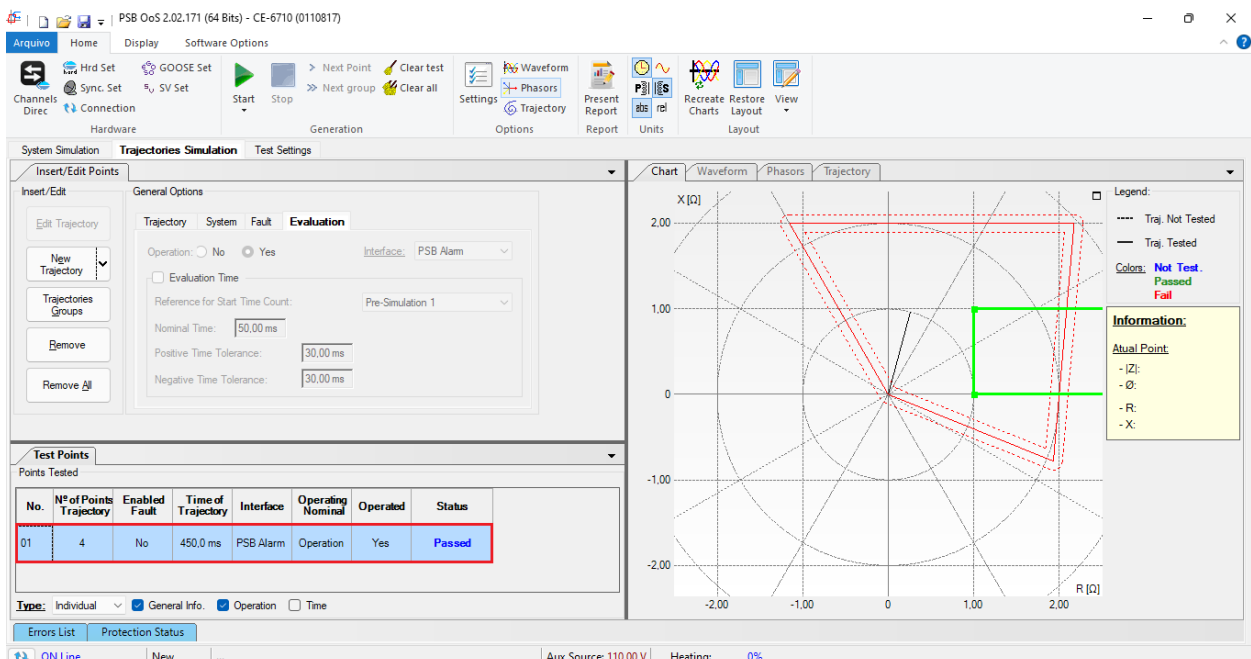


Figure 57

INSTRUMENTOS PARA TESTES ELÉTRICOS

7.5 Simulation of Asynchronous Oscillation Trajectories

In this test, the performance of function 78 is verified. For this, make the following adjustments:

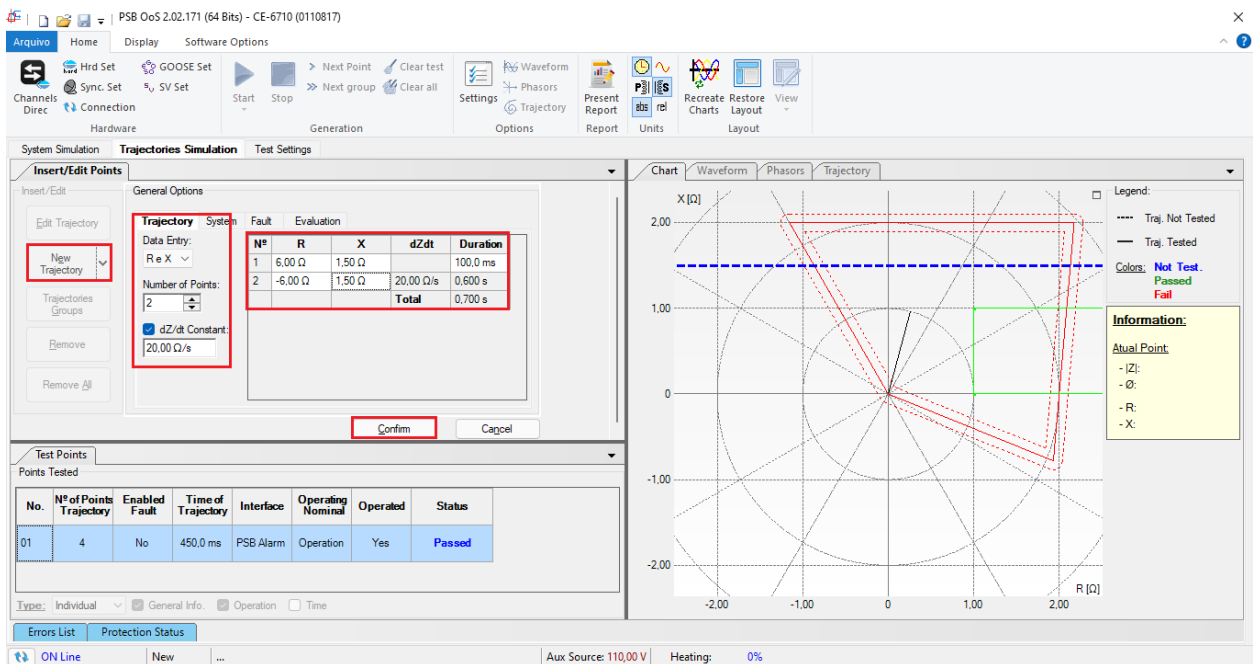


Figure 58

The parameters of the “System” tab are the same as in the previous test. The “Fault” field does not need to be adjusted and in the “Evaluation” option, make the following adjustments:

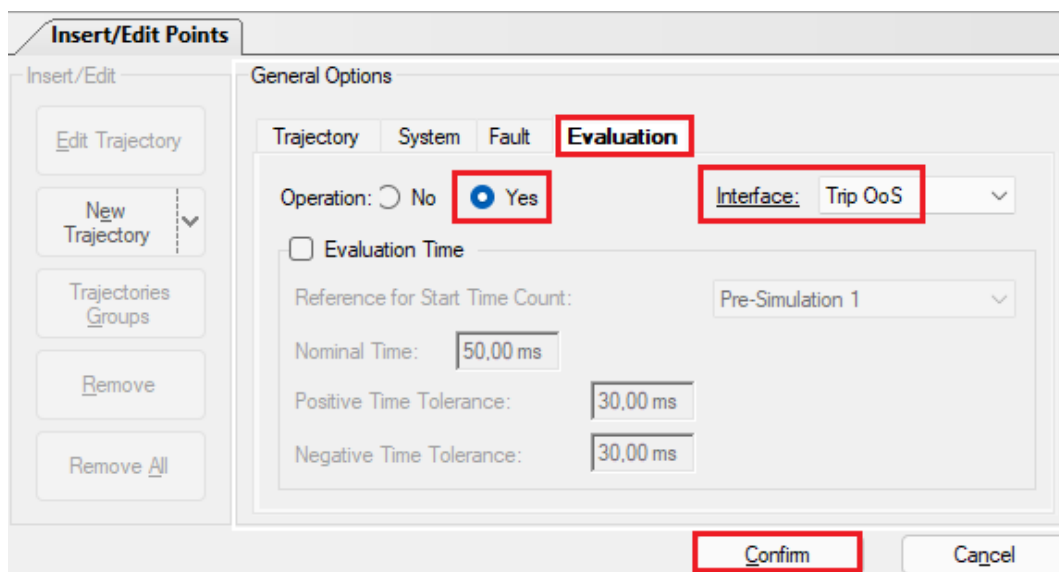


Figure 59

INSTRUMENTOS PARA TESTES ELÉTRICOS

After generating the signals, check the waveforms, the performance of the binary, the impedance trajectory and the time between the blinders following the final result.

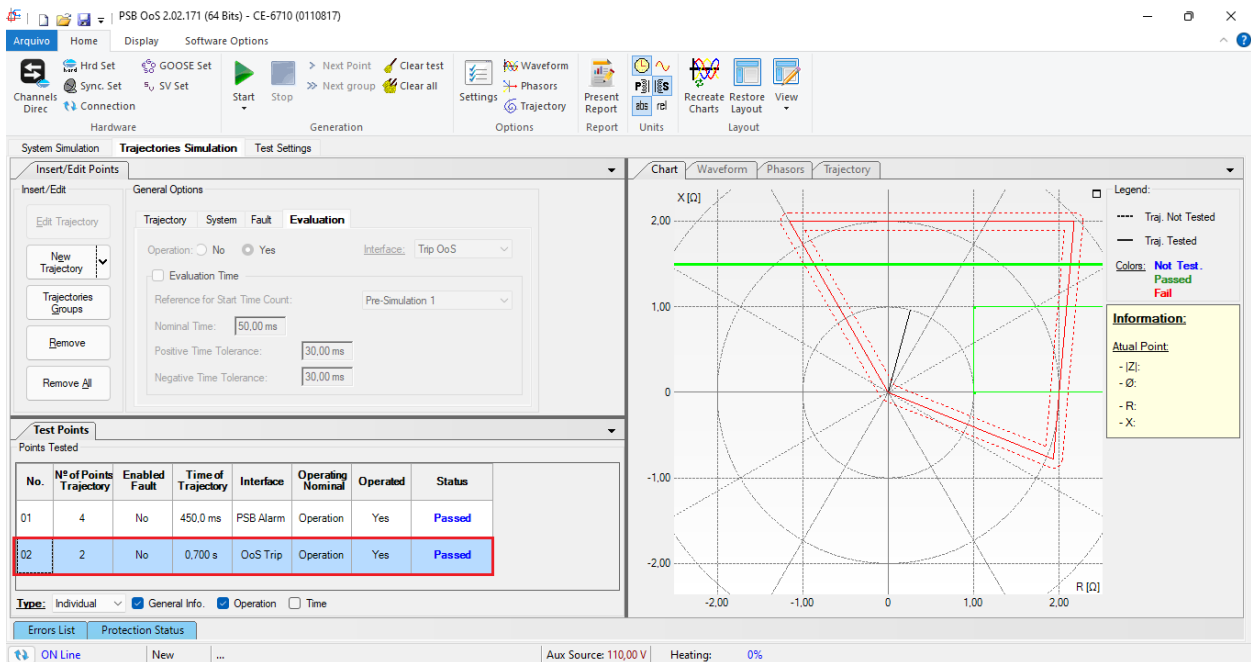


Figure 60

7.6 Simulation of Three-Phase Fault Trajectories

In this test, the performance of the distance trip is verified. In this case, a dZ/dt of $100.00\Omega/s$ should be set. To do this, make the following adjustments:

INSTRUMENTOS PARA TESTES ELÉTRICOS

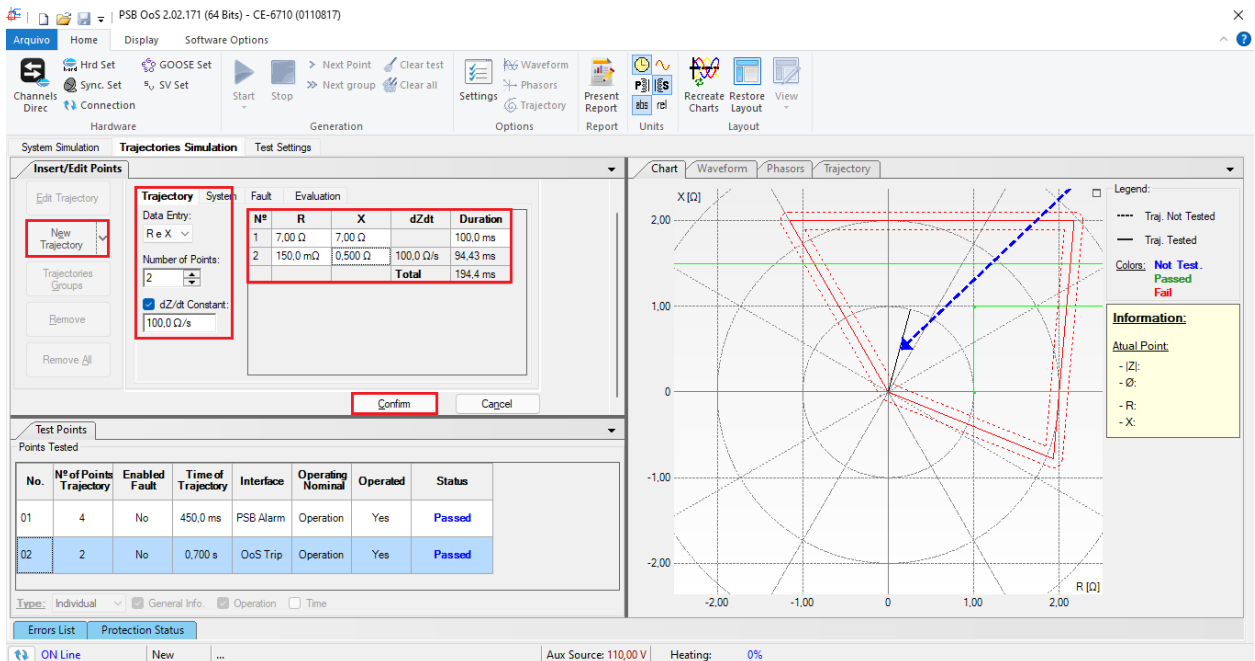


Figure 61

The parameters of the “System” tab are the same as in the previous test. The “Fault” field must be set as follows:

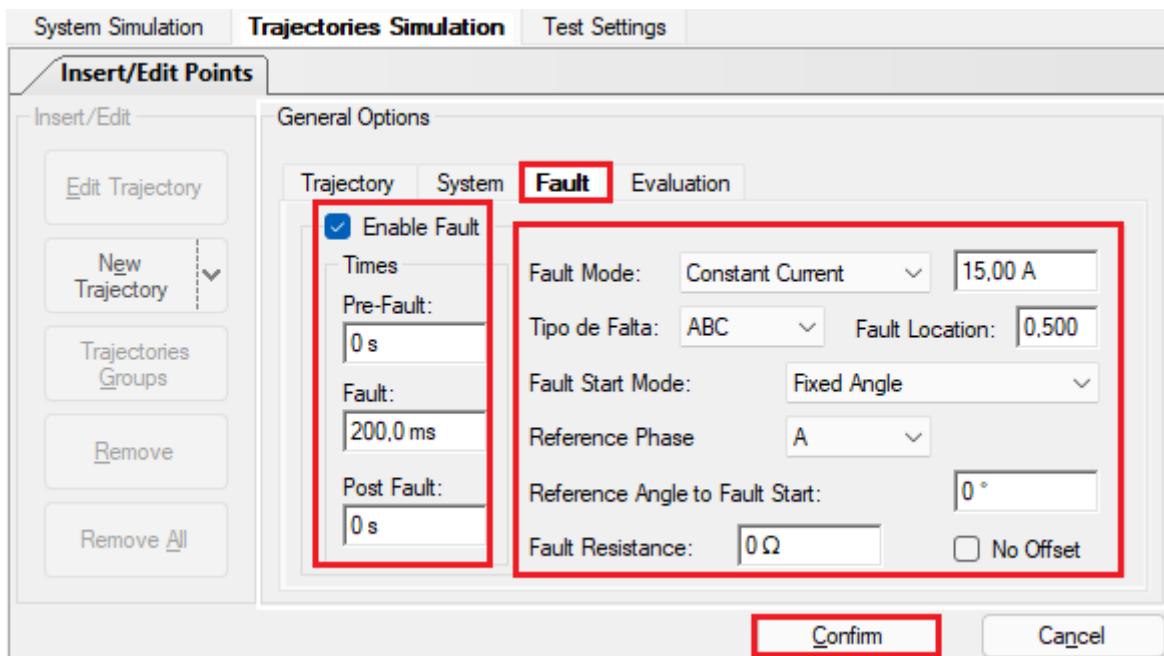


Figure 62

In the “Evaluation” option, make the following adjustments:

INSTRUMENTOS PARA TESTES ELÉTRICOS

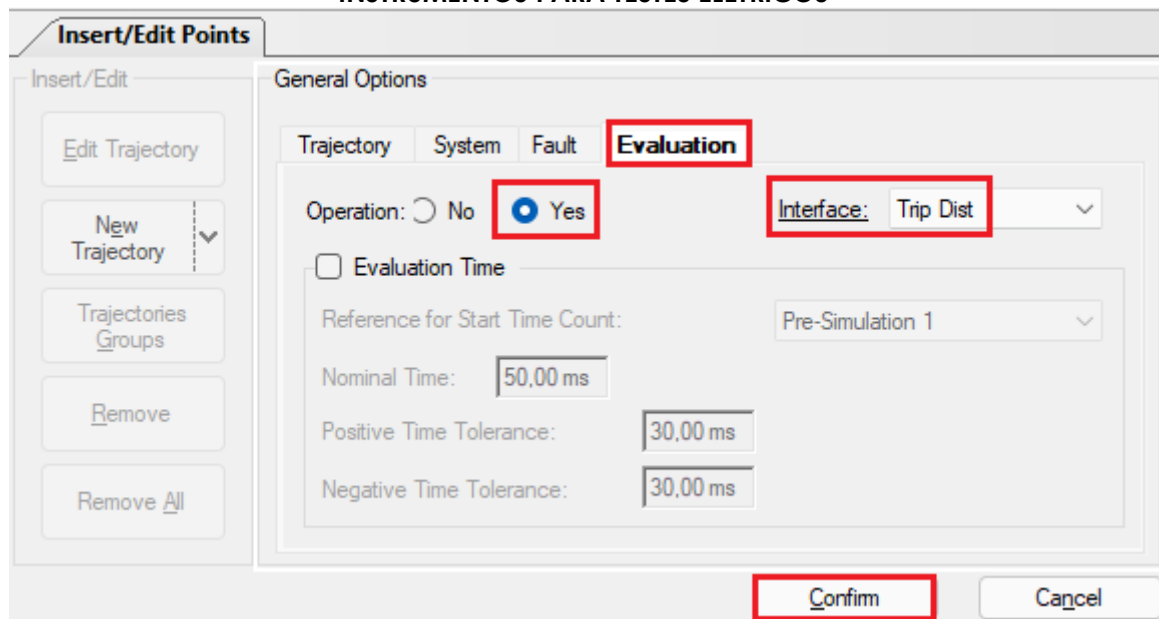


Figure 63

After generating the signals, check the waveforms, the performance of the binary, the impedance trajectory and the time between the blinders following the final result.

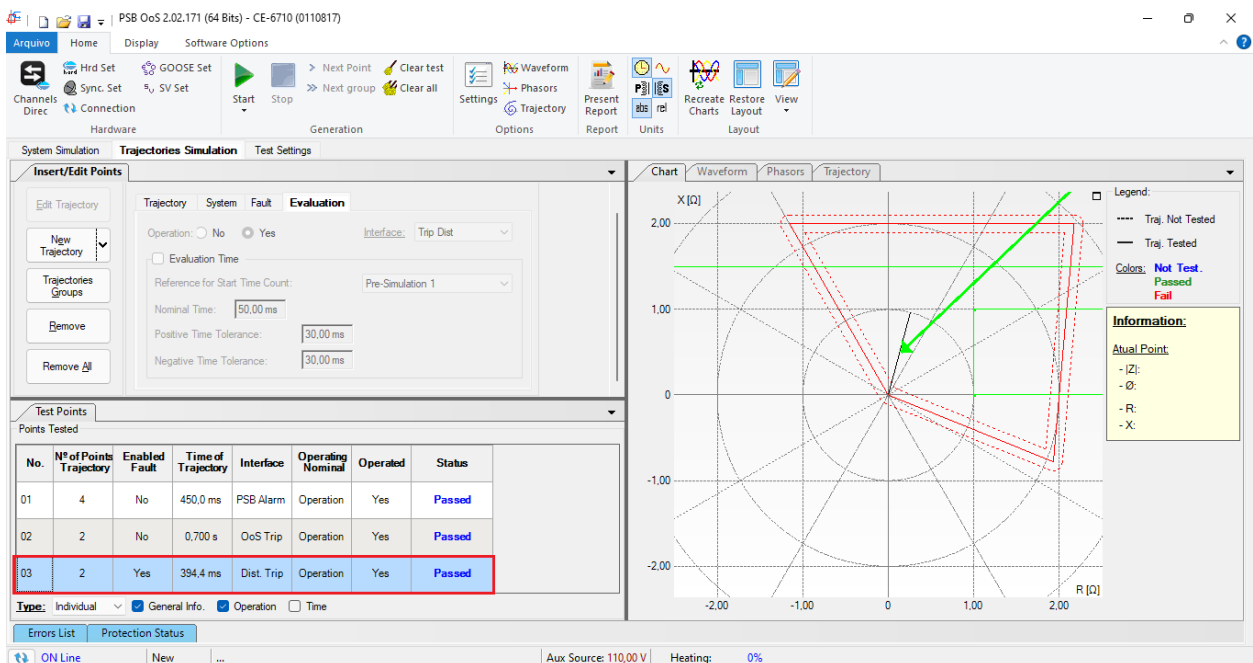


Figure 64

8. Report

After finishing the test, click on the icon highlighted in the previous figure or use the “*Ctrl +R*” command to call up the report pre-configuration screen. Choose the desired language as well as the options that should be part of the report.

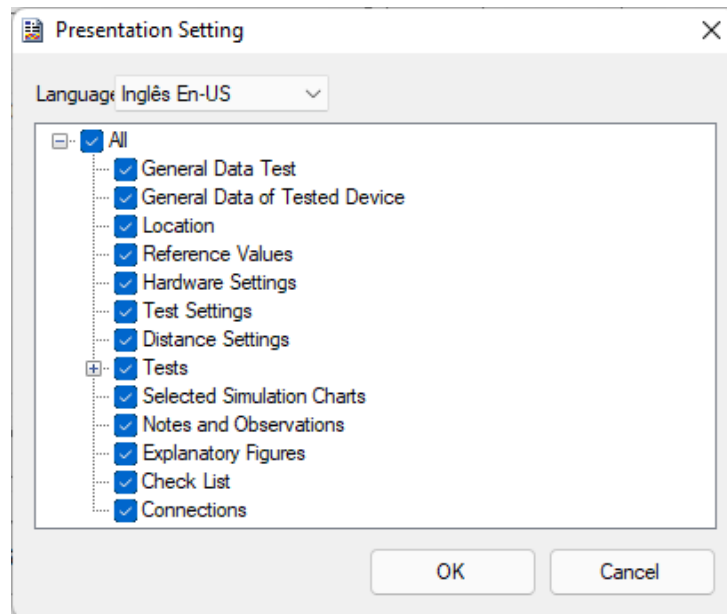


Figure 65

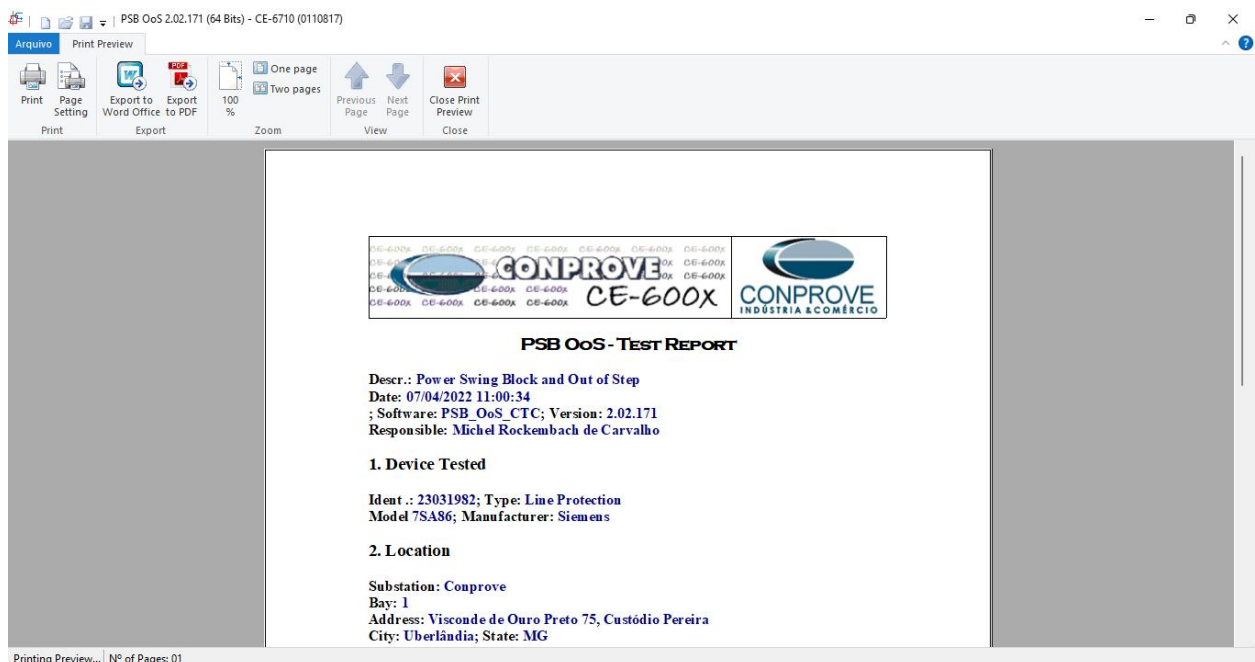


Figure 66

APPENDIX A

A.1 Terminal Designations

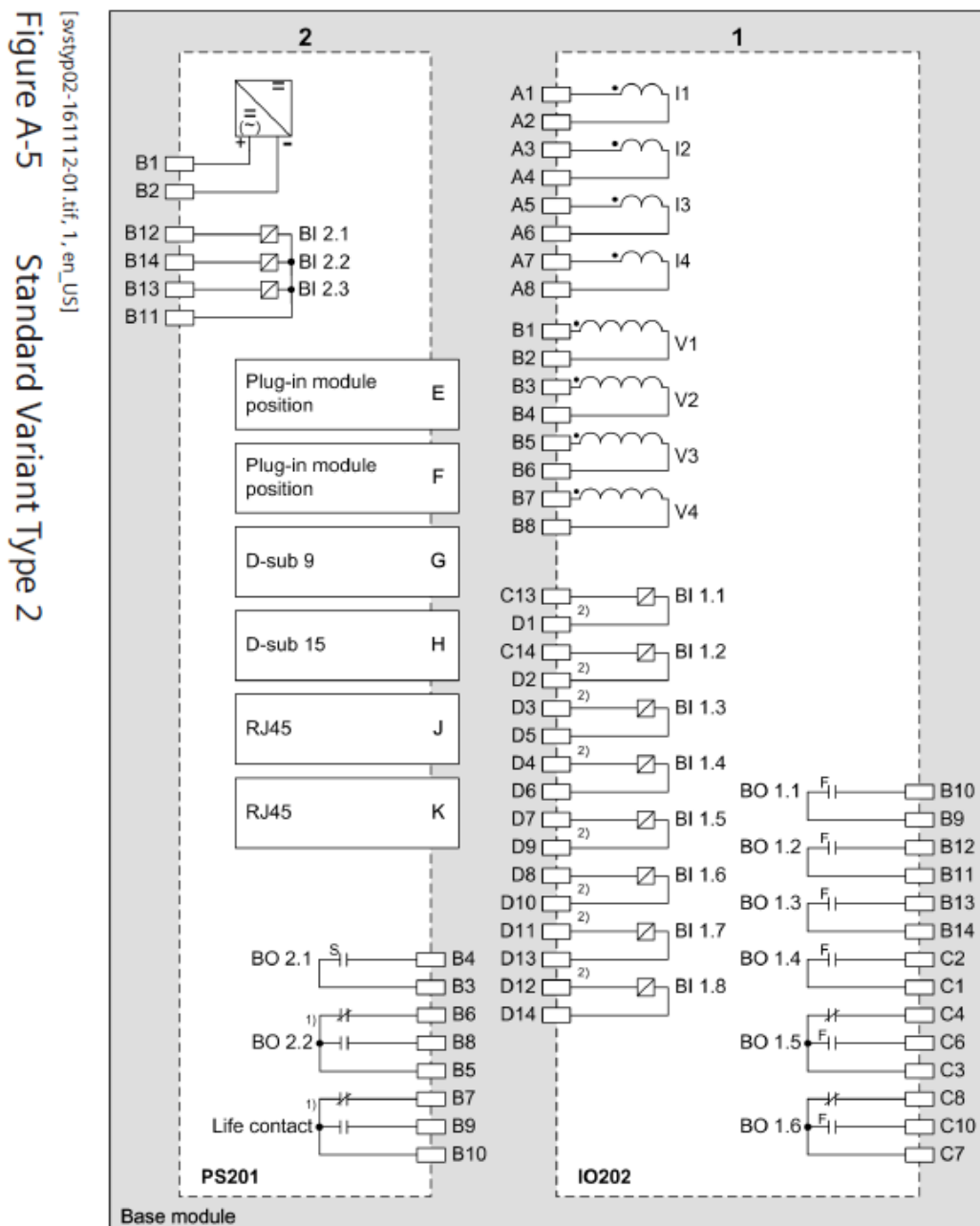


Figure A-5 Standard Variant Type 2

¹⁾ Technical data like type F, but switching time 10 ms

²⁾ Use these terminals to root the binary inputs.

Positions for printed circuit board assemblies on the rear side

Figure 67

INSTRUMENTOS PARA TESTES ELÉTRICOS

A.2 Technical data

Times

Shortest operate time	Approx. 9 ms + OOT ⁴¹ at 50 Hz Approx. 8 ms (60 Hz) + OOT	
Dropout time	Approx. 30 ms	
Incremental times	0.00 s to 60.00 s; ∞ for all zones	Increments of 0.01 s
Timer tolerance	1 % of the setting value or 10 ms	
The times set are pure time delays.		

Direction determination for polygon:			
For all fault types		With actual short-circuit, buffered or cross-polarized voltages	
Directional sensitivity		Dynamically unlimited, stationary about 1 V	
Every zone can be configured as forward, reverse, or non-directional.			
Setting ranges for MHO characteristic:			
Z _r impedance range	For I _{rated} = 1 A	0.050 Ω to 600.000 Ω	Increments of 0.001 Ω
	For I _{rated} = 5 A	0.010 Ω to 120.00 Ω	
Polarization		With buffered or cross-polarized voltages	
Every zone can be configured as forward or backward.			
Load cutout (for impedance pickup):			
R _{load} = Minimum load resistance	For I _{rated} = 1 A	0.050 Ω to 600.000 Ω	Increments of 0.001 Ω
	For I _{rated} = 5 A	0.010 Ω to 120.000 Ω	
φ _{load} = Maximum load angle		20.0° to 60.0°	Increments of 0.1 °
Dropout Ratios			
- Currents		Approx. 0.95	
- Impedances		Approx. 1.05	
Measured-value correction		For ground-current coupling in parallel lines	
Measurement tolerances for sinusoidal measurements		$\left \frac{\Delta X}{X} \right \leq 5\%$ for $30^\circ \leq \varphi_{sc} \leq 90^\circ$	
		$\left \frac{\Delta R}{R} \right \leq 5\%$ for $0^\circ \leq \varphi_{sc} \leq 60^\circ$	
		$\left \frac{\Delta Z}{Z} \right \leq 5\%$ for $-30^\circ \leq \varphi_{sc} - \varphi_{line} \leq 30^\circ$	

APPENDIX B

Equivalence of software parameters and the relay under test.

Table 1

PSB_OoS Software		Siemens 7SA86 Relay	
Distance Angle	51	Dist characteristic angle	26
Forward/Reverse/Non-Directional	51	Directional mode	27
R	51	R (ph-ph)	27
X	51	X reach	27
Temp. Disp.	51	Operate delay (multi -ph)	27

INSTRUMENTOS PARA TESTES ELÉTRICOS

APPENDIX C

In the DIGSI software, right-click on the relay icon “7SA86” and then “Export”.

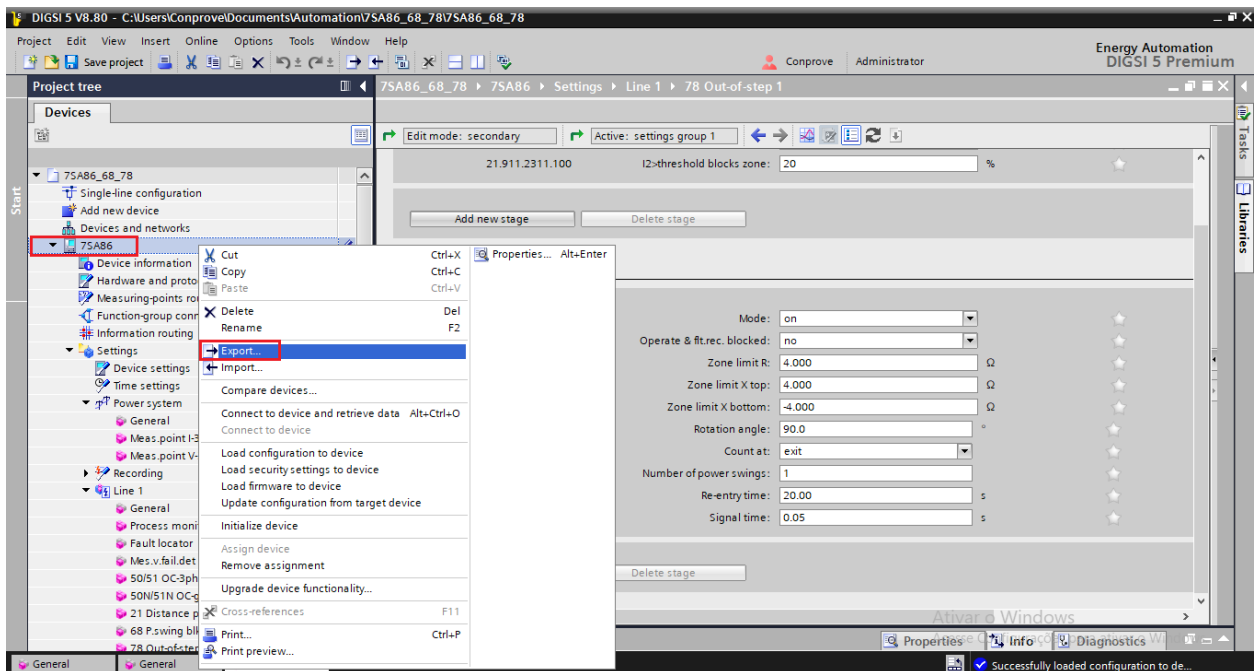


Figure 68

Select the “RIO” option, check the folder where the file will be saved and click the “Export” button.

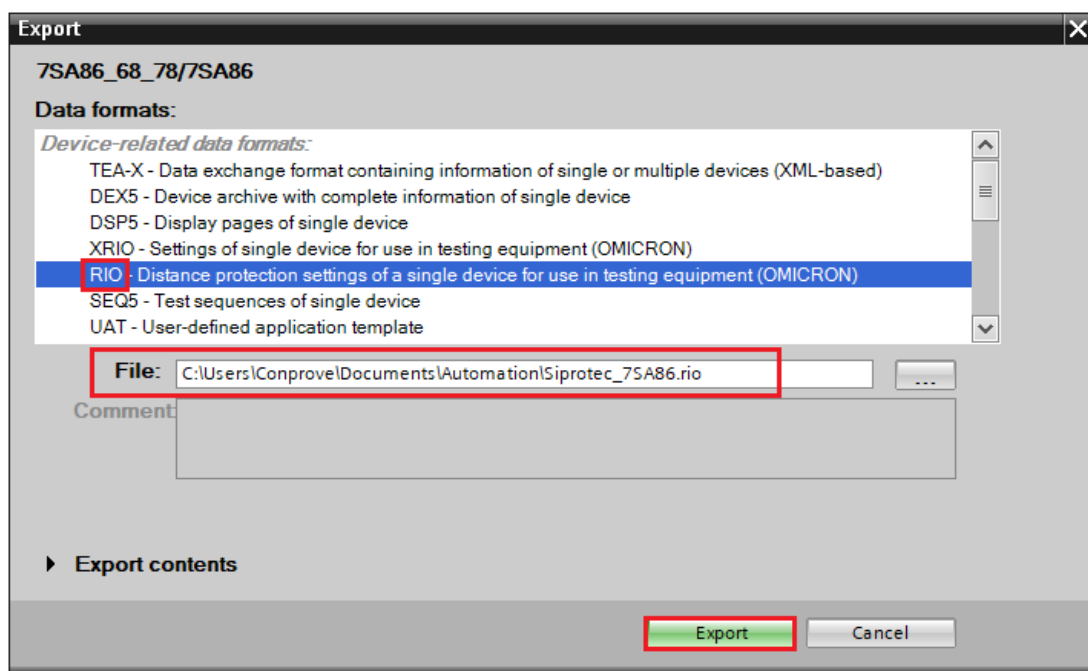


Figure 69

INSTRUMENTOS PARA TESTES ELÉTRICOS

In the PSB_OoS software, inside the “Settings” window, import the file in the “.RIO” extension.

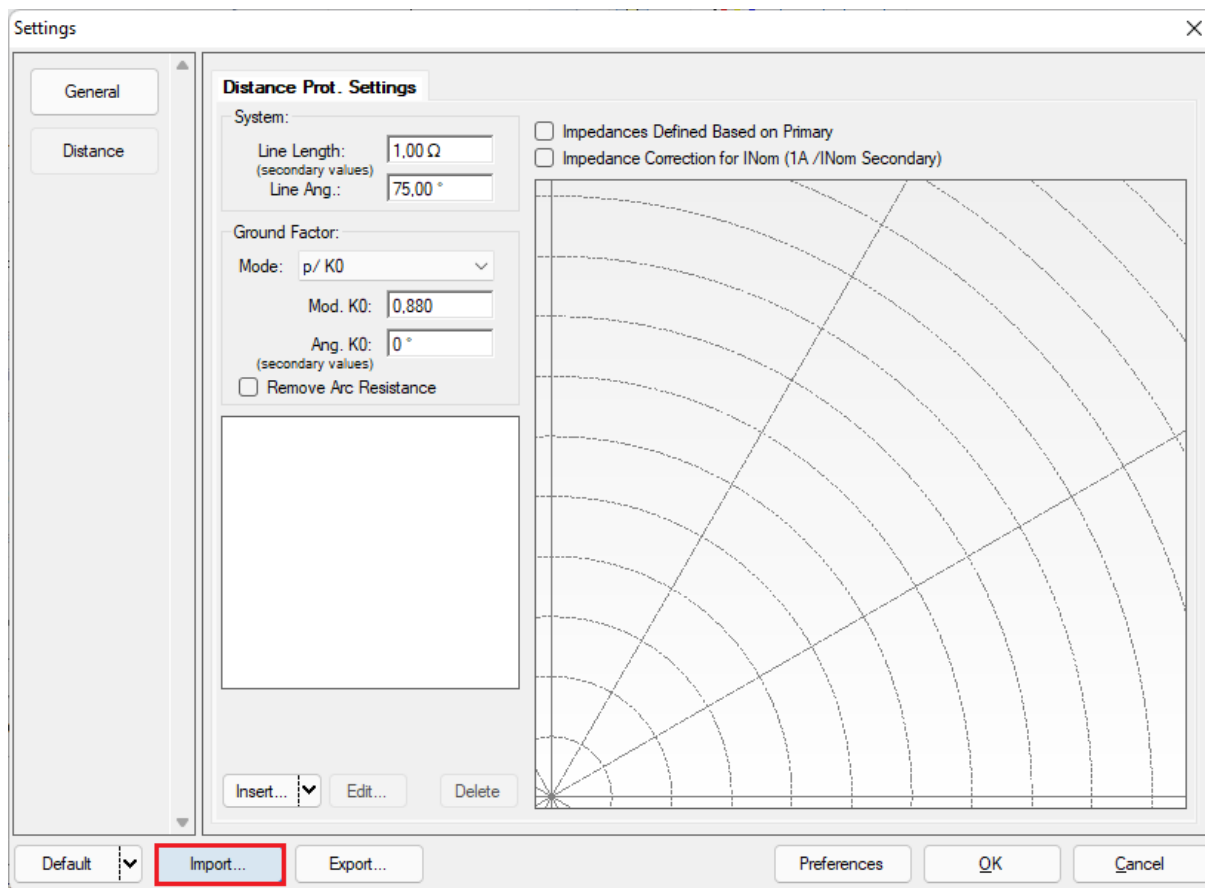


Figure 70

The figure below shows that all zones are registered, including earth fault zones.

INSTRUMENTOS PARA TESTES ELÉTRICOS

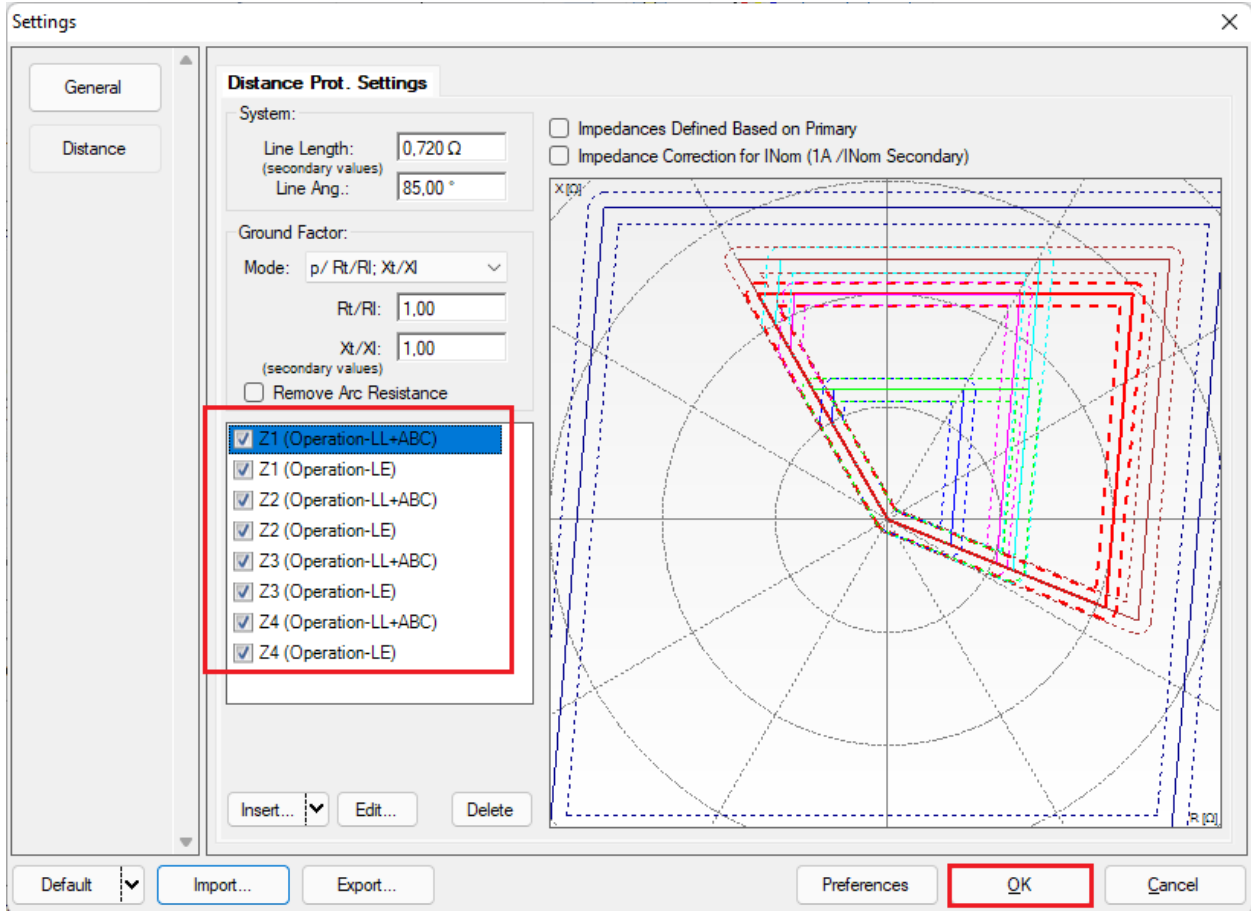


Figure 71