INSTRUMENTOS PARA TESTES ELÉTRICOS

Test Tutorial

Equipment Type: Protection Relay

Brand: ABB

Model: REL650

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

Tool Used: CE-6006; CE6707; CE-6710; CE-7012 or CE-7024

Objective: PSB Test in Synchronous Power Oscillation Conditions

Version Control:

Version	Descriptions	Date	Author	Reviewer
1.0	Initial Version	17/03/2022	M.R.C.	G.C.D.P.

Summary

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.

Copyright

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 3 on the relay terminal X410 and the negative (black terminal) of the Aux Vdc Source to pin 1 of the relay terminal X410.

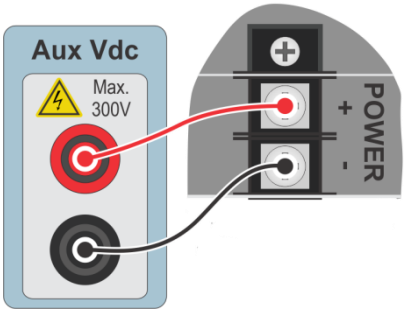

Figure 1

1.2 *Current and Voltage Coils*

To establish the connection of the voltage coils, connect channels V1, V2 and V3 with pins 1, 3 and 5 of the relay terminal X102 and the common ones to pins 2, 4 and 6. If these last three points are short-circuited, connect all common to that point.

To establish the connection of the current coils, connect channels I4, I5 and I6 with pins 1, 3 and 5 of the relay terminal X101 and the common ones to pins 2, 4 and 6. If these last three points are short-circuited, connect all common to that point.

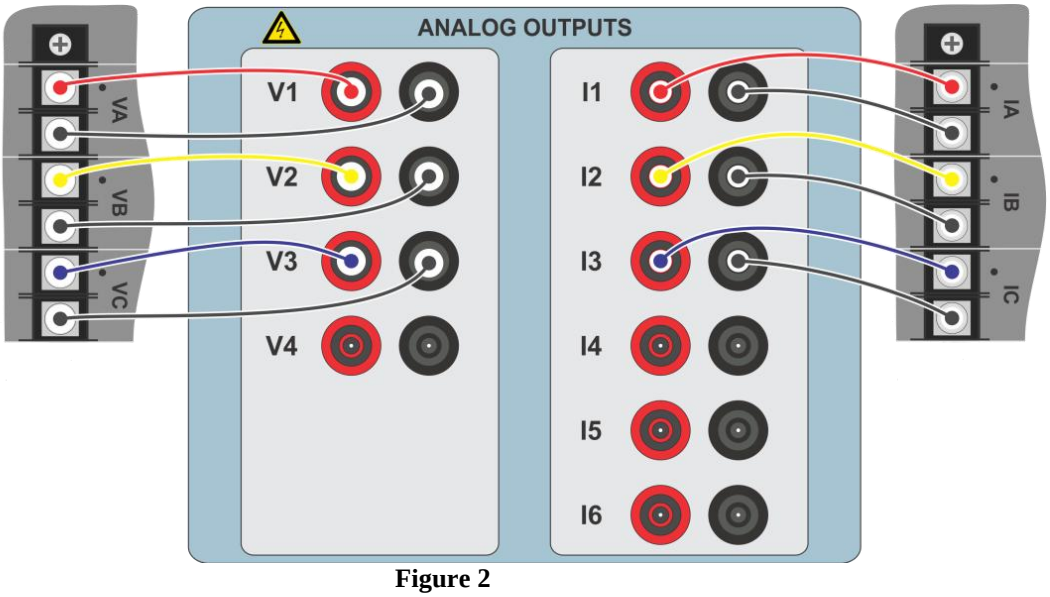

Figure 2

1.3 *Binary Inputs*

Connect the binary inputs of the CE-6710 to the binary outputs of the X307 relay slot.

- BI1 to pin 07 and its common to pin 08.
- BI2 to pin 09 and its common to pin 10.

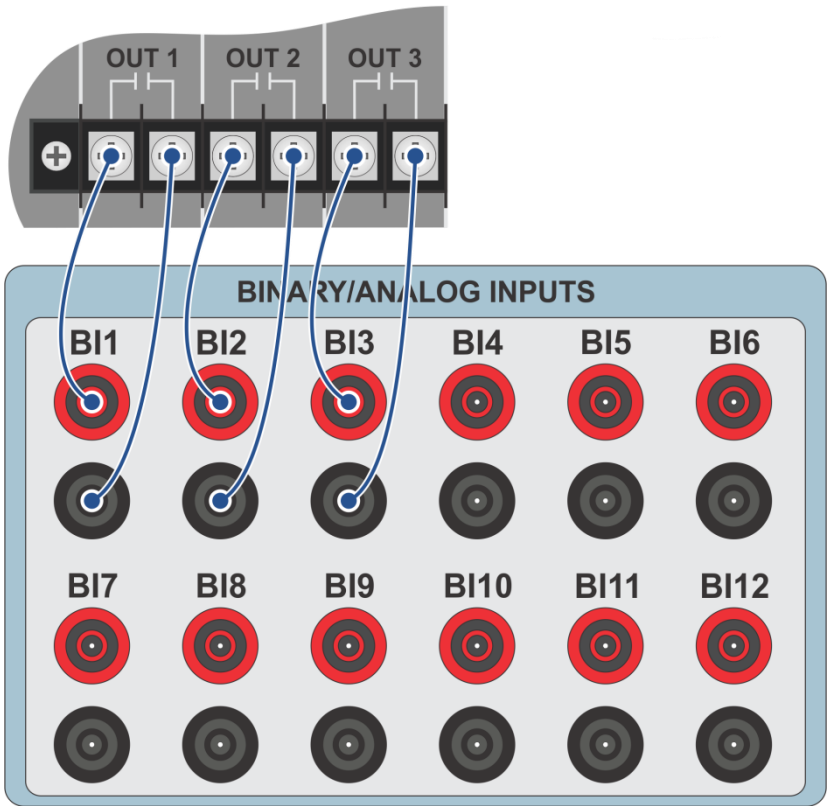

Figure 3

2. REL650 relay configuration

Connect a notebook Ethernet cable to the relay. Then open PCM600 by double clicking on the software icon.

Figure 4

<u>Note: In this tutorial, it is considered that there is no configuration in the relay, so that all parameterization will be inserted in the relay.</u>

2.1 *Creating a new file*

First, a new project must be added. Click on *"File"* and then *"New Project…"*.

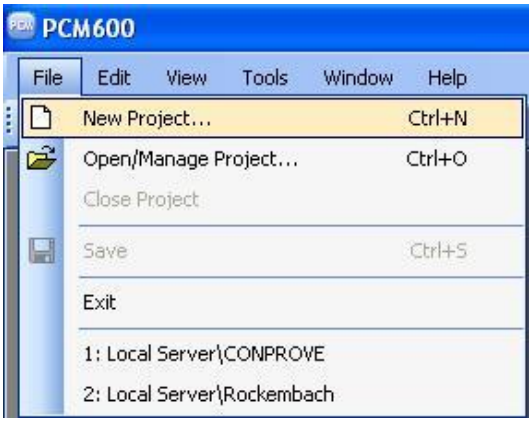

Figure 5

Choose a name for the project, in which case *"68"* was used and then click on *"Create"*.

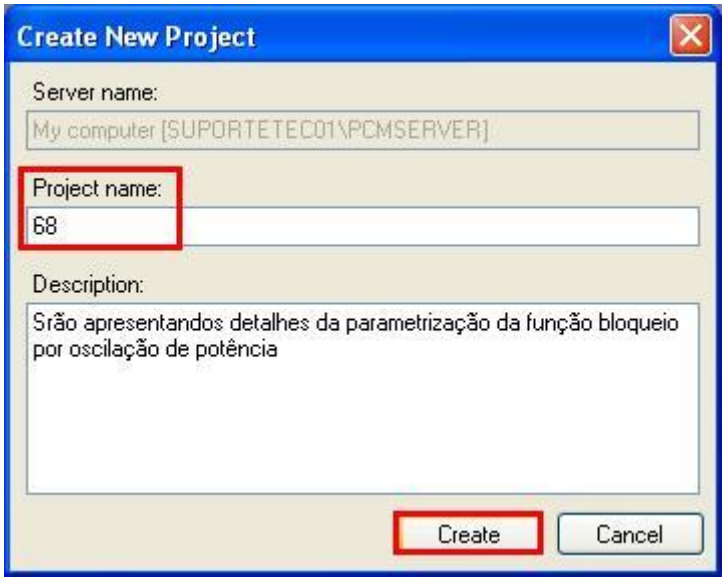

Figure 6

Right click on the created plant and insert a substation.

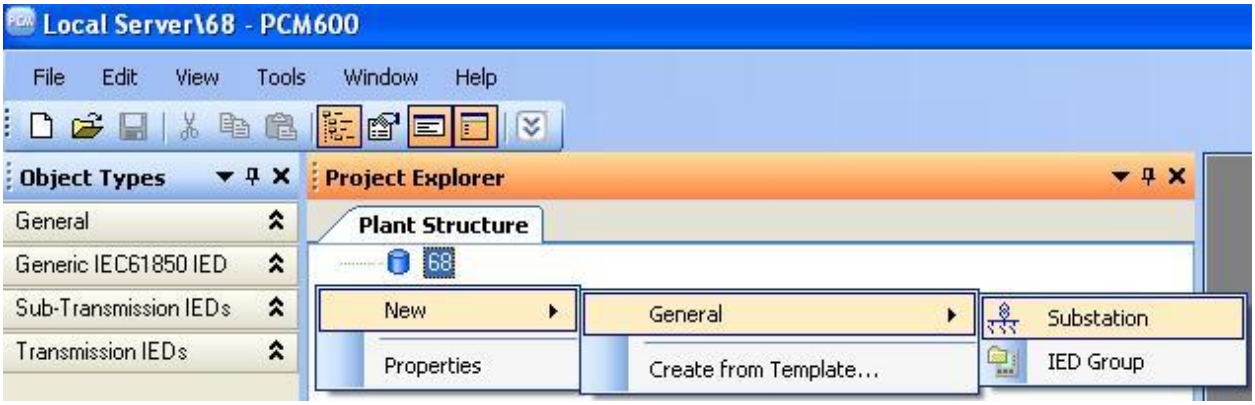

Figure 7

Inside the created substation, enter the voltage level according to the following figure:

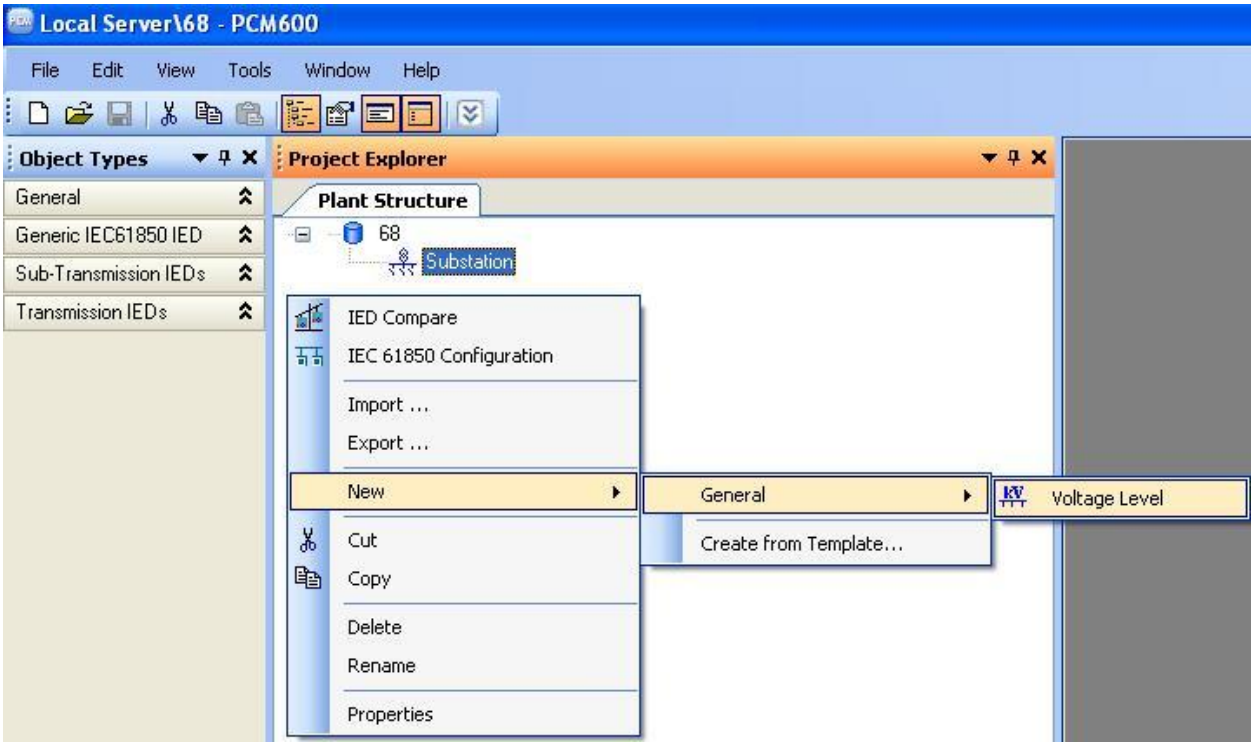

Figure 8

Within the voltage level, a bay must be inserted.

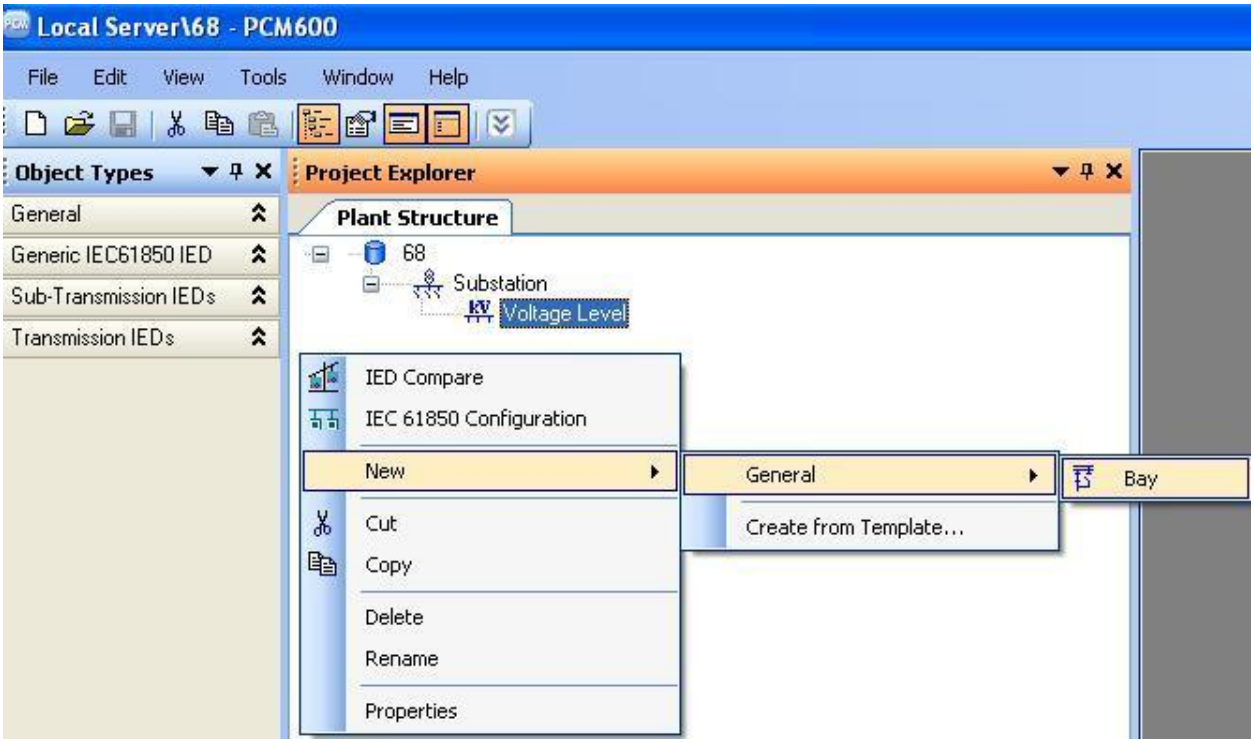

Figure 9

The REL650 relay is inserted inside the bay.

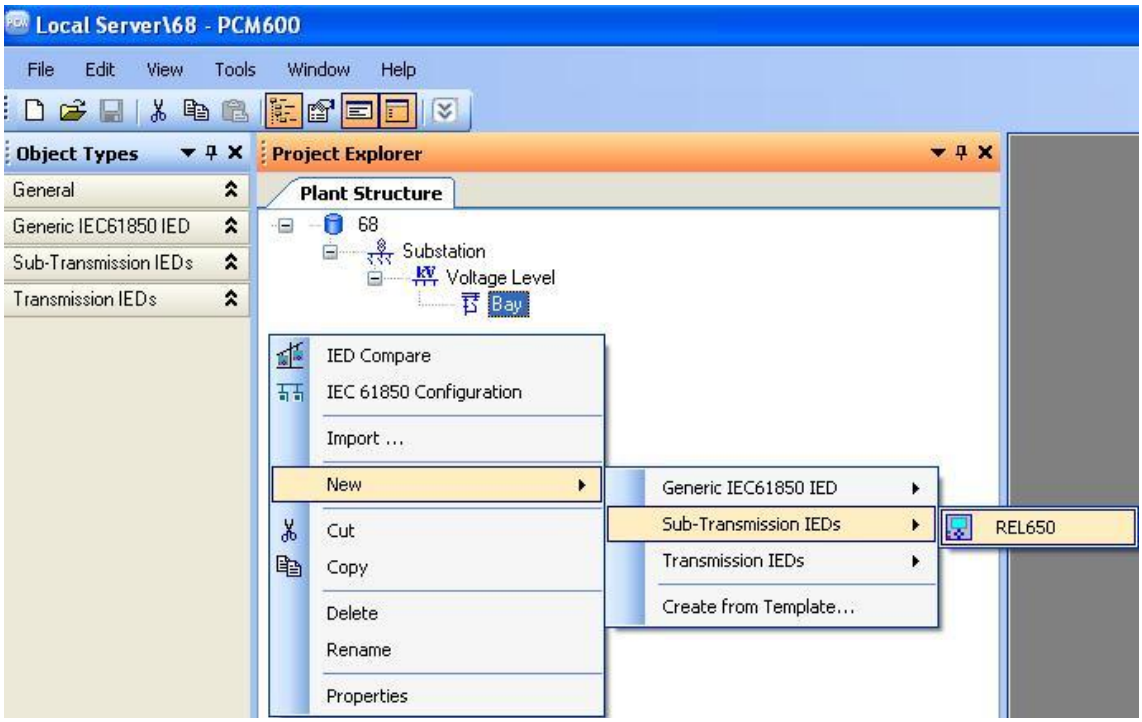

Figure 10

2.2 *Setting up communication*

Choose the option *"Online Configuration"* and click on *"Next >"*.

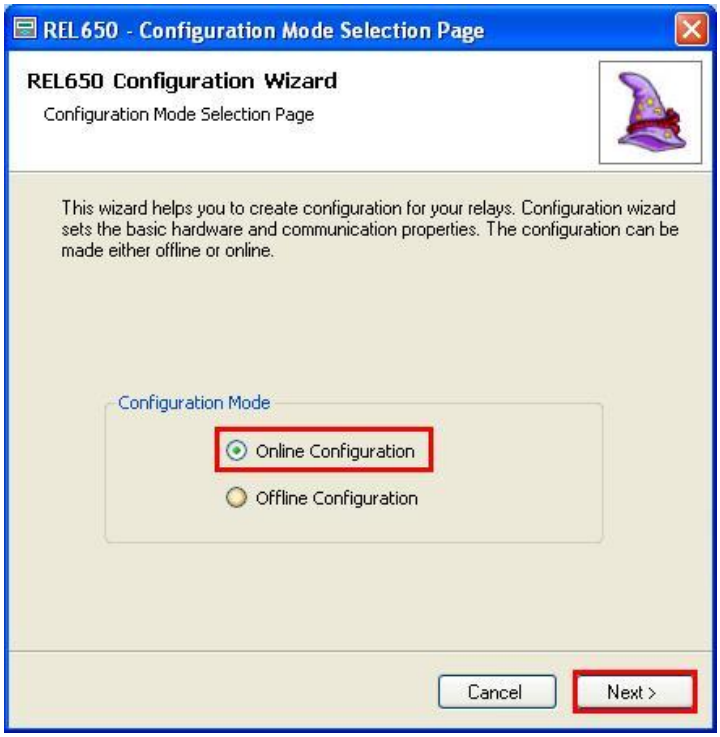

Figure 11

Choose the *"Next >"* option again.

Figure 12

On the next screen, the user chooses between two options *"LAN1"* or *"Front Port"*, then the relay itself must be displayed which IP is configured. To do so, go to *"Main Menu > Configuration > Communication > TCP-IP Configuration"* and view the desired IP. Adjust this value in the PCM and in this tutorial the *"Front Port"* option was chosen.

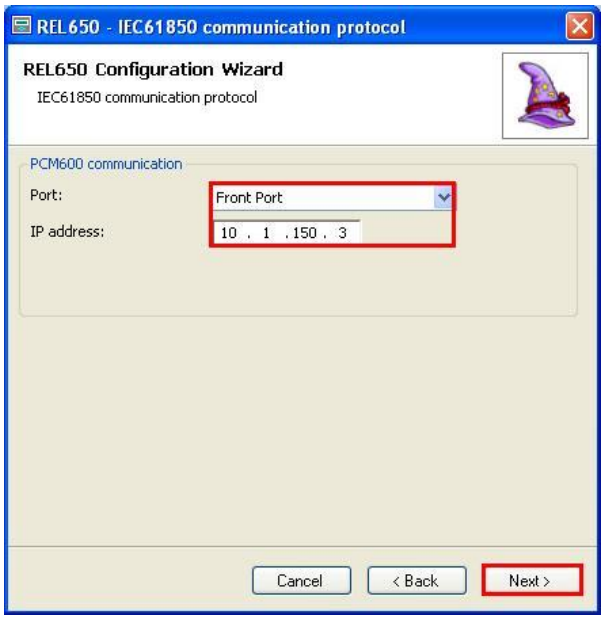

Figure 13

Then click on *"Next >"* and on the next screen on *"Scan"*.

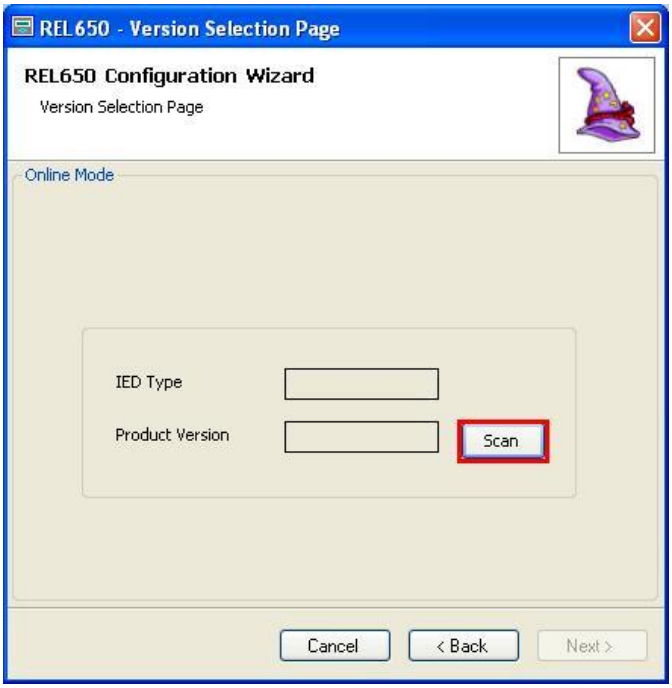

Figure 14

If the settings are correct, the software identifies the relay model and its version, as shown in the following screen.

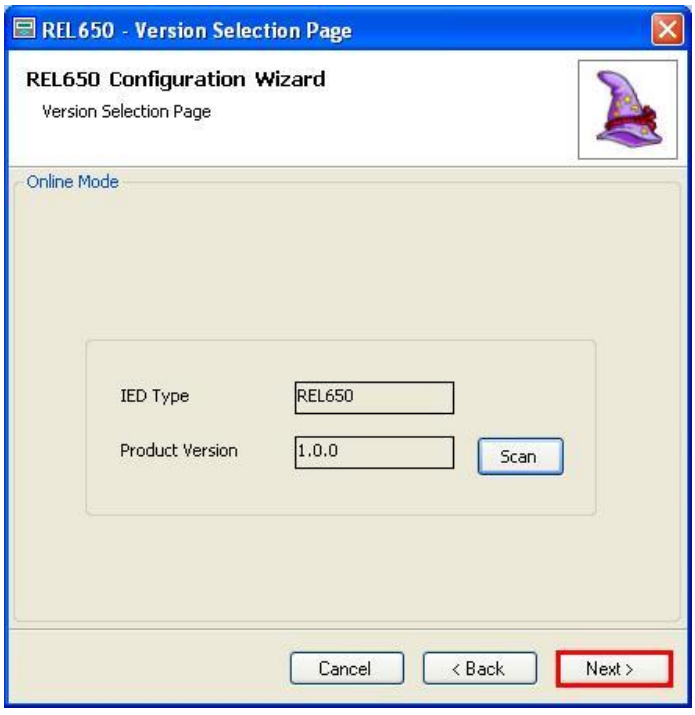

Figure 15

On the next screen the relay identifies the rack and display type.

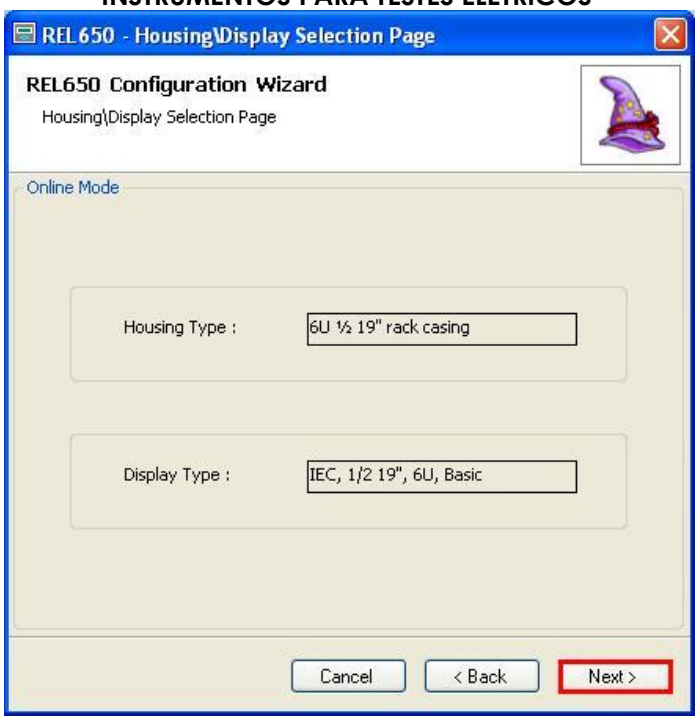

Figure 16

Finally the complete relay information.

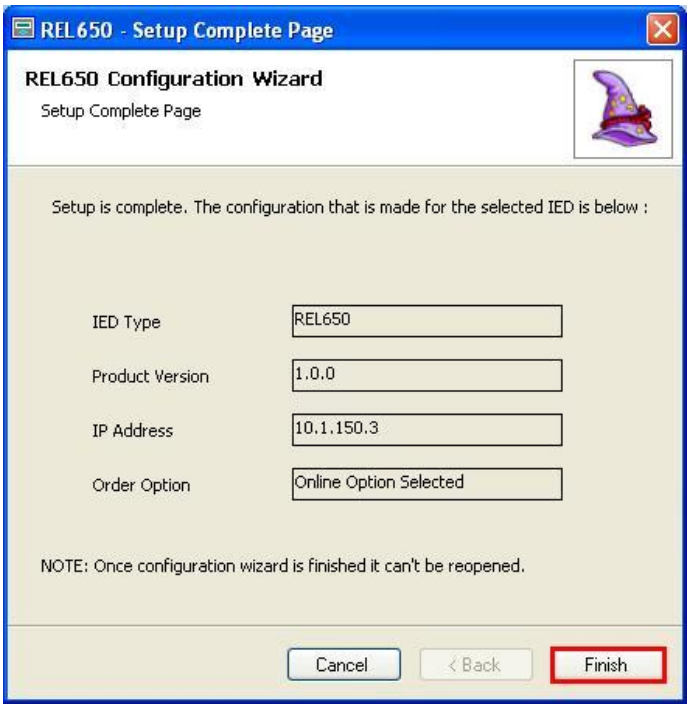

Figure 17

2.3 *TRM_2*

Click on the *"+"* signs next to *"IED Configuration"* and *"HW Configuration"*. Within the last option the relay shows all the slots that are inserted in the relay. Right-click on the *"TRM_2"* option and select *"Parameter Setting"*.

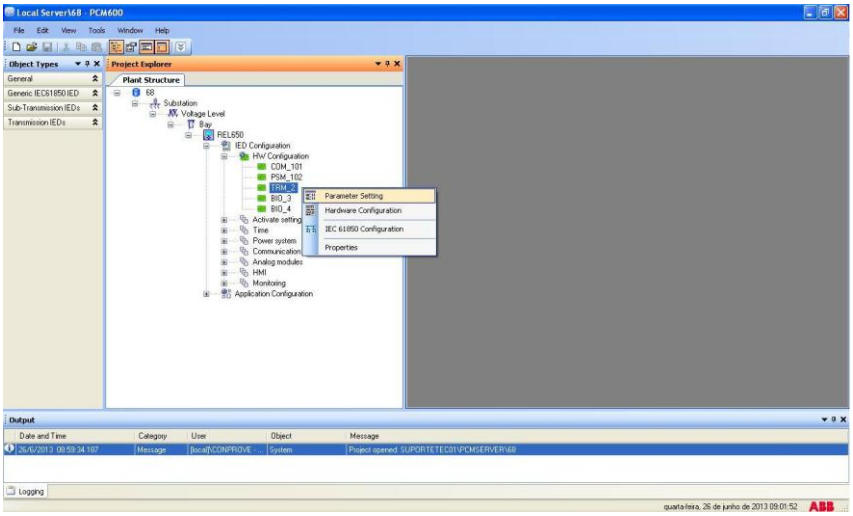

Figure 18

In this window, the current and voltage transformation ratio must be configured. For current use the first four channels and for voltage use channels 6 to 8.

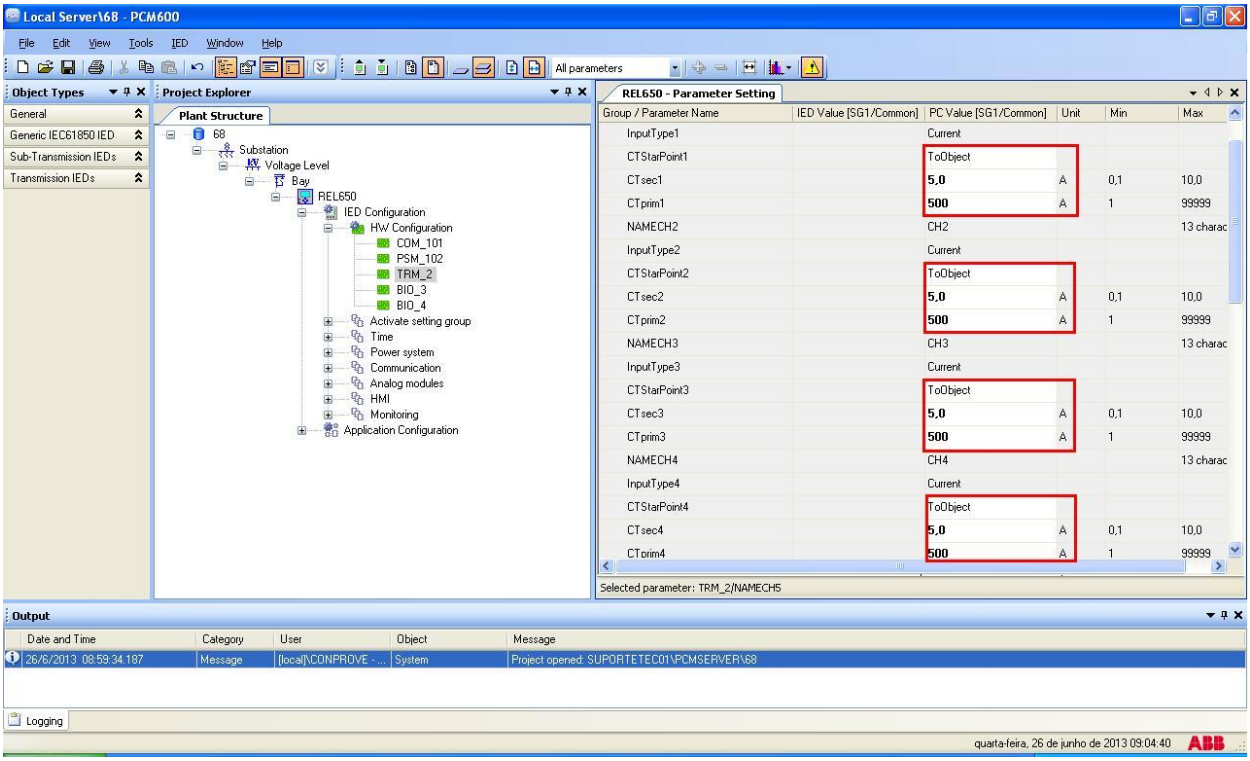

Figure 19

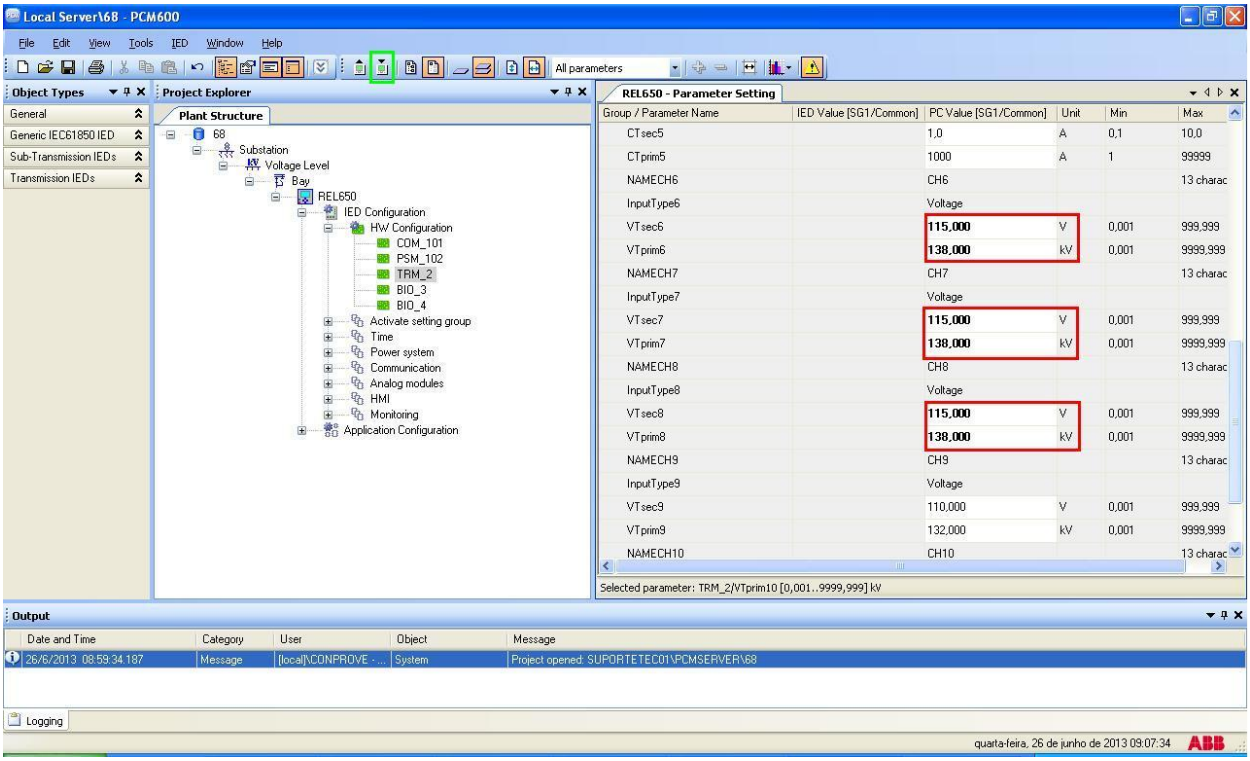

Figure 20

In the icon highlighted in green in the previous figure, the changes are sent to the relay. There are three shipping options:

1. Submit only a specific value;
2. Submit all changes made within a setting group.
3. Send all parameterized settings within the group.

In this case, only the settings that have been changed are sent.

Figure 21

Note: Whenever the user makes a change in any setting group, this procedure must be repeated.

2.4 *SETGRPS: 1*

Click the *"+"* sign near to *"Activate setting group"* and then *"SETGRPS: 1"* and make sure that group one is active.

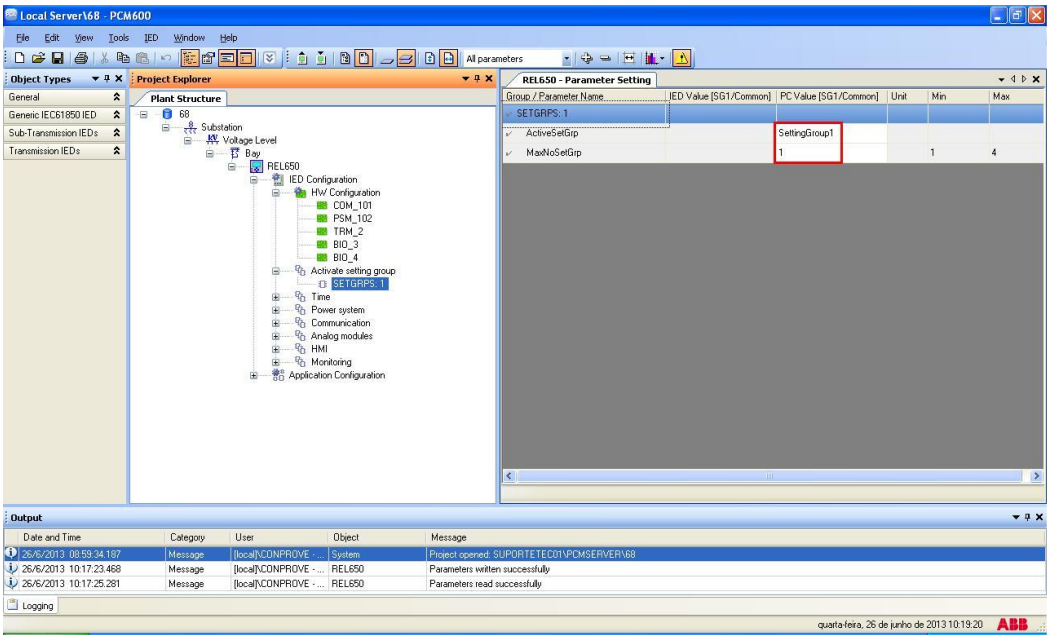

Figure 22

2.5 *PRIMVAL: 1*

Click on the *"+"* signs near to *"Power System"* and *"Primary values"* and select the *"PRIMVAL: 1"* option. In this group, the frequency and phase sequence values are adjusted. Send the settings to the relay if there is any change.

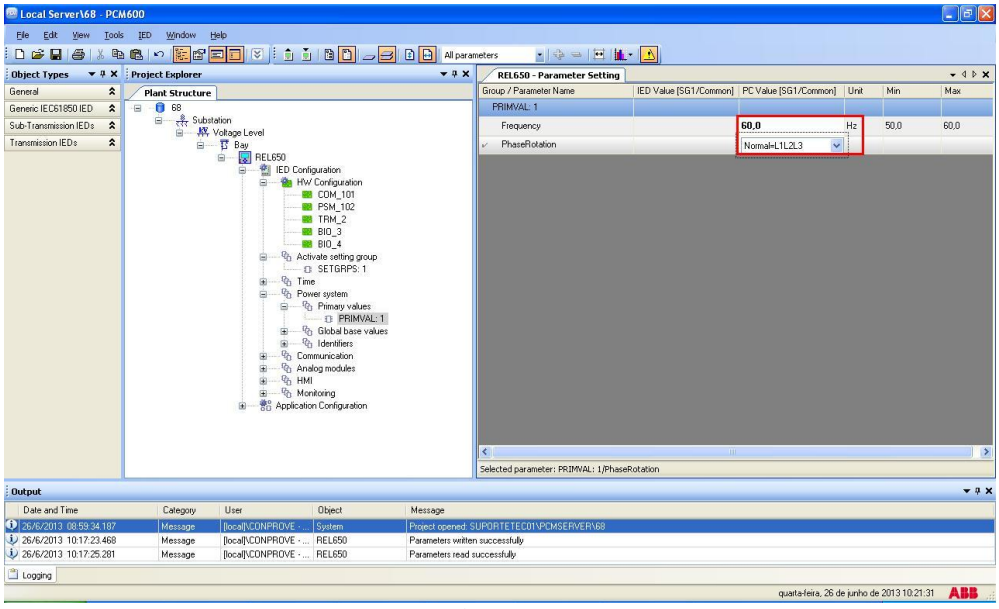

Figure 23

2.6 *GBASVAL: 1*

Click the *"+"* sign near to *"Global base values"* and then *"GBASVAL: 1"* and adjust the base voltage, current and power values. The other groups of base values will not be used.

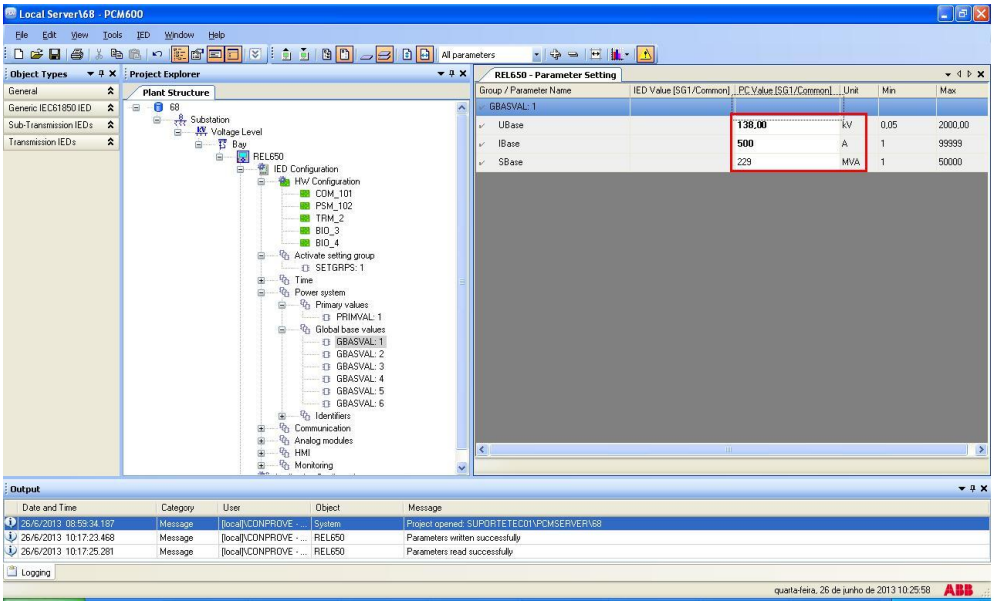

Figure 24

2.7 *AISVBAS: 1*

Click on the *"+"* signs beside *"Analog modules"* and *"Reference channel service values"* and select the option *"AISVBAS: 1"* and set channel 6 as the reference channel, which is equivalent to the A-phase voltage.

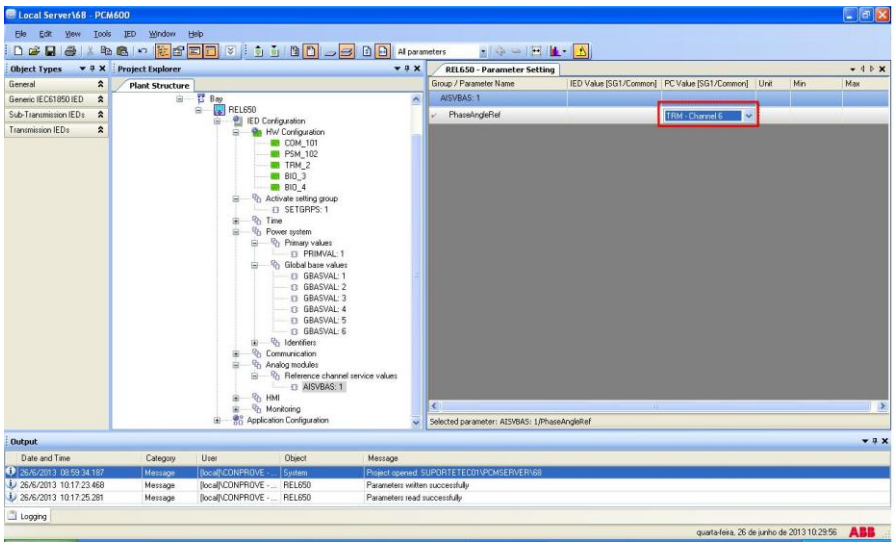

Figure 25

2.8 *Application Configuration*

Select the *"Application Configuration"* option, right click and choose *"Application Configuration"* again. In this field, the protection logic blocks must be entered.

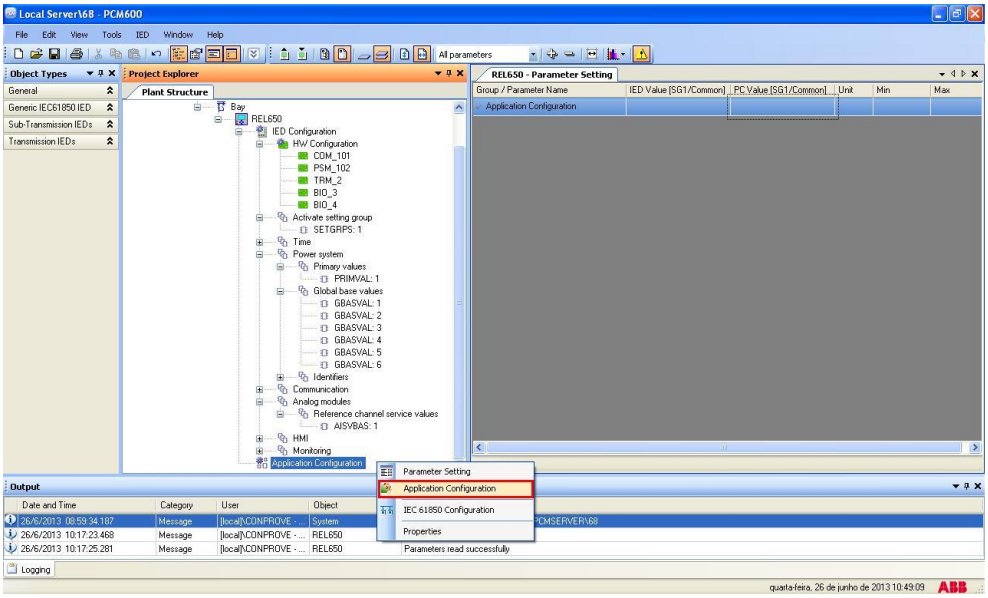

Figure 26

On the screen that opens, right click and then choose the option *"Insert FunctionBlock"*.

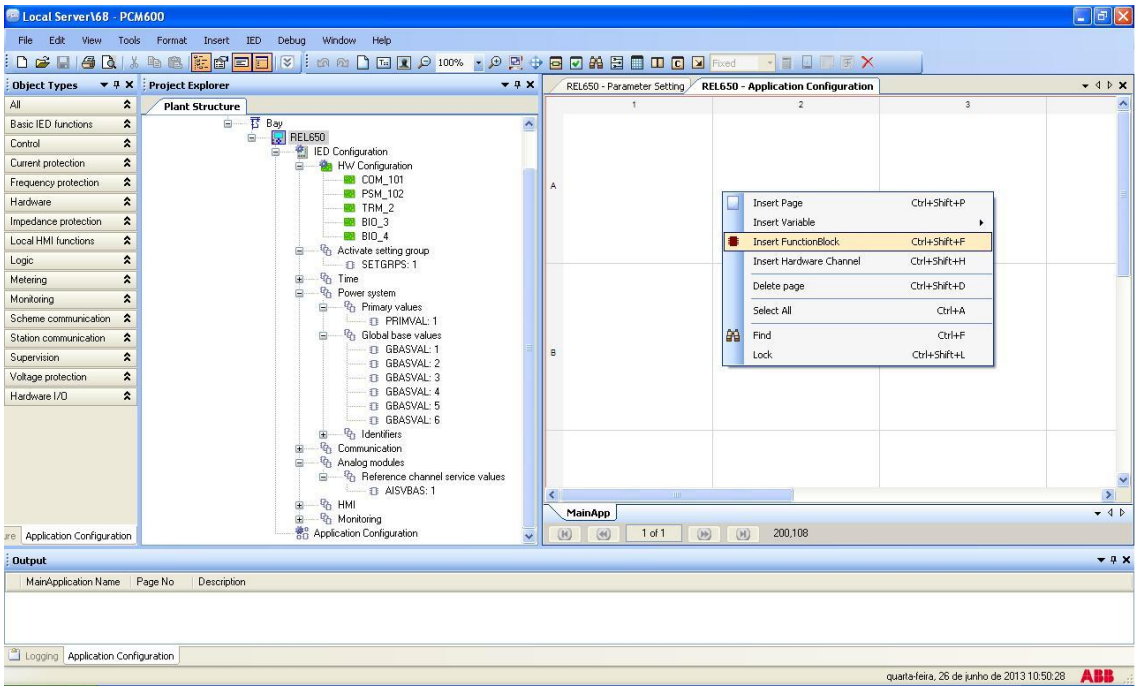

Figure 27

2.9 *SMAI_20_1 (Currents)*

Click on the *"+"* sign near to *"Basic IED functions"* and insert the *"SMAI_20_1"* block that will be responsible for the current channels. To understand the perfect functioning of the different blocks, consult the REL650 manual.

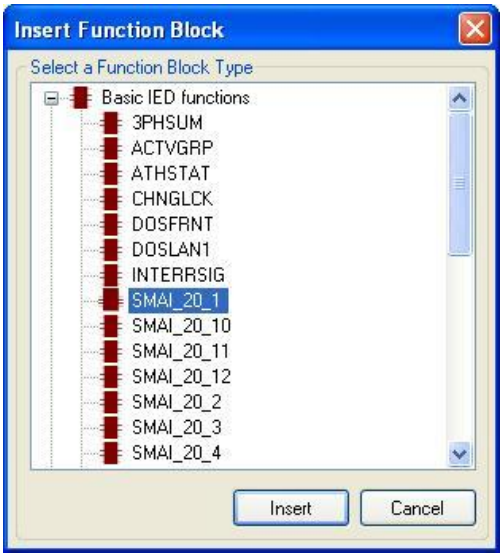

Figure 28

On the next screen set the *"Cycle Time"* to 5.

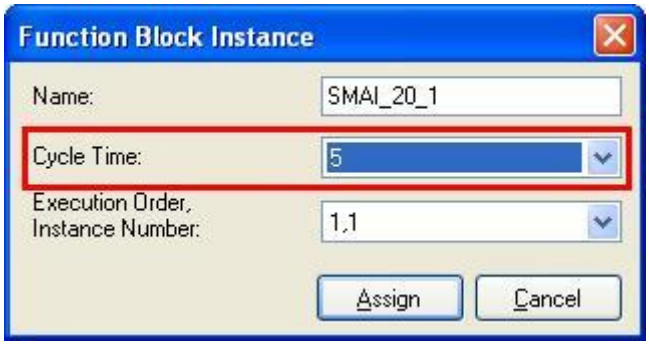

Figure 29

Insert the same block again, repeating the operation of the three previous figures, however change the *"Cycle Time"* to 20.

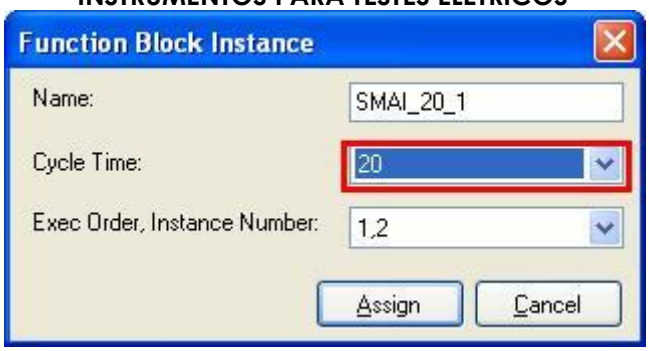

Figure 30

The next step is to route the channel input of the function block with its physical channel. To do this, right-click outside the block and choose the following option.

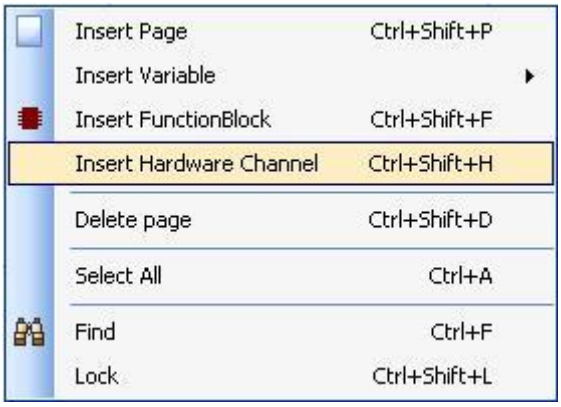

Figure 31

Choose the *"Analog Input"* option and click on *"Insert"*.

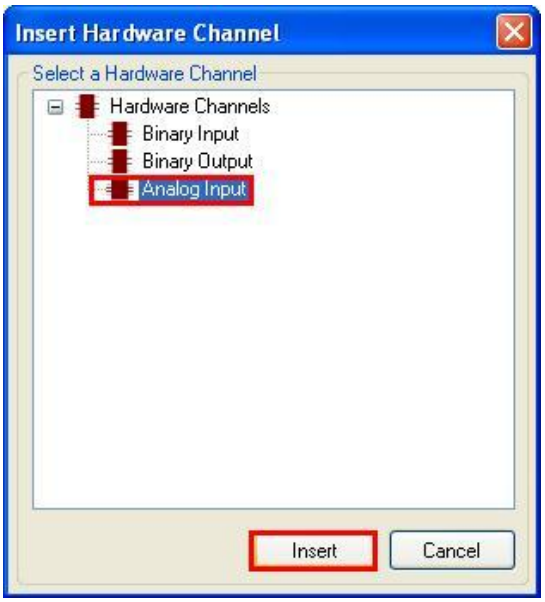

Figure 32

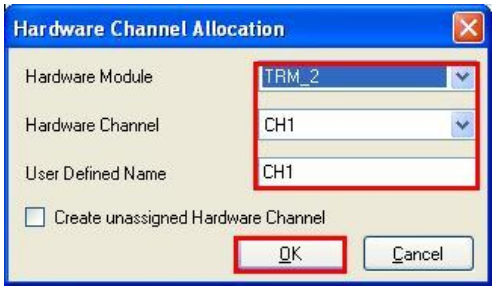

Figure 33

Repeat the procedure of the 3 previous figures changing the *"Hardware Channel"* option and *"User Defined Name"* to CH2, CH3 and CH4. Then make the connections with the blocks.

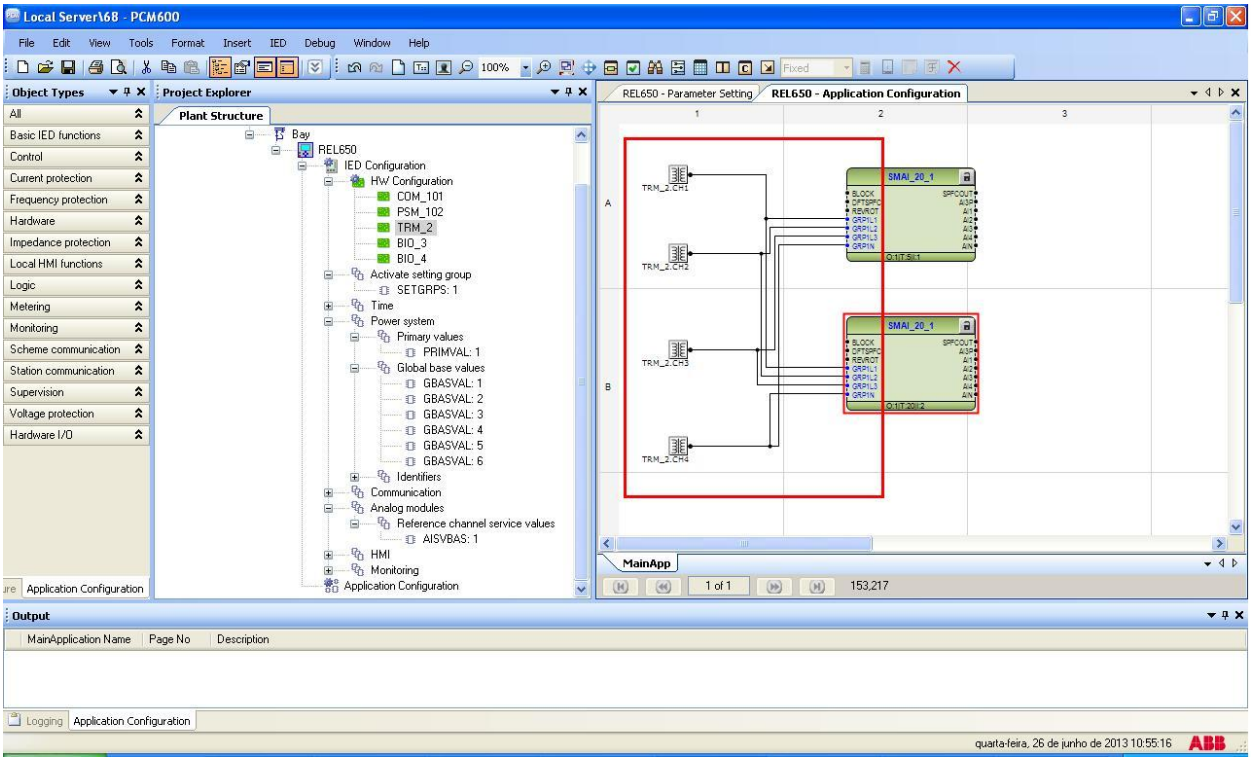

Figure 34

Assign an output to the *"AI3P"* option of each block. Right click and choose *"Insert Variable > Output"*.

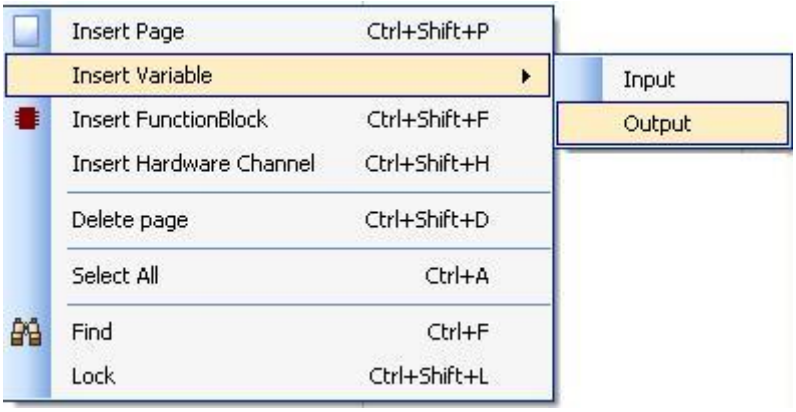

Figure 35

Choose a name for these variables, in this case *"AI3P_TC_05ms"* for the first block and *"AI3P_TC_20ms"* for the second block and connect with the *"AI3P"* outputs of each block.

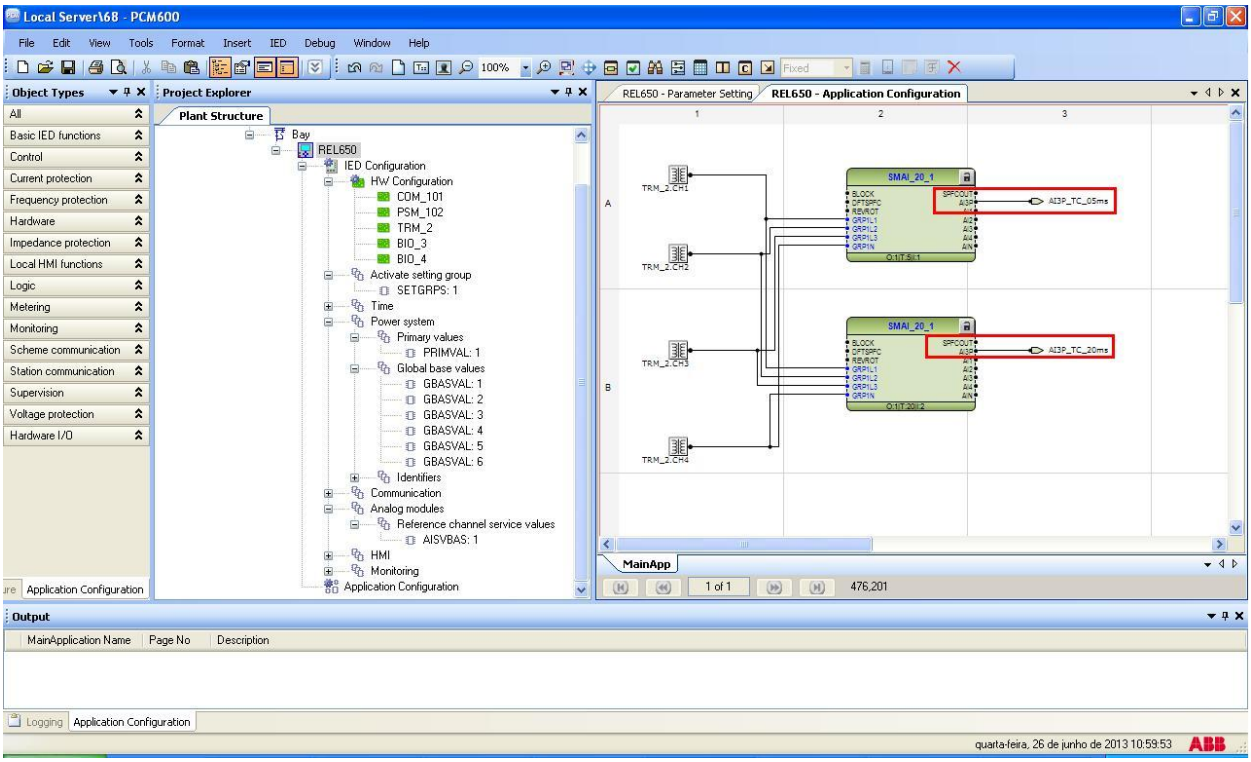

Figure 36

Clicking on the icon highlighted in green and on the *"MainApp"* tab, change the name of the tab to *"CANAIS_CORRENTE",* for example.

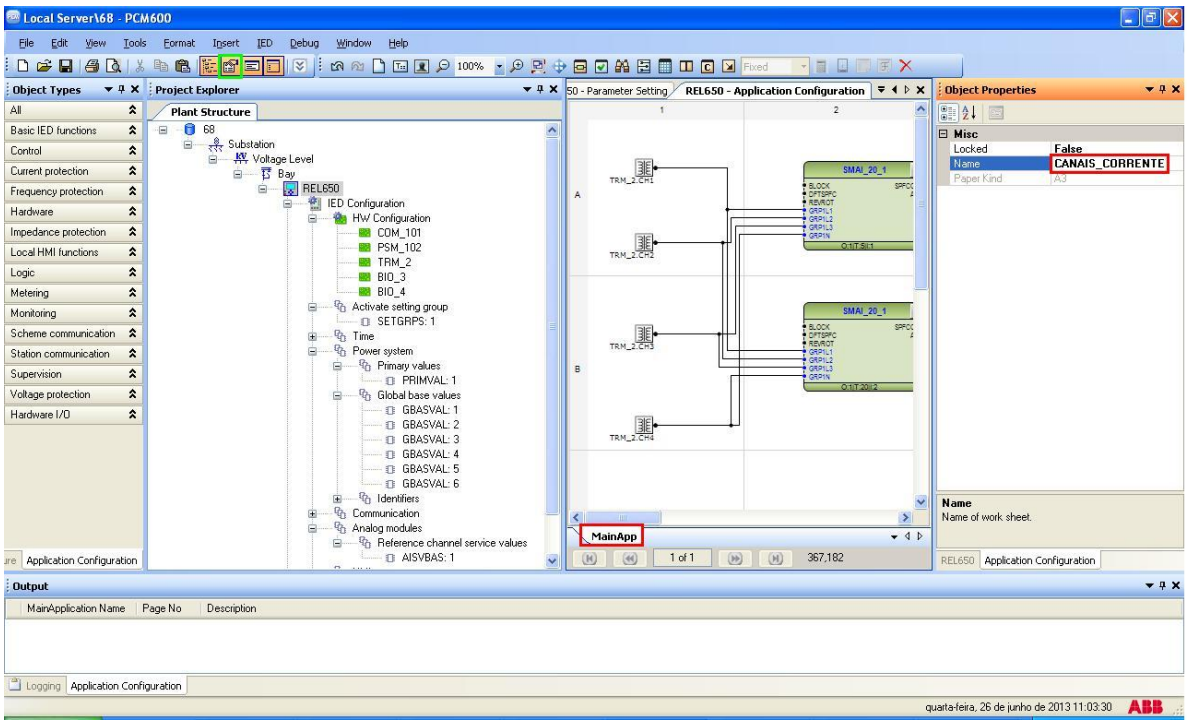

Figure 37

Close the *"Object Properties"* window then click on *"Insert > MainApplication"*.

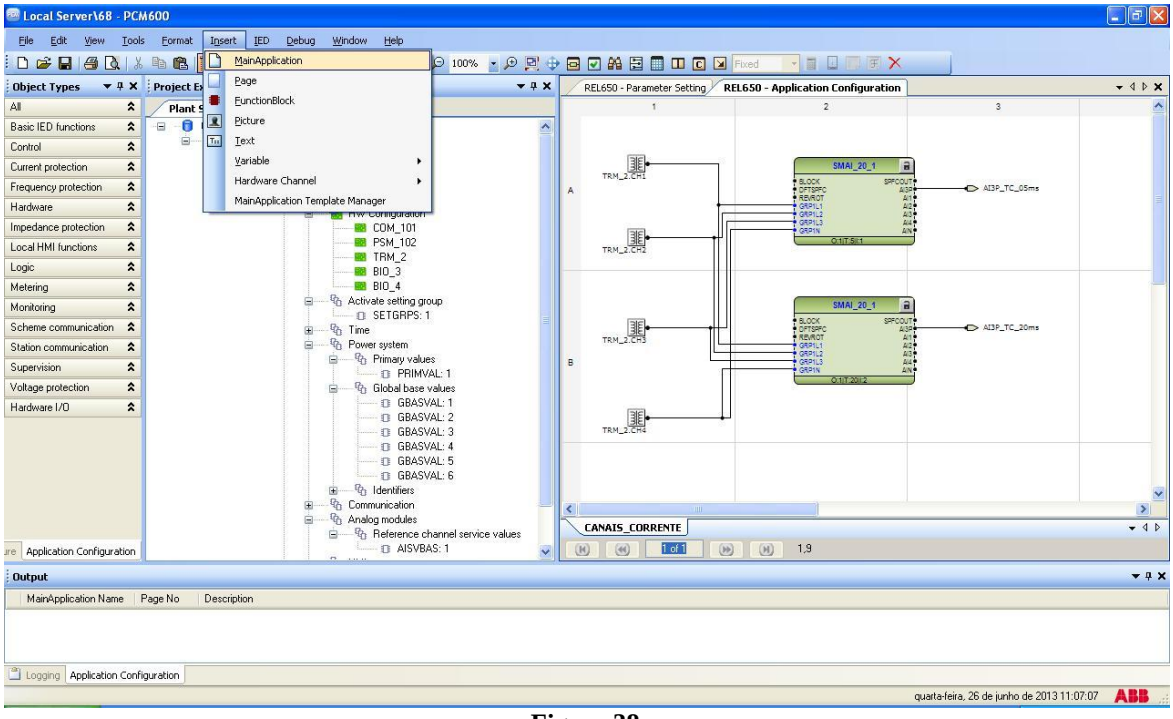

Figure 38

2.10 *SMAI_20_2 (Voltages)*

In the new tab, configure the block responsible for the voltage channels. Repeat the procedure in figures 27 to 36, changing the block used to *"SMAI_20_2"*, the measurement channels CH6, CH7 and CH8 and the output variables to *"AI3P_TP_05ms"* and *"AI3P_TP_20ms"*.

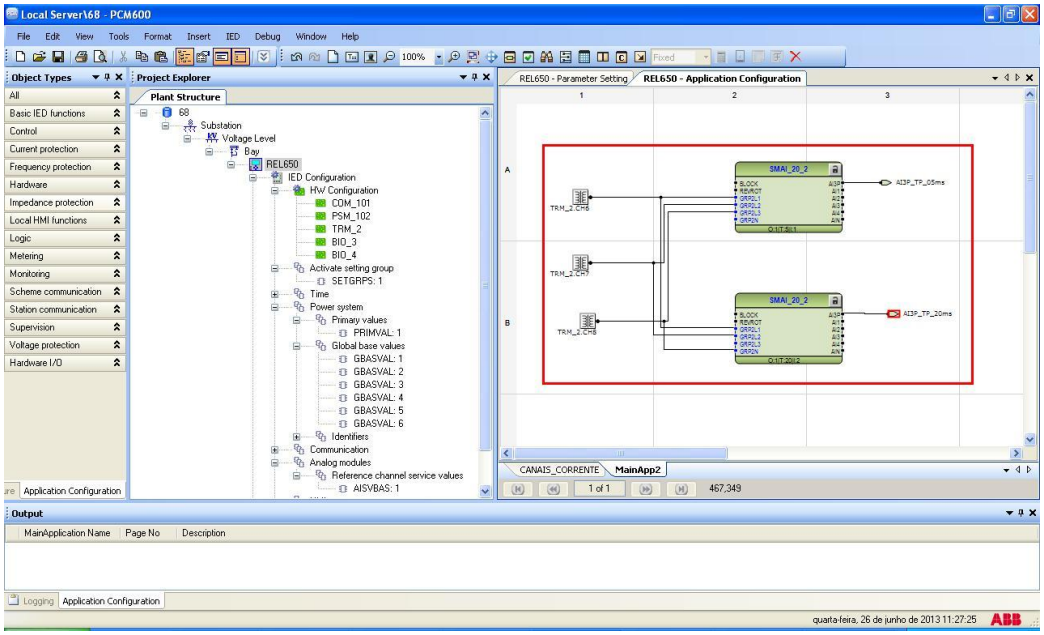

Figure 39

Click on the icon highlighted in green, click on the *"MainApp2"* tab and change the name of the tab to *"CANAIS_TENSÃO"*.

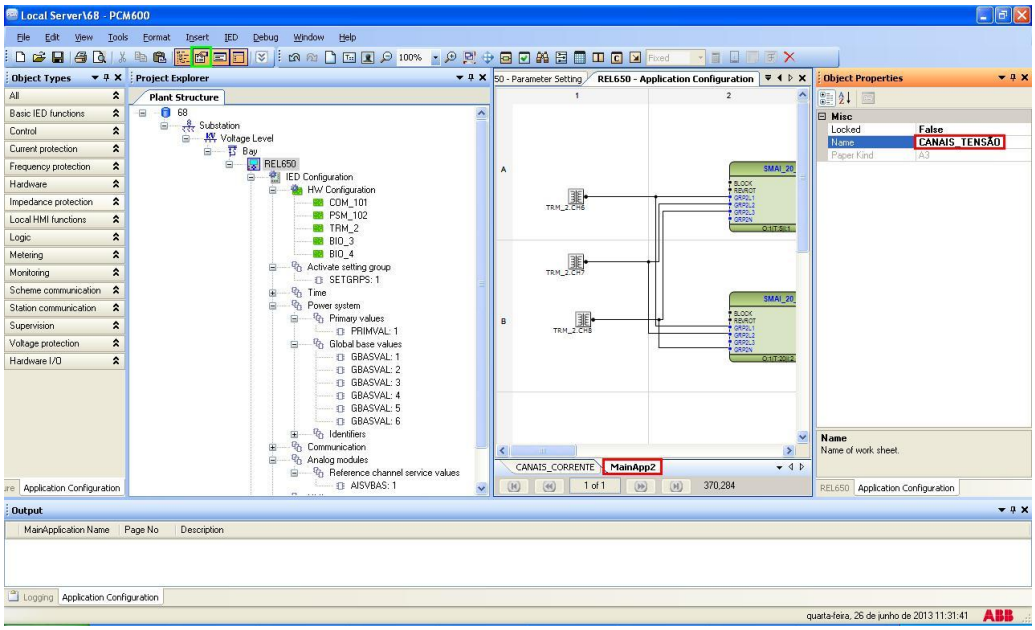

Figure 40

Close the *"Object Properties"* window and insert a new *"MainApplication"* tab to create the distance function block.

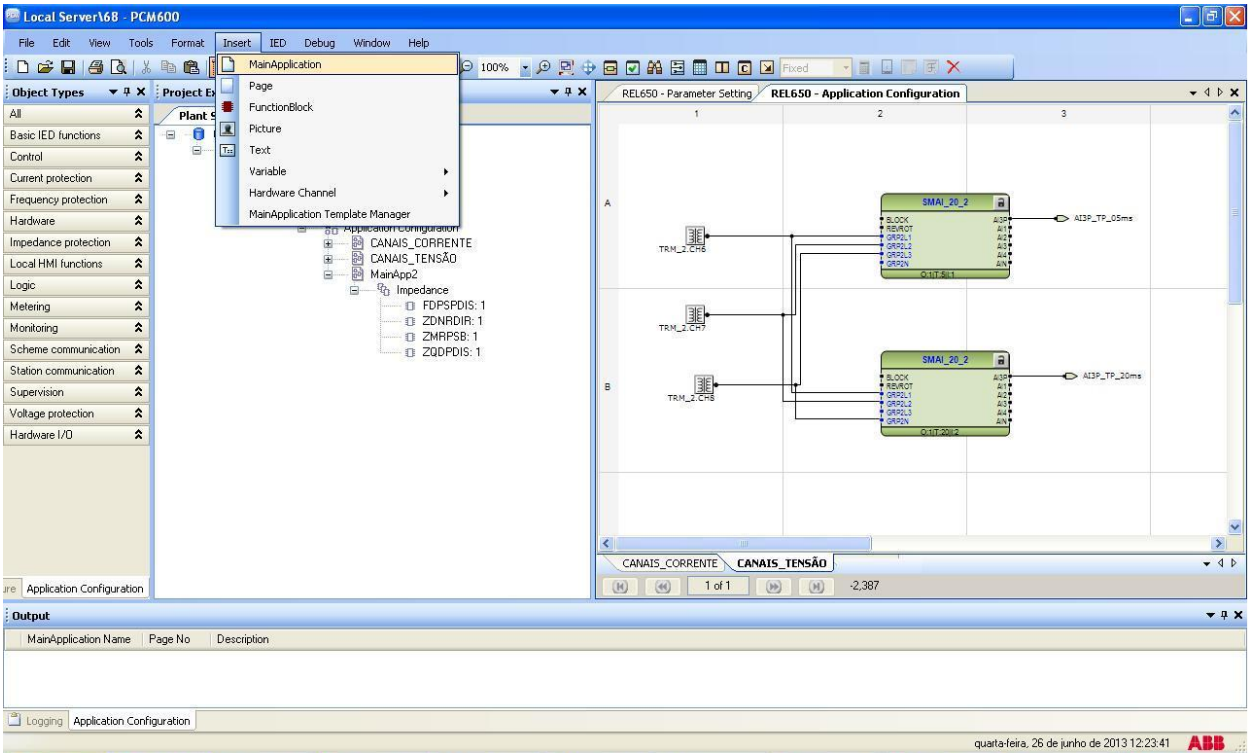

Figure 41

2.11 *ZQDPDIS (Quadrilateral Distance)*

Right-click on the new tab, choose the *"Insert Function Block"* option, click on the *"+"* sign next to *"Impedance protection"* and finally choose the *"ZQDPDIS"* block.

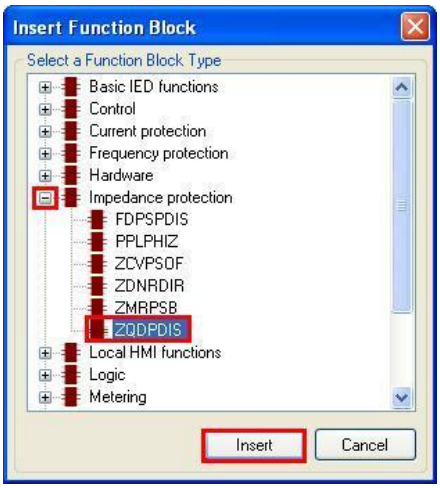

Figure 42

Click *"Assign"* in the next window (not shown). To use the full potential of the distance function, three more blocks must be used together with the ZQDPDIS block.

2.12 *ZDNRDIR (Directionality of the distance function)*

Right-click on the tab and choose the *"Insert Function Block"* option, click on the *"+"* sign next to *"Impedance protection"* and finally choose the *"ZDNRDIR"* block. This block determines if the zone characteristics are forward, reverse or no directionality (offset).

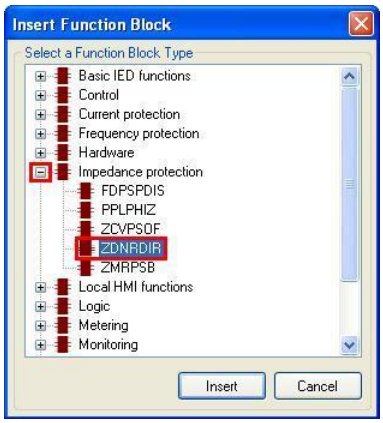

Figure 43

Click *"Assign"* in the next window (not shown).

2.13 *FDPSPDIS (Phase selector with load compensation)*

Right-click on the tab and choose the *"Insert Function Block"* option, click on the *"+"* sign next to *"Impedance protection"* and finally choose the *"FDPSPDIS"* block. This block determines in which phase the fault occurs and also allows load compensation.

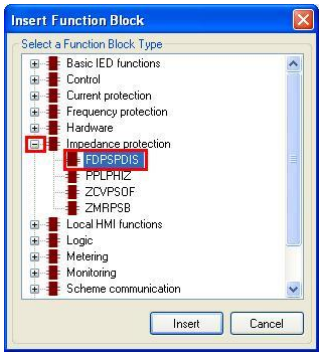

Figure 44

Click *"Assign"* in the next window (not shown).

2.14 *ZMRPSB (Power Swing)*

Right-click on the tab and choose the *"Insert Function Block"* option, click on the *"+"* sign next to *"Impedance protection"* and finally choose the *"ZMRPSB"* block. This block is responsible for detecting the power swing.

Figure 45

Click *"Assign"* in the next window (not shown).

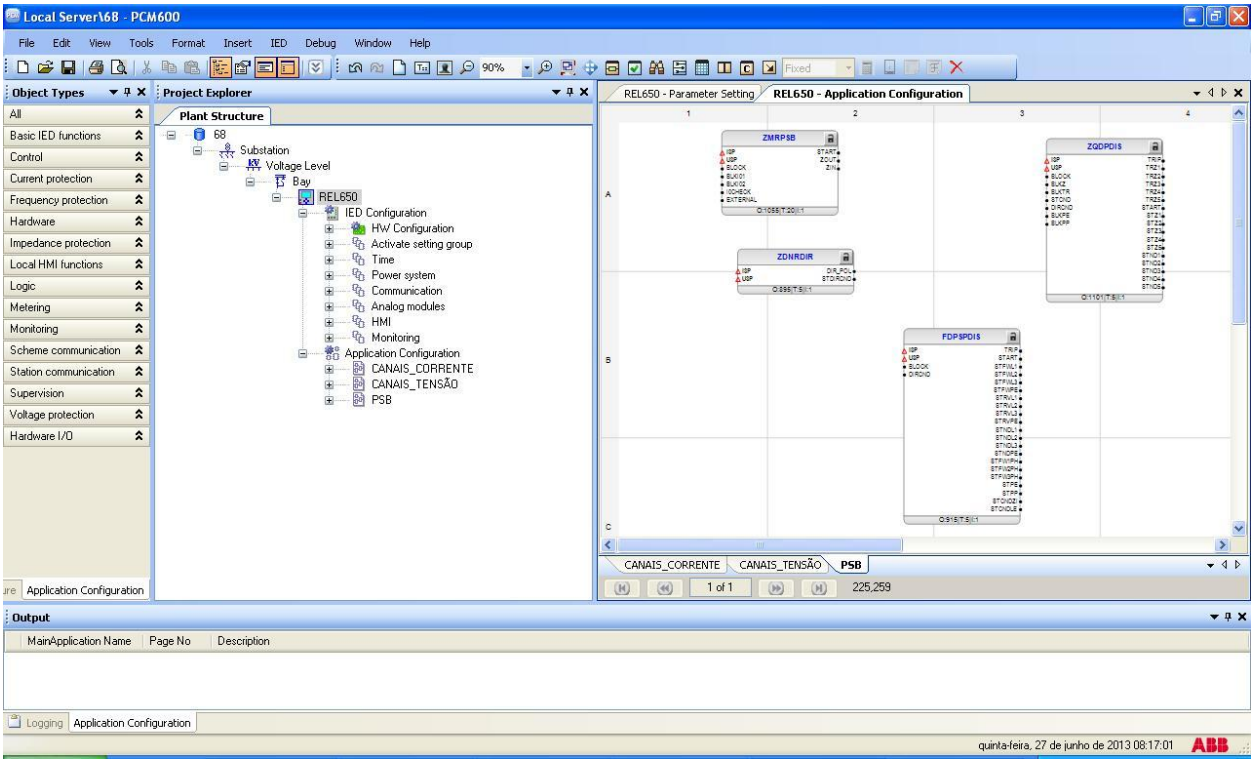

Figure 46

Right-click and choose *"Insert Variable > Input"* to insert two current and voltage input variables with a 5ms cycle. Use the same name given in figures 36 and 39. Connect with the voltage and current inputs of each of the distance function. For the voltage and current inputs of the *"ZMRPSB"* block, the 20ms signals are used.

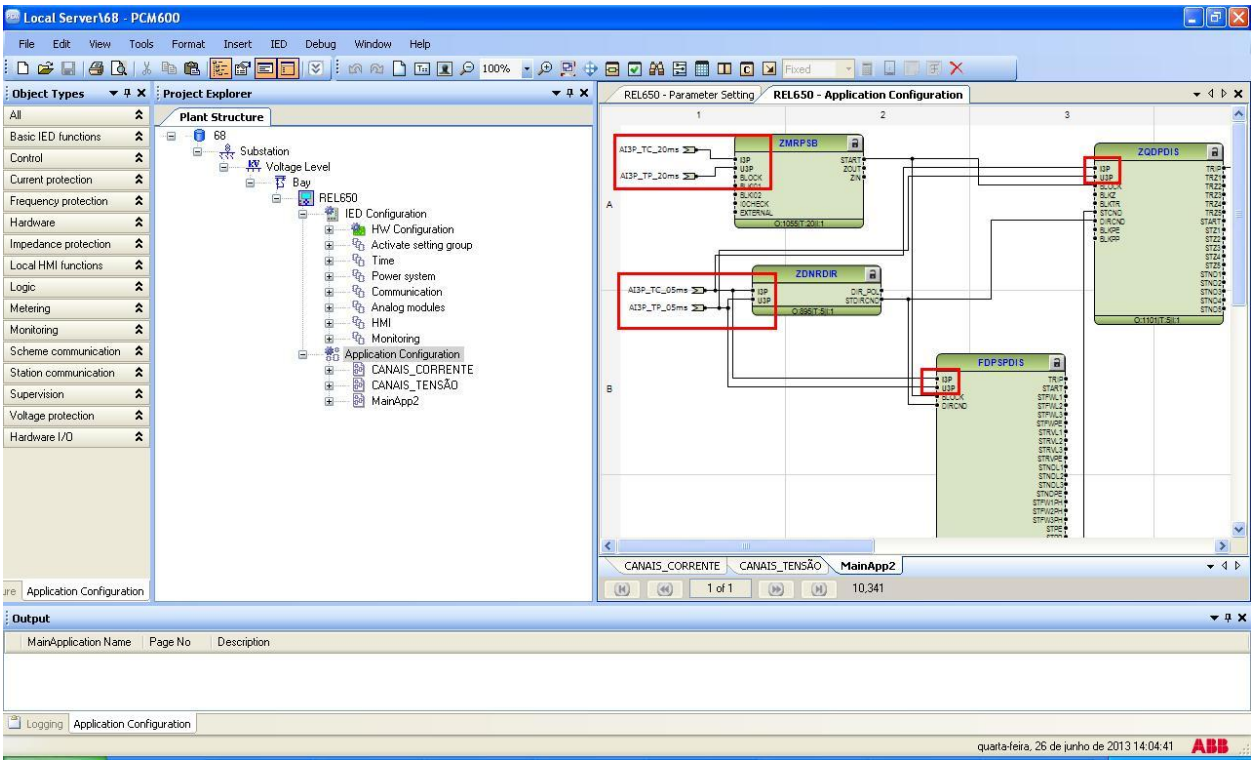

Figure 47

Connect the *"STDIRCND"* output of the *"ZDNRDIR"* block to the *"DIRCND"* inputs of the *"FDPSPDIS"* and *"ZQDPDIS"* blocks. Then connect the *"STCNDZI"* output of the *"FDPSPIDS"* block to the *"STCND"* input of the *"ZQDPIS"* block. Create an output variable and connect it to the trip of the *"ZQDPIS"* block. The name of this variable can be *"TRIP_21"*. Connect the *"START"* output of the *"ZMRPSB"* block to the *"BLOCK"* inputs of the *"FDPSPDIS"* and *"ZQPDIS"* blocks. Create an output variable and link it with the *"START"* signal from the *"ZMRPSB"* block and name it, for example, as *"Start_68"*.

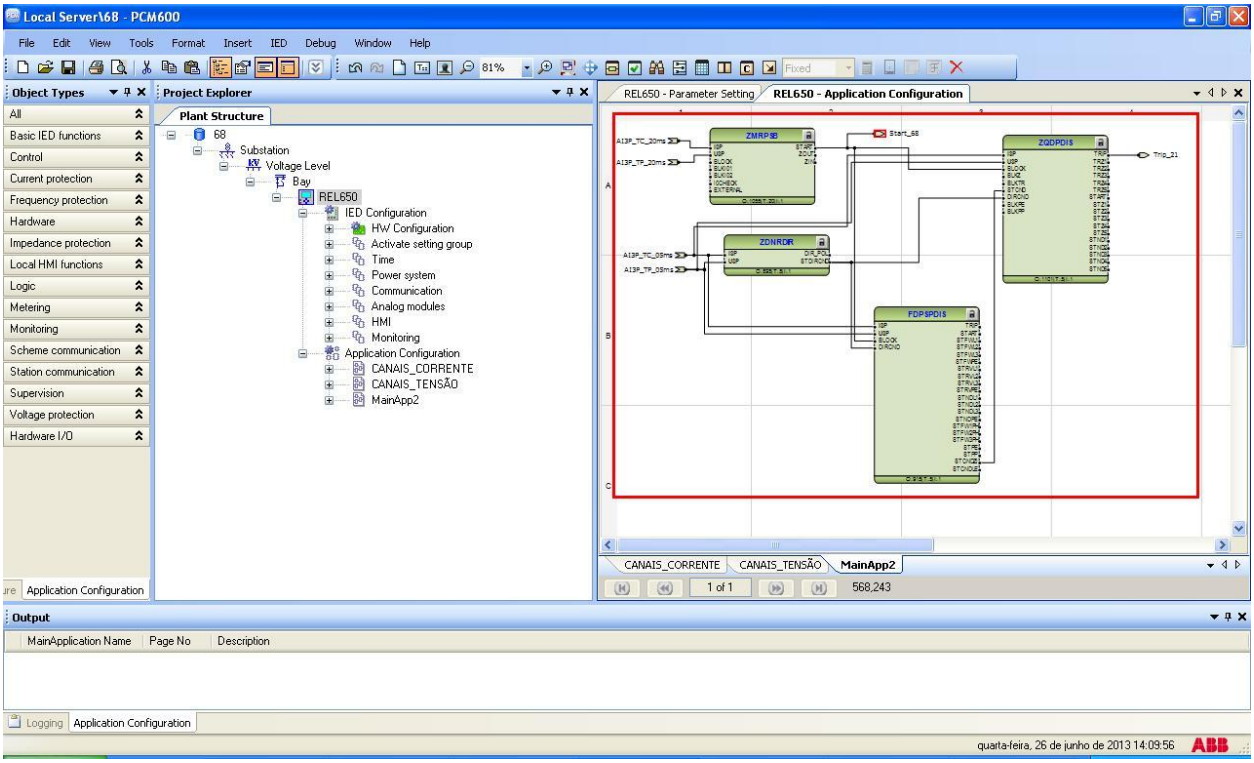

Figure 48

Change the name of the tab to *"PSB"*.

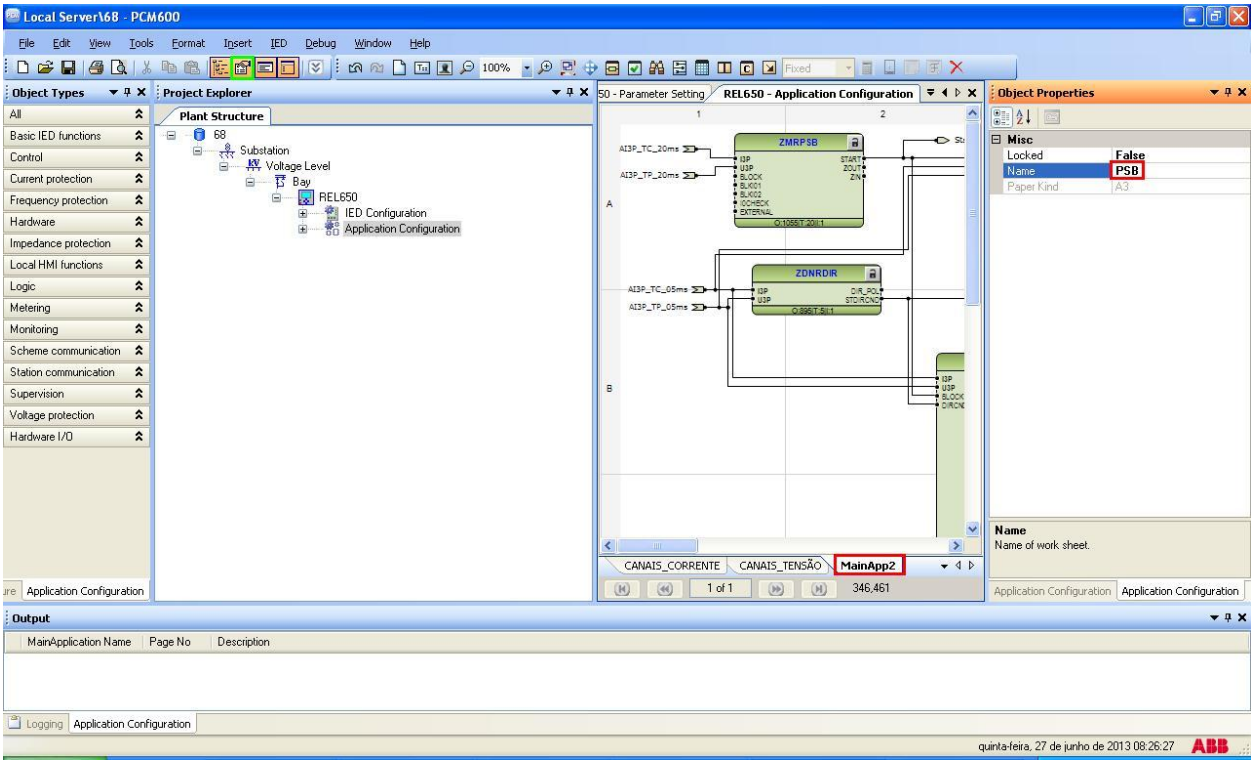

Figure 49

2.15 *Binary Outputs*

The last block to be created is the one for the binary outputs. So create a new "*MainApplication"* tab as shown below.

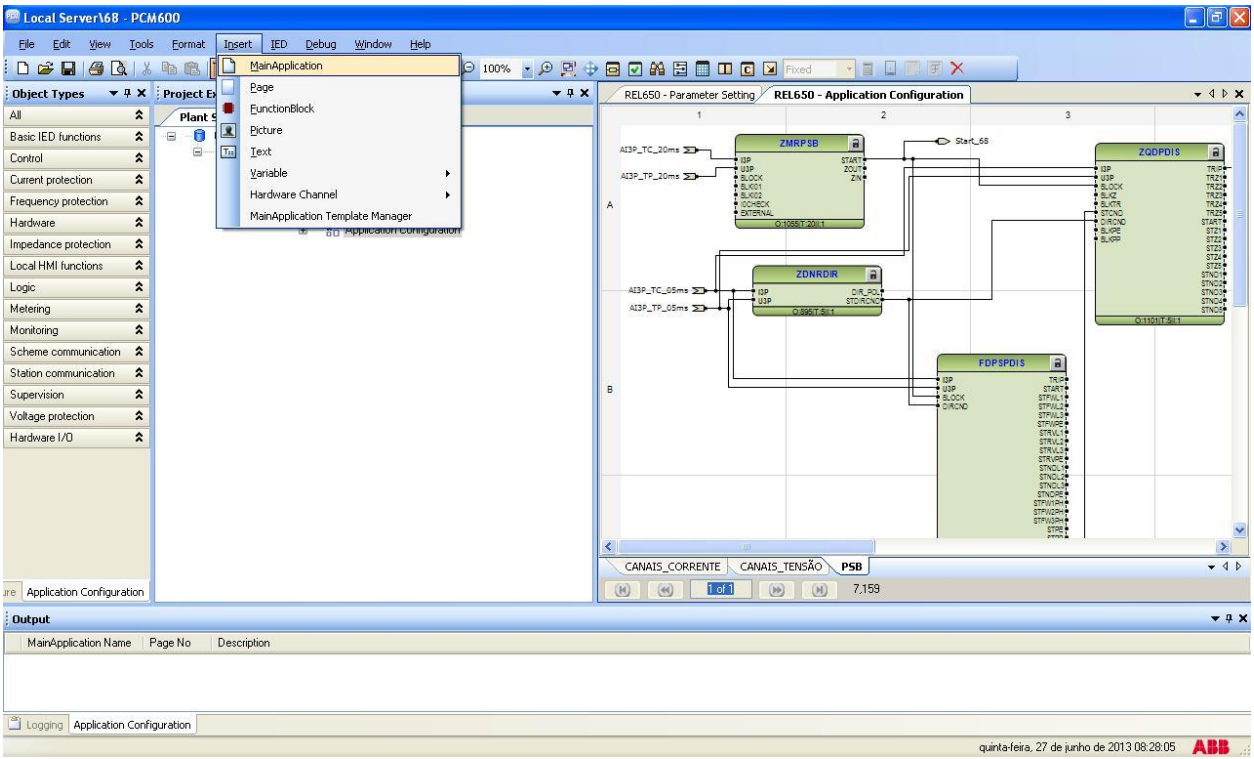

Figure 50

Right-click inside the new tab and choose *"Insert Hardware Channel",* then *"Binary Output"* and *"Insert"*.

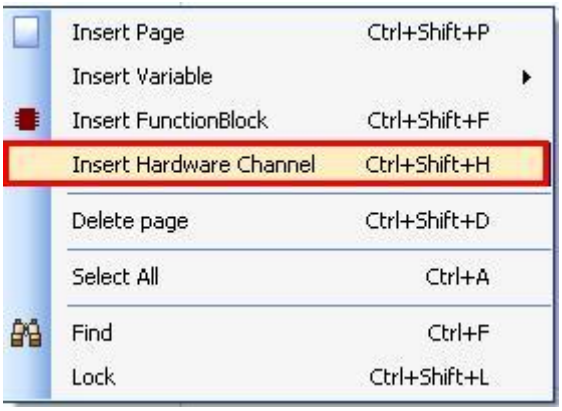

Figure 51

Figure 52

The next step is to choose the Hardware module *"PSM_102"* and the binary output (BO4).

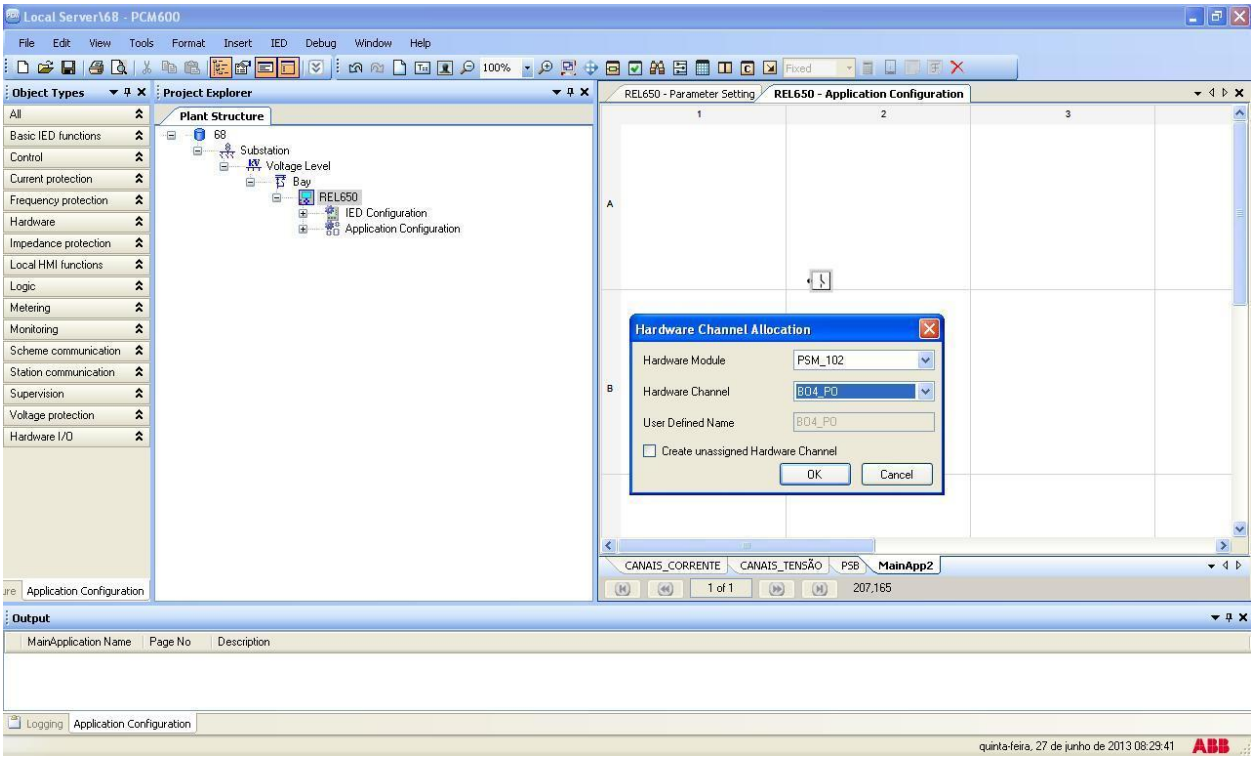

Figure 53

Create two input variables using the same names as the output variables of the *"PSB"* tab and associate the binary outputs. Change the name of the tab to *"SAÍDAS_BINÁRIAS"*.

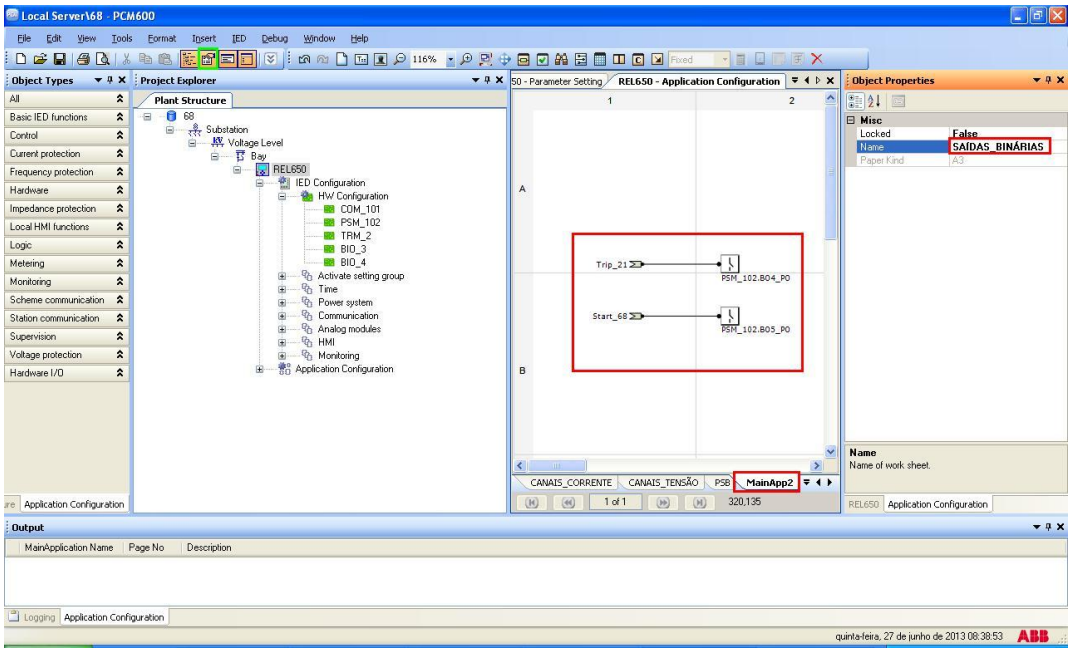

Figure 54

Click on the icon highlighted in green to validate the configuration, then on *"OK"* and save the configuration.

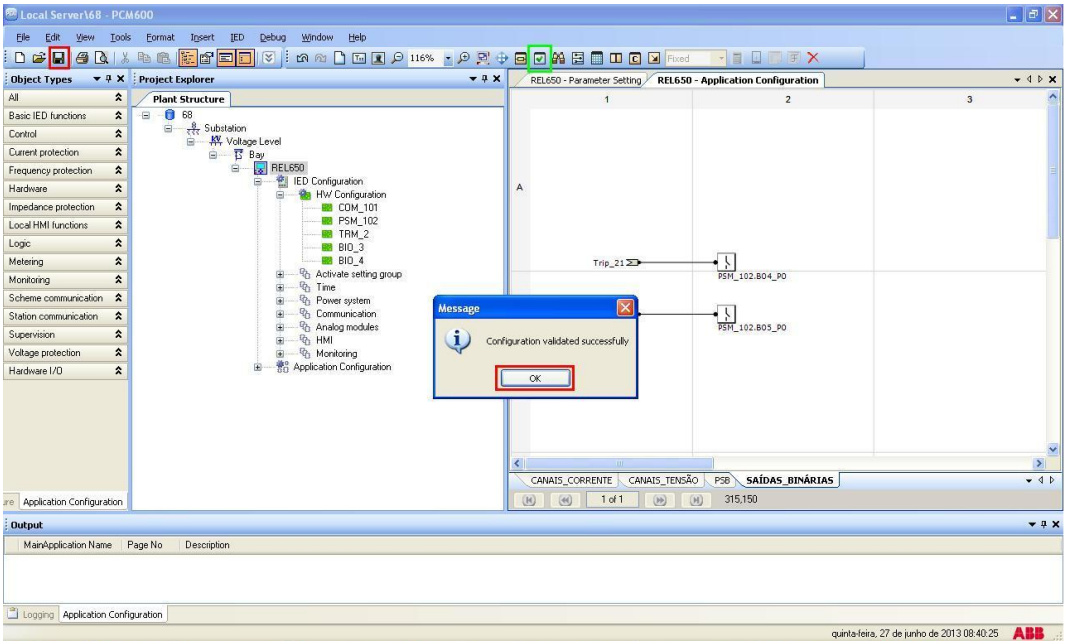

Figure 55

3. Parameterization of the ABB REL650 relay

3.1 *REL 650 Parameter Setting*

Choose the top tab *"REL 650 Parameter Setting"* and click on the *"+"* signs beside *"Application Configuration > DISTANCE > Impedance"* and finally *"ZQDPDIS: 1"*.

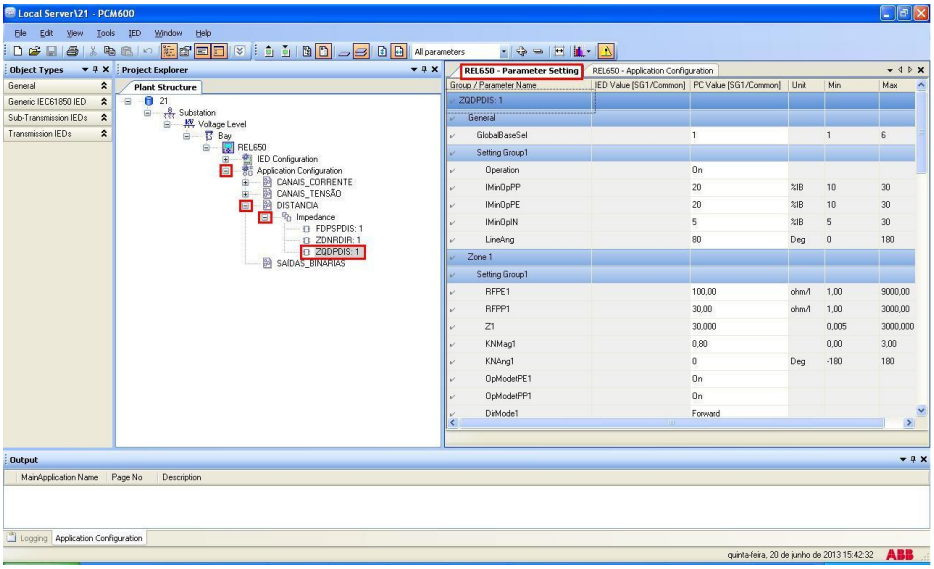

Figure 56

The relay allows up to 5 protection zones to be parameterized, but for simplicity in this tutorial only 3 zones will be active. The first two will have forward directionality and the third reverse directionality. For the first zone make the following adjustments:

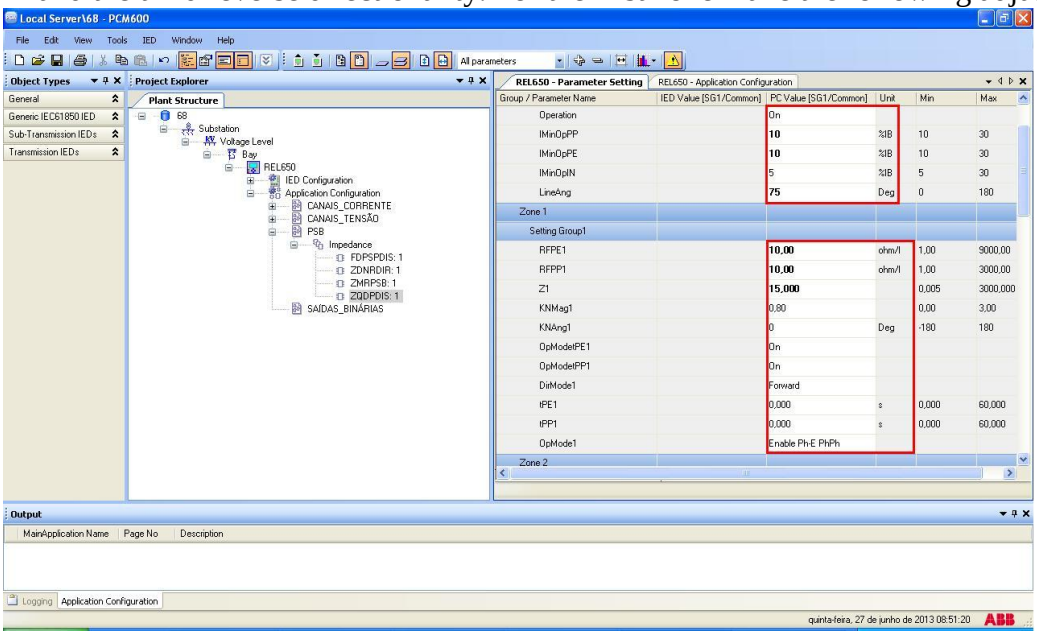

Figure 57

adjustments to the second zone.

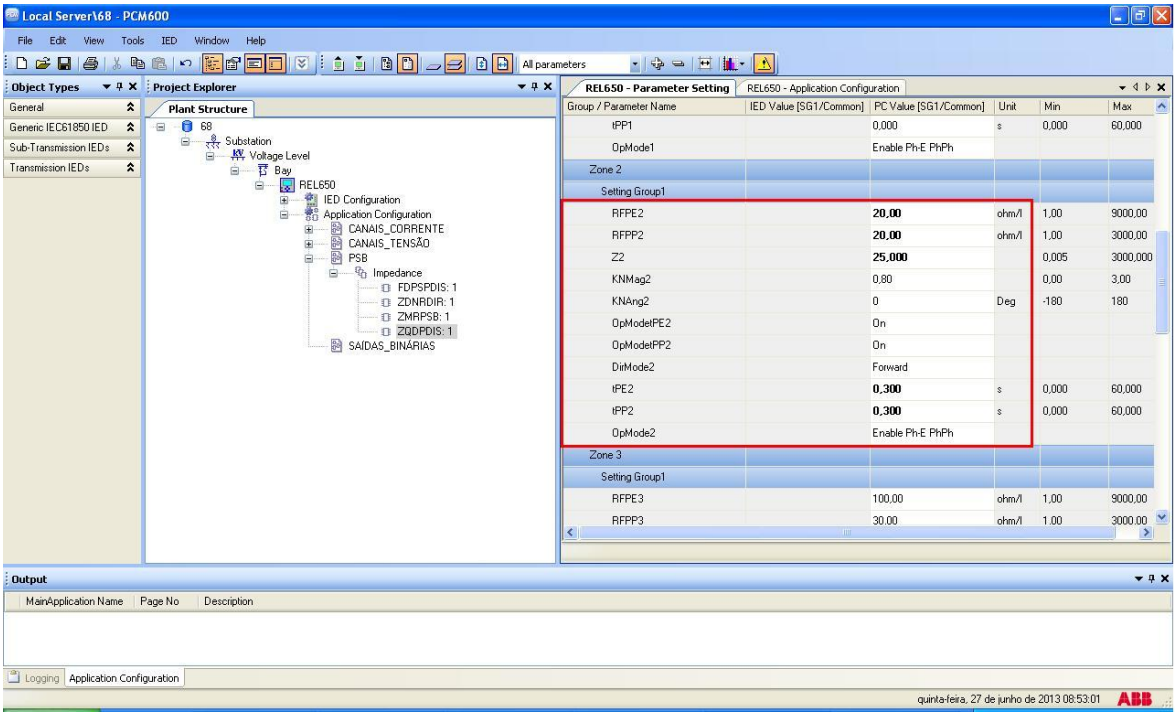

Figure 58

Finally, parameterize the third zone.

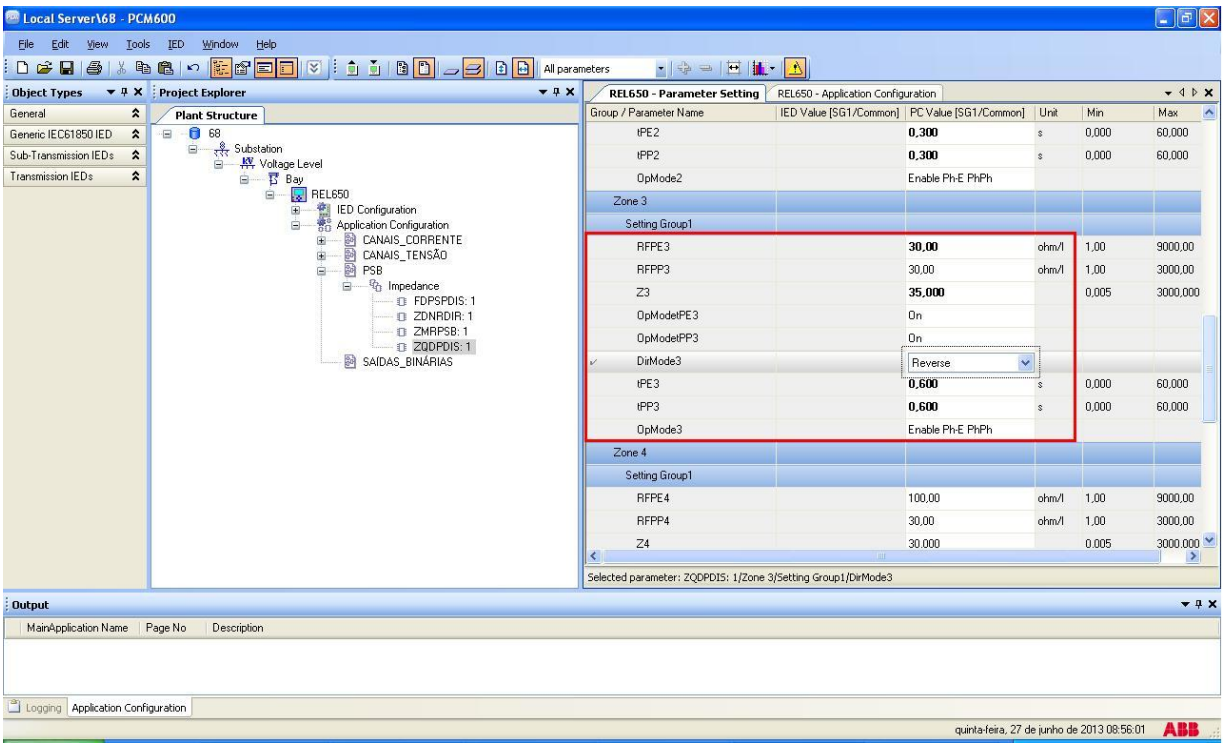

Figure 59

To disable zones 4 and 5 make the following adjustment.

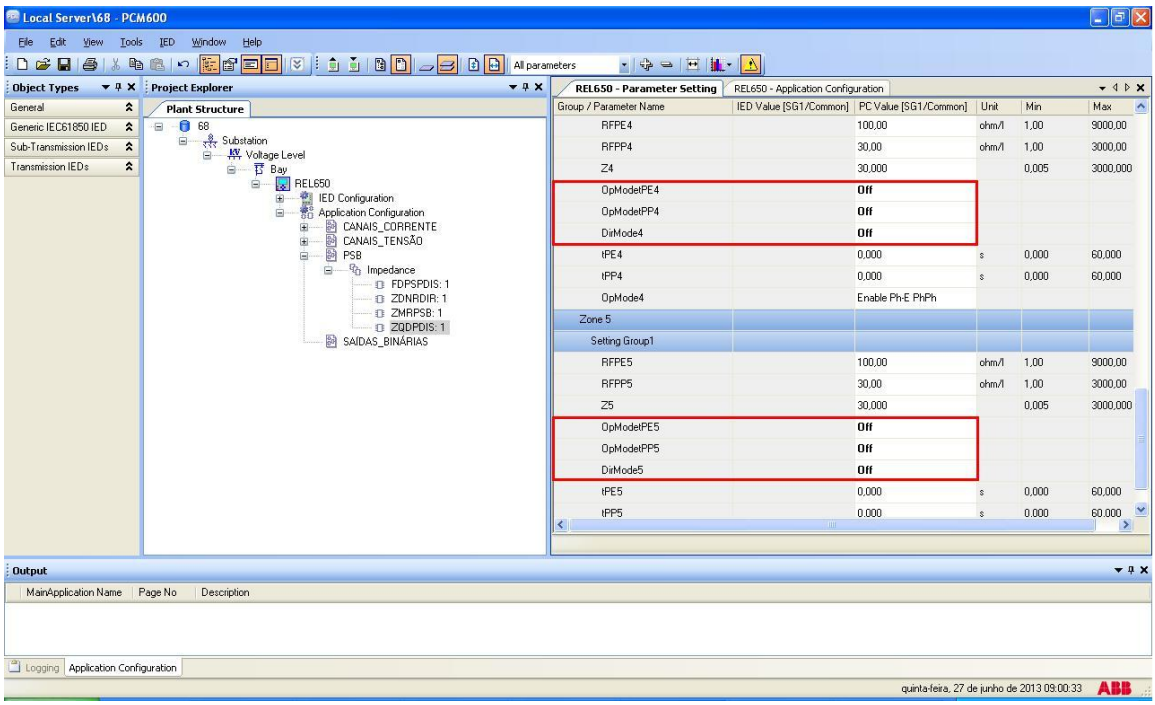

Figure 60

The next step is to parameterize the directionality limits. For this click on the *"ZNRDIR:1"* option and make the following adjustments:

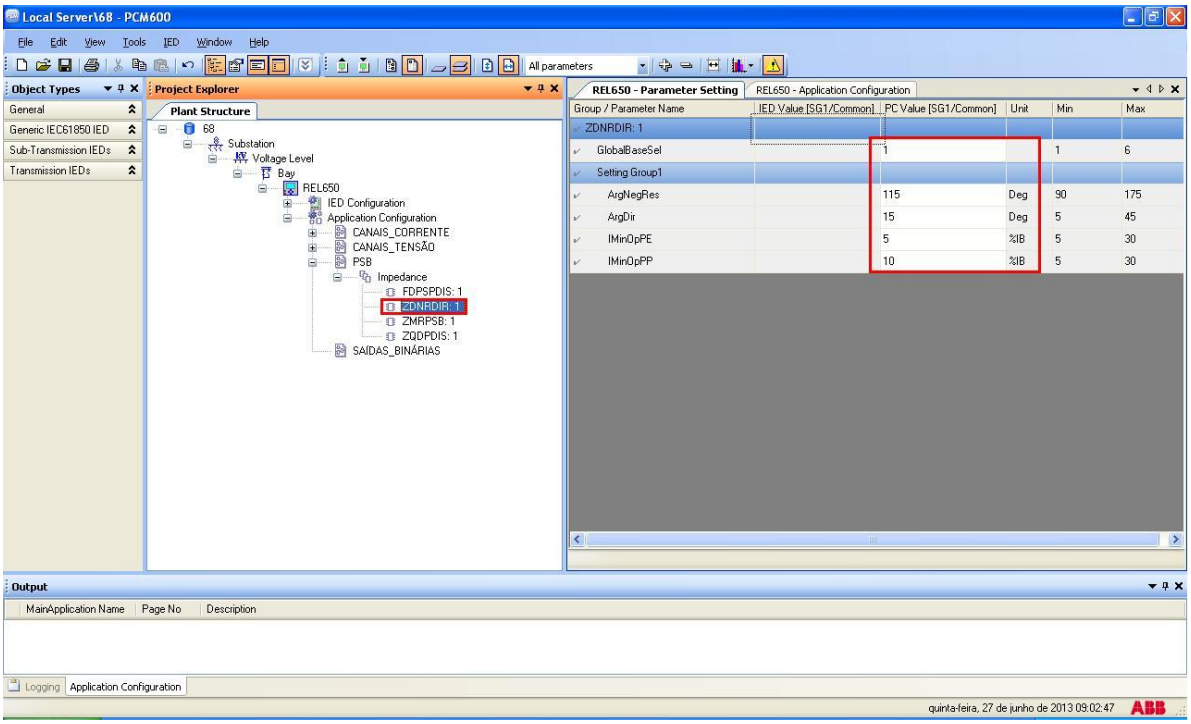

Figure 61

The next parameterization is for the phase selector and load compensator. Select the *"FDPSPDIS:1"* option and perform the following adjustments.

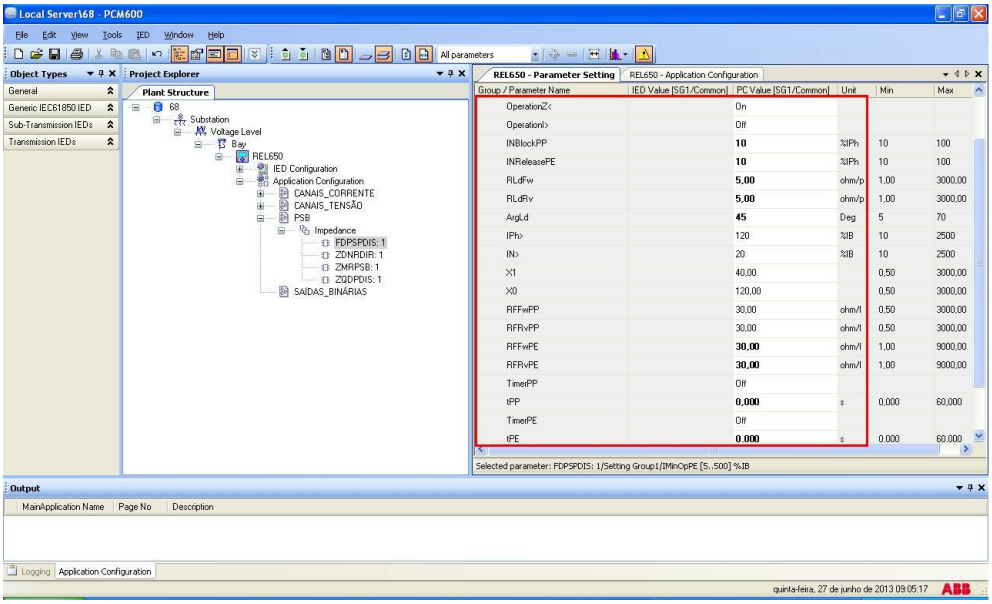

Figure 62

The last two parameters not shown in the previous figure must be set to their minimum values. The last parameterization is for the power swing. Select the *"ZMRPSB:1"* option and perform the following adjustments.

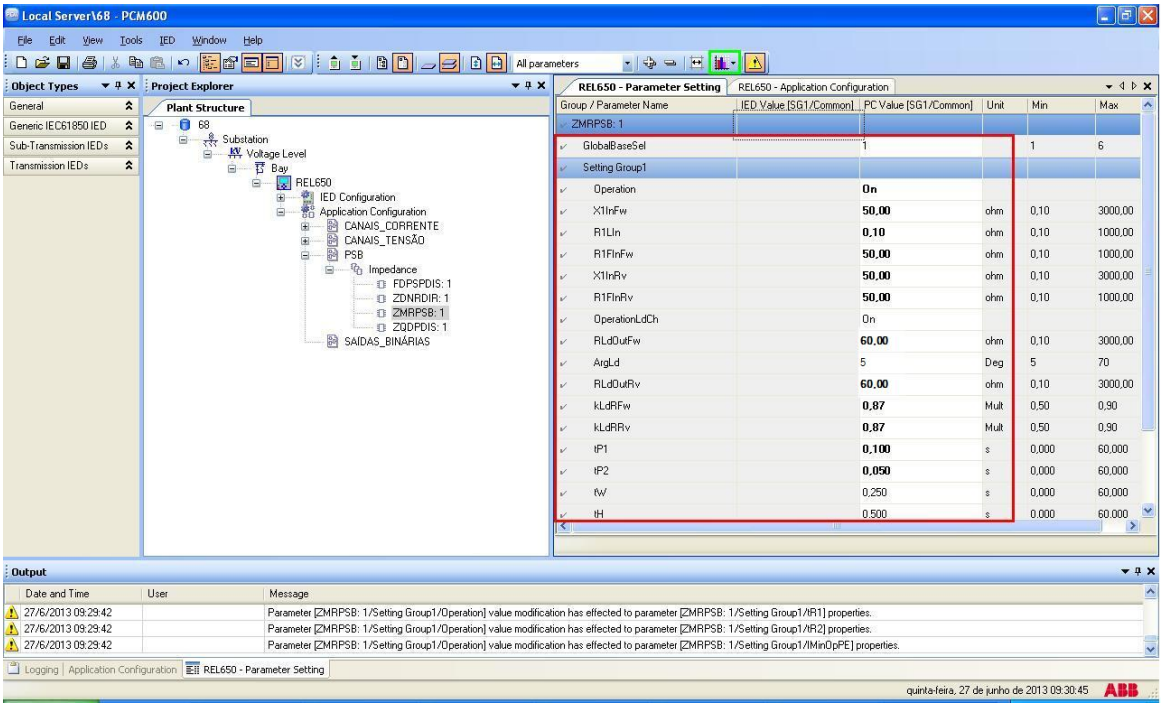

Figure 63

The last three settings not shown *"tR1"*, *"tR2"* and *"IMinOpPE"* are at their factory default settings. Click on the icon highlighted in green in the previous figure to view the distance and power swing characteristics.

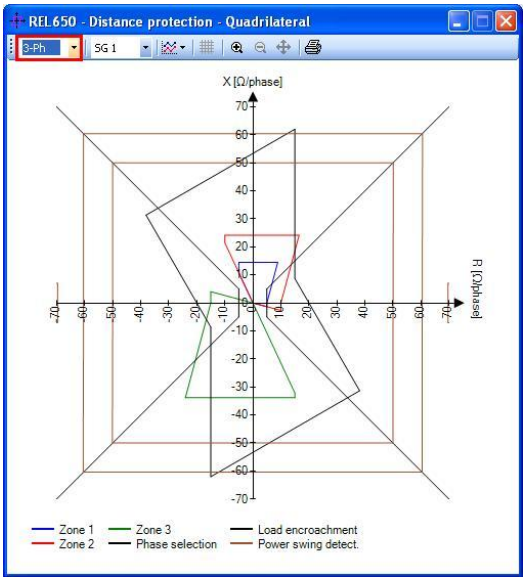

Figure 64

These settings are the two responsible for power swing detection. In this case, two quadrilaterals were used, the smaller one (INNER) with a range of 50Ω and the larger one (OUTER) with a range of 60Ω. Save all settings by clicking on the icons highlighted in green and then right-click on the relay icon and send the changes. In the following message click on *"Yes"*.

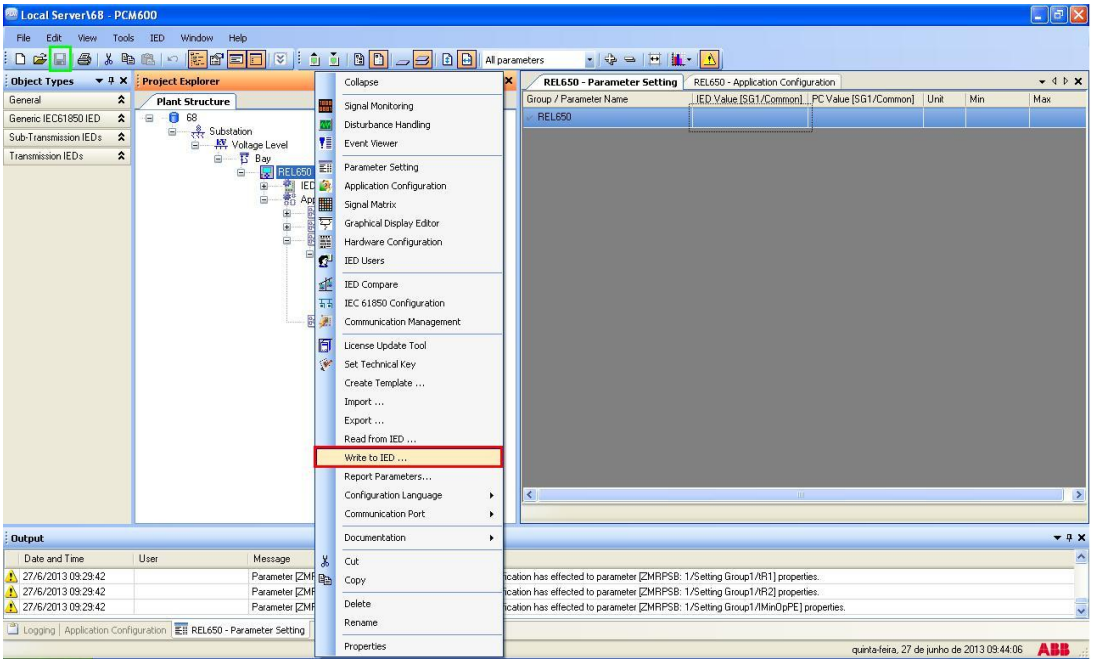

Figure 65

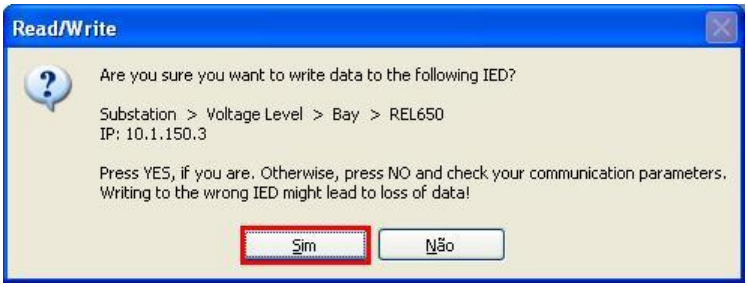

Figure 66

4. PSB_OoS software adjustments

4.1 *Opening the PSB_OoS*

Click on the CTC application manager icon.

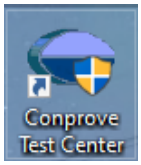

Figure 67

Click the *"PSB_OoS"* software icon.

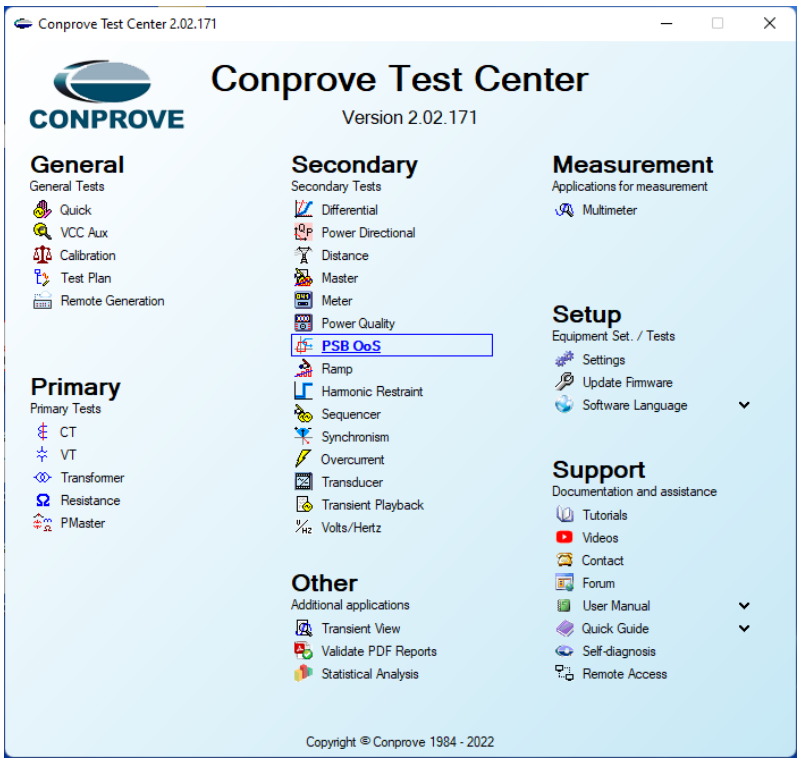

Figure 68

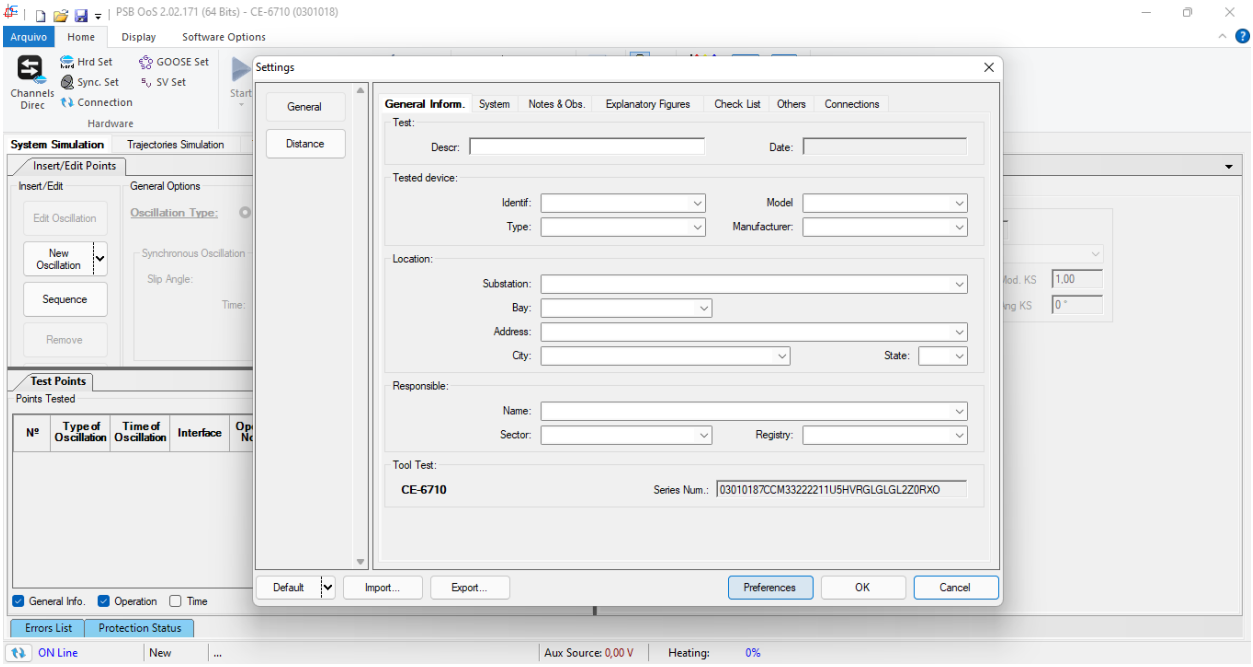

Figure 69

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.

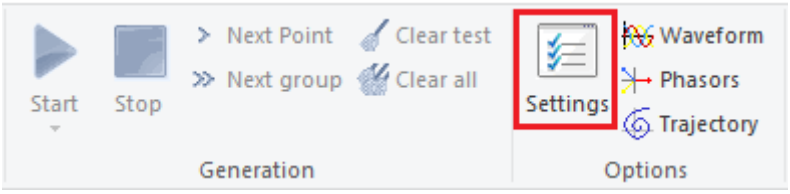

Figure 70

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.

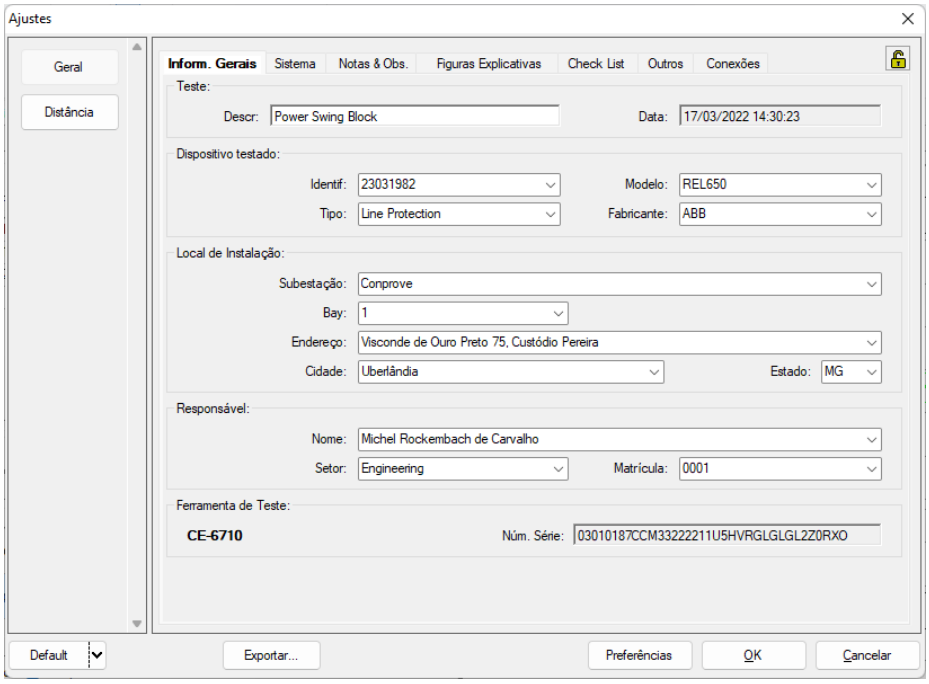

Figure 71

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.

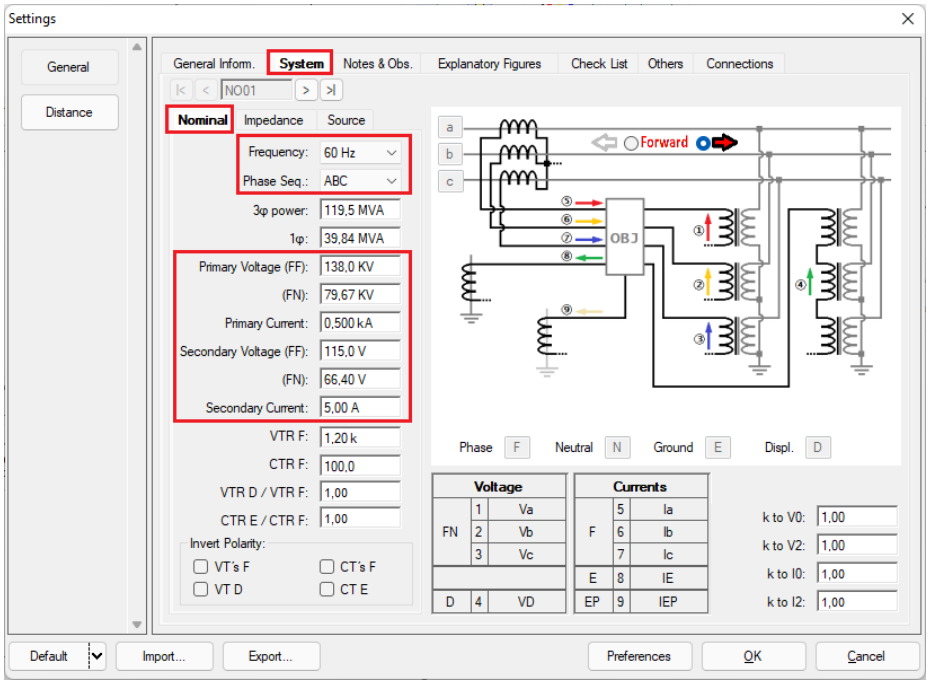

Figure 72

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.

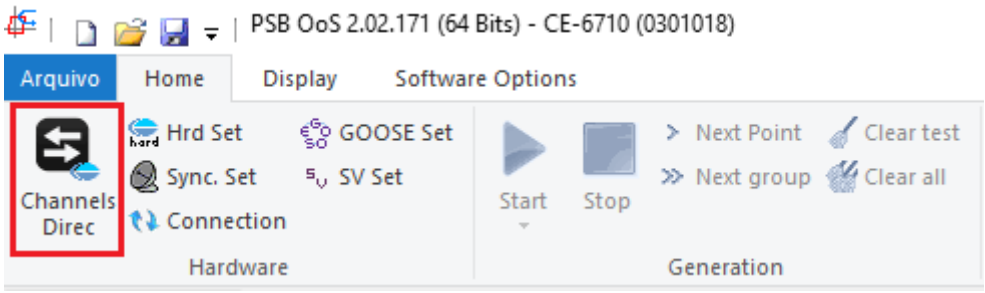

Figure 73

Then click on the highlighted icon to configure the hardware.

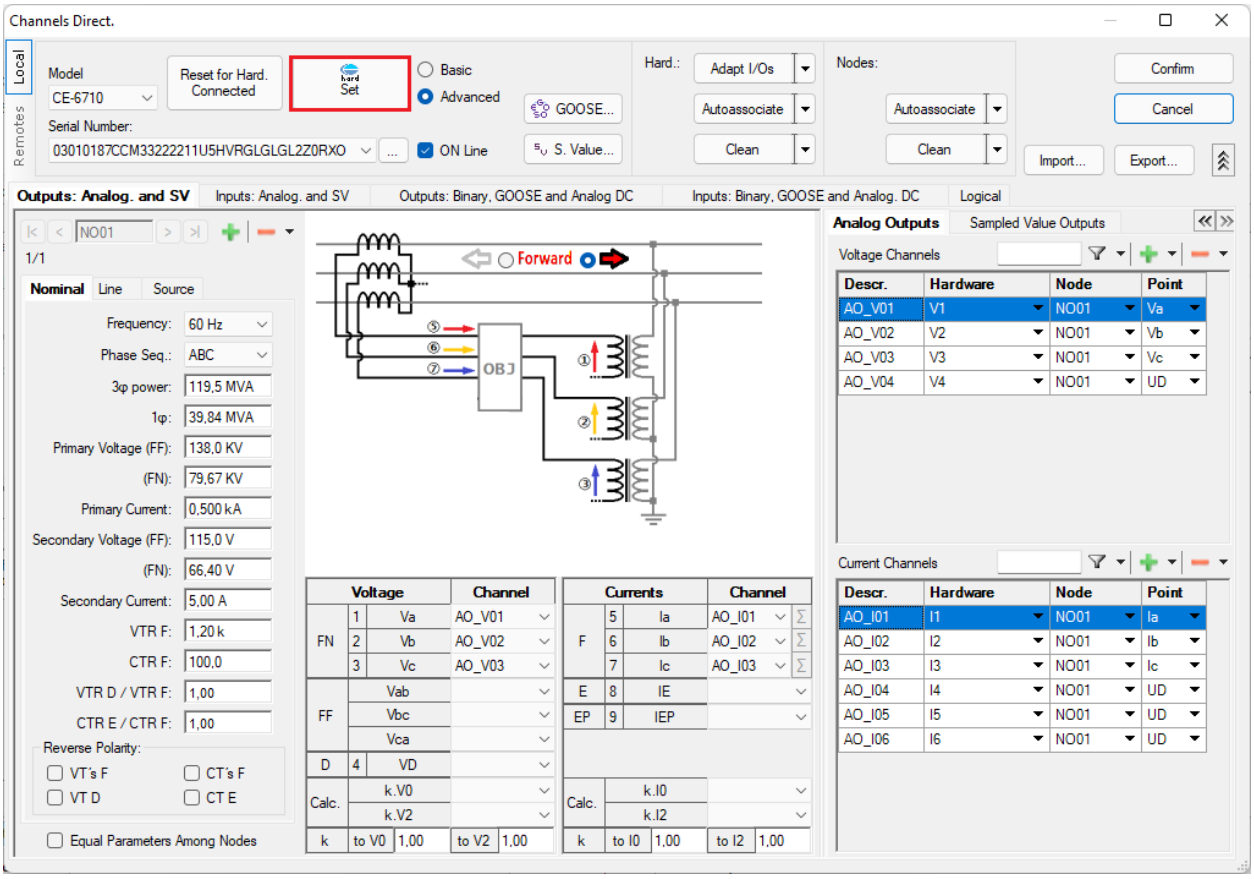

Figure 74

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

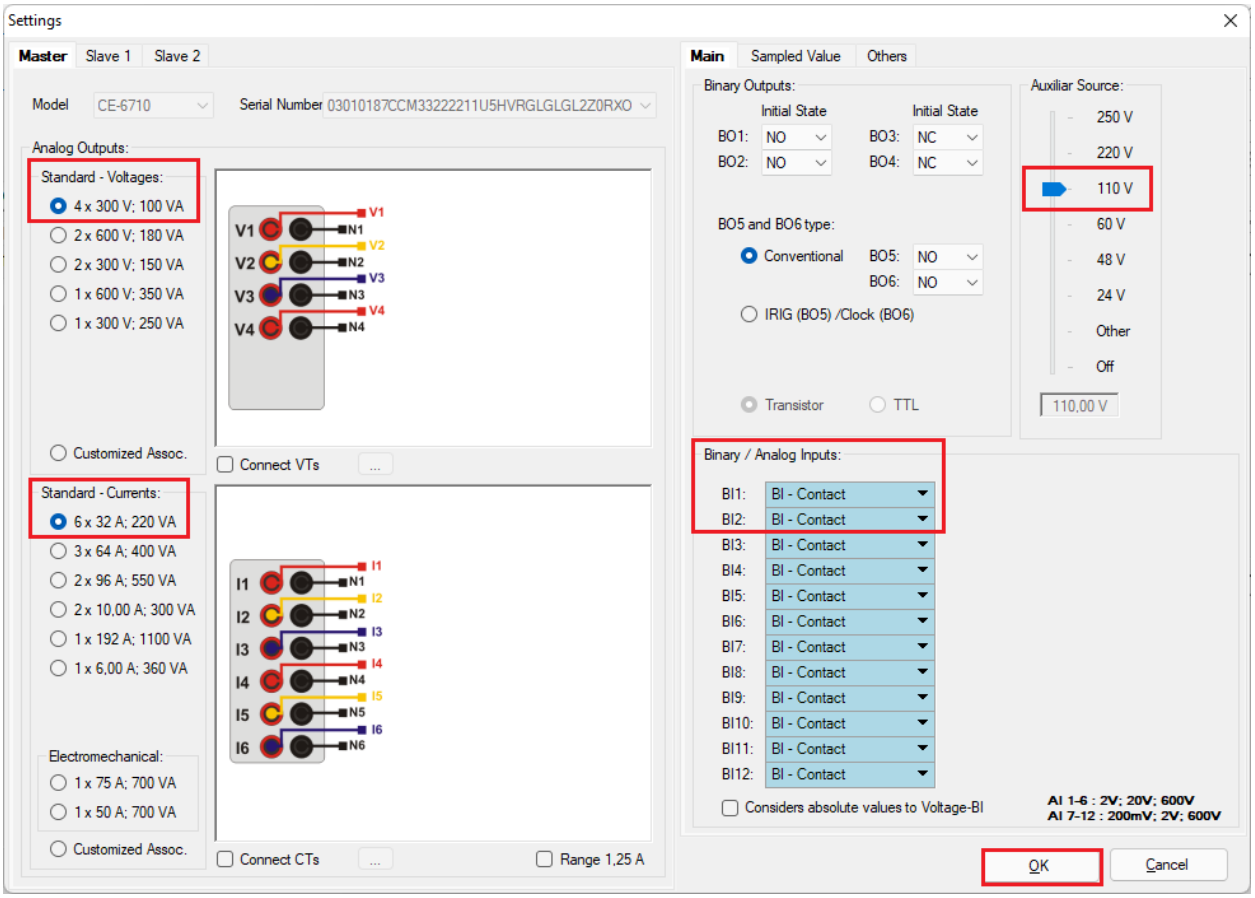

Figure 75

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

Figure 76

6. Distance Adjustments

Note: The ABB REL650 relay has peculiar characteristics for each type of fault. For a test in the distance function, 9 types of zones must be entered (for more details, check the respective tutorial). As the test to be performed is of power oscillation, it is enough to register the zones for three-phase faults.

6.1 *Distance screen > Distance Prot. Settings*

Return to the *"Distance Prot. Settings"* screen, with the first screen showing the parameters of length, line angle and ground compensation factor. For this specific test there is no need to configure them.

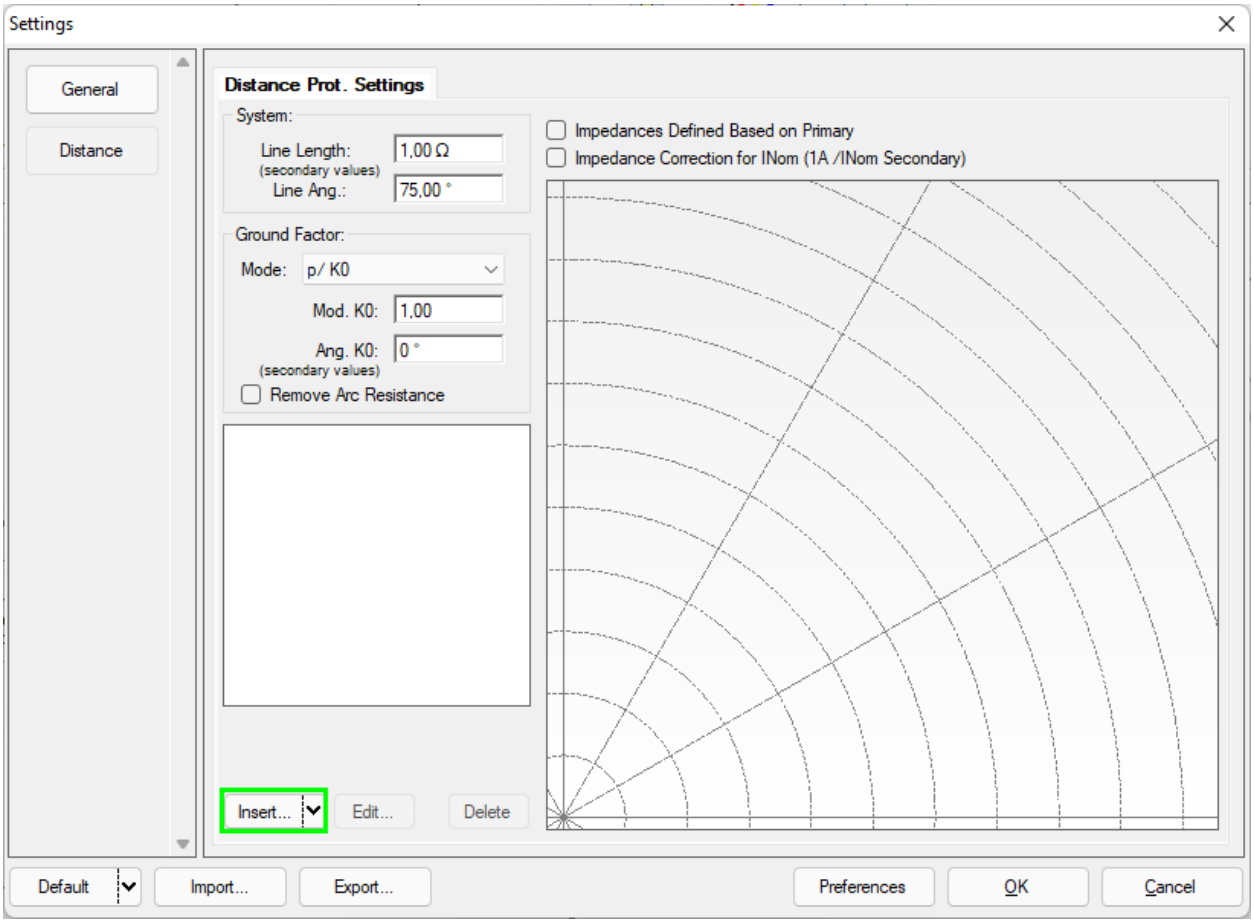

Figure 77

6.2 *Inserting the Zones (Three Phase)*

The following three figures show the parameters of each zone for three-phase faults to be set in the PSB_OoS software.

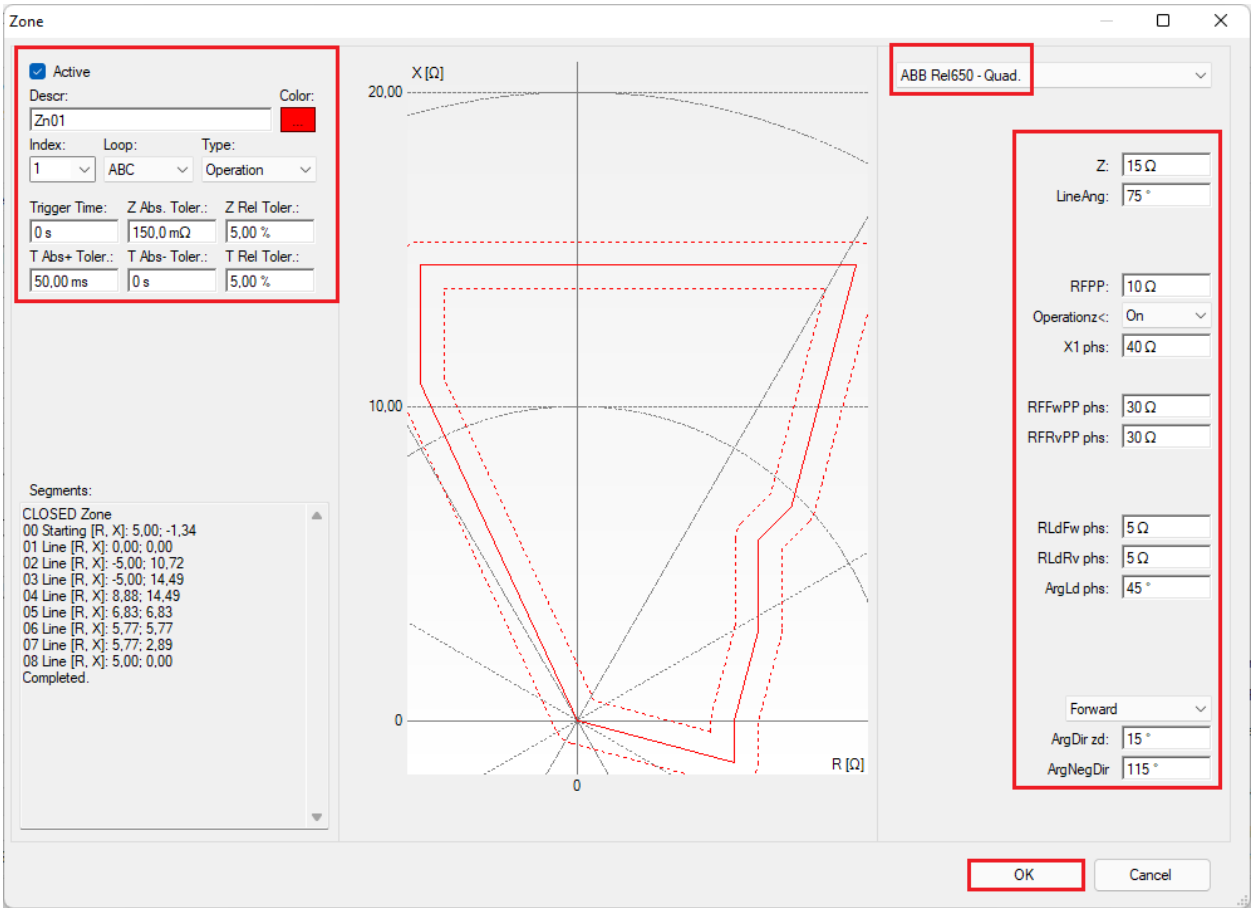

Figure 78

Click on *"OK"* on the previous figure and on *"Insert"* on the next figure to add one more zone.

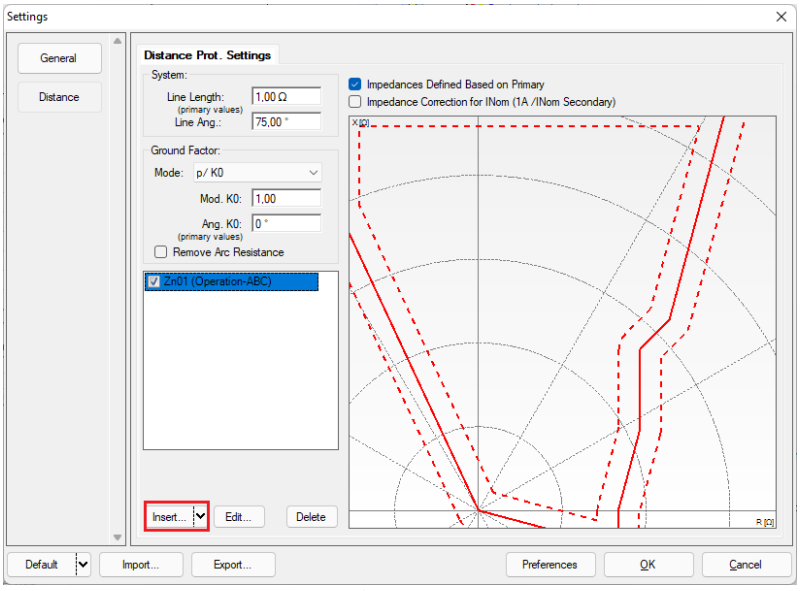

Figure 79

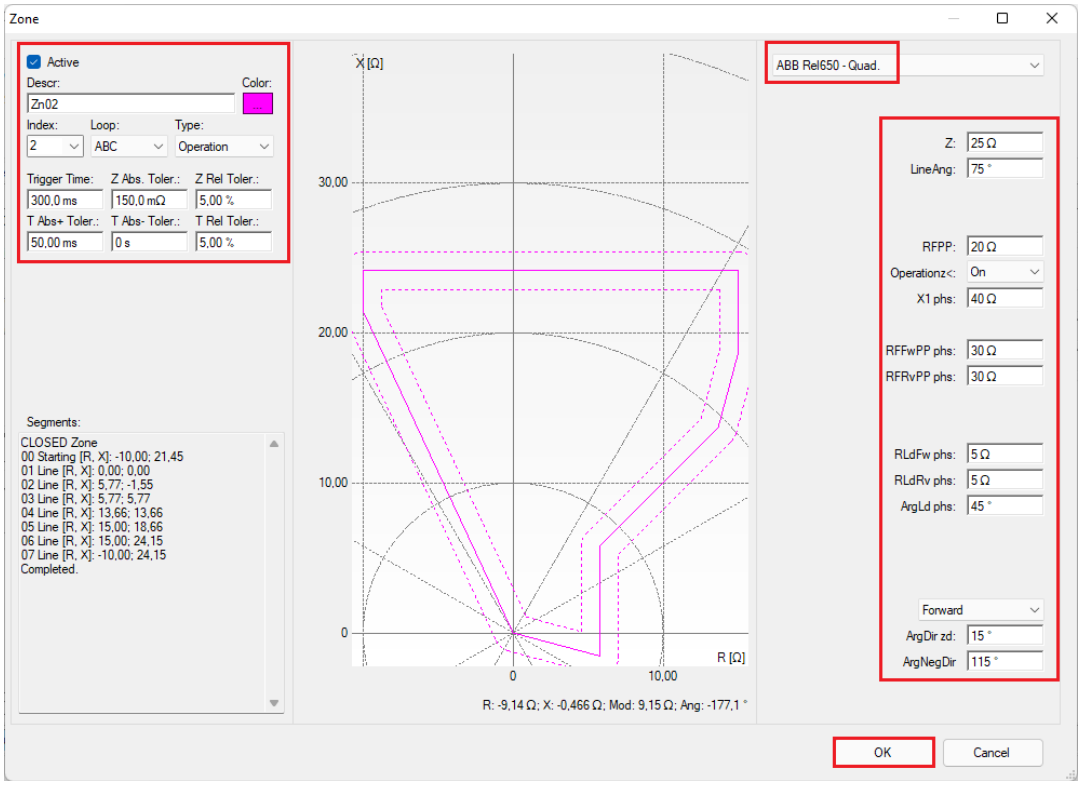

Figure 80

Repeat the previous procedure to enter the third zone.

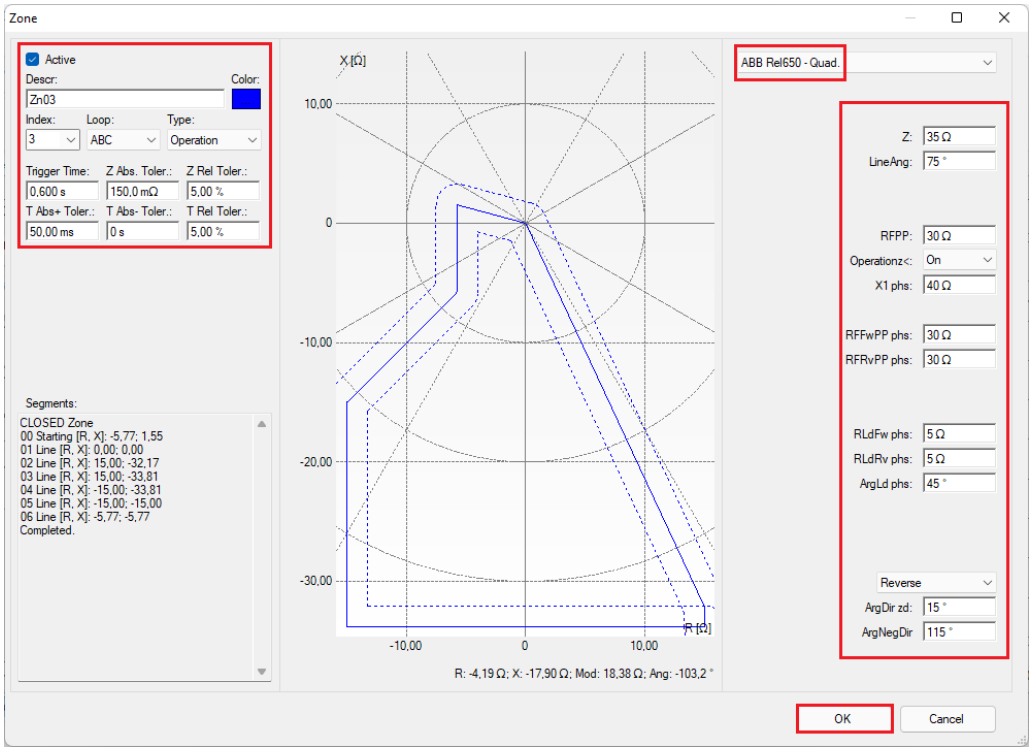

Figure 81

6.3 *Inserting the Blinders*

The following two figures show the parameters of each blinder used to detect power swing.

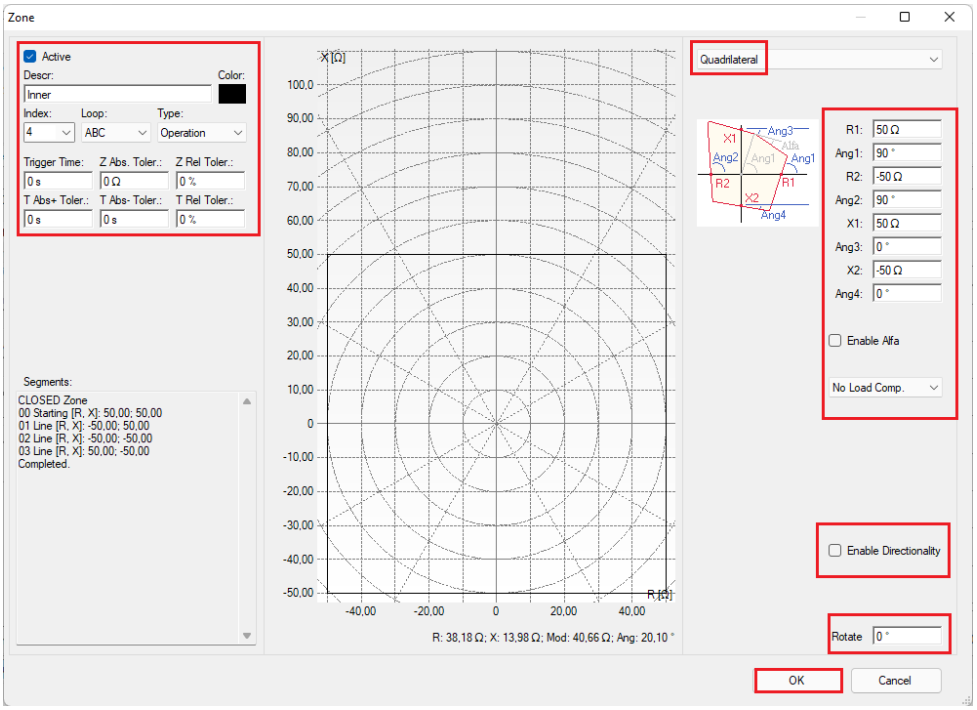

Figure 82

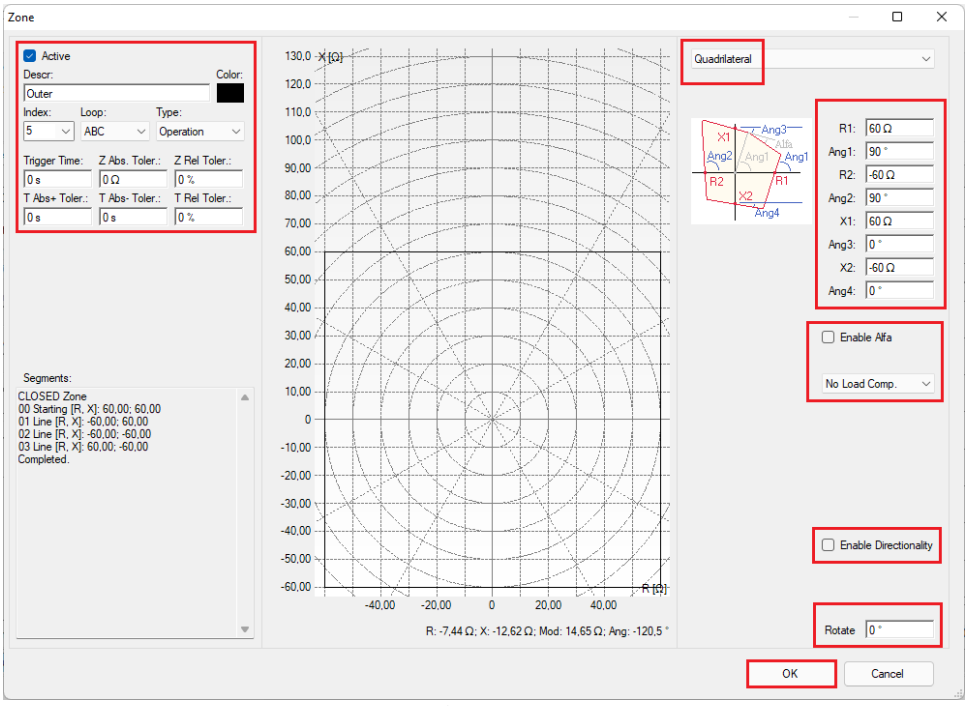

Figure 83

NOTE: The REL650 has its impedance settings referenced to the primary. Therefore, the following option must be selected.

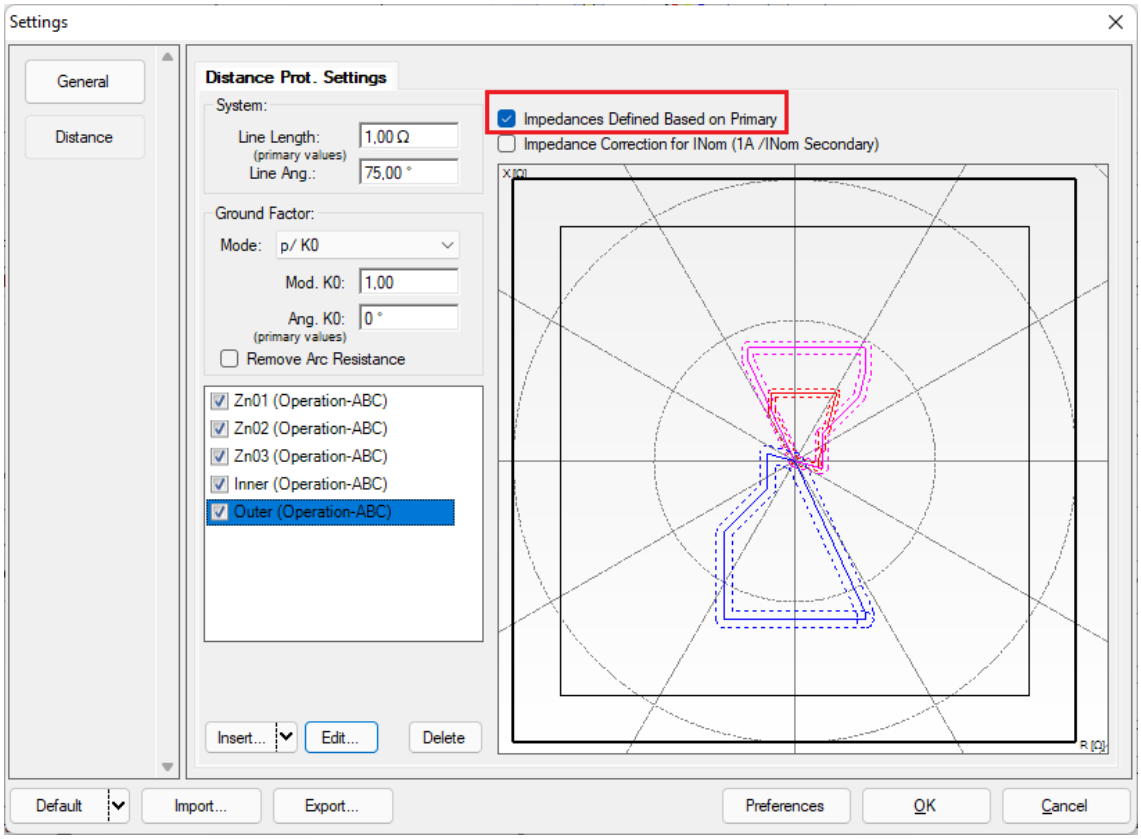

Figure 84

If the user does not select this option when clicking *"OK"* in the previous figure, the following message is displayed.

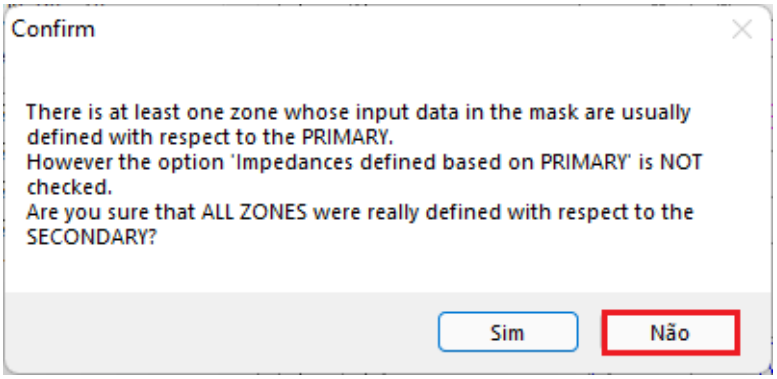

Figure 85

In this case click *"No"* and check the highlighted option.

7. Test structure for the PSB_OoS function

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 situation with nominal conditions and duration of 100ms.

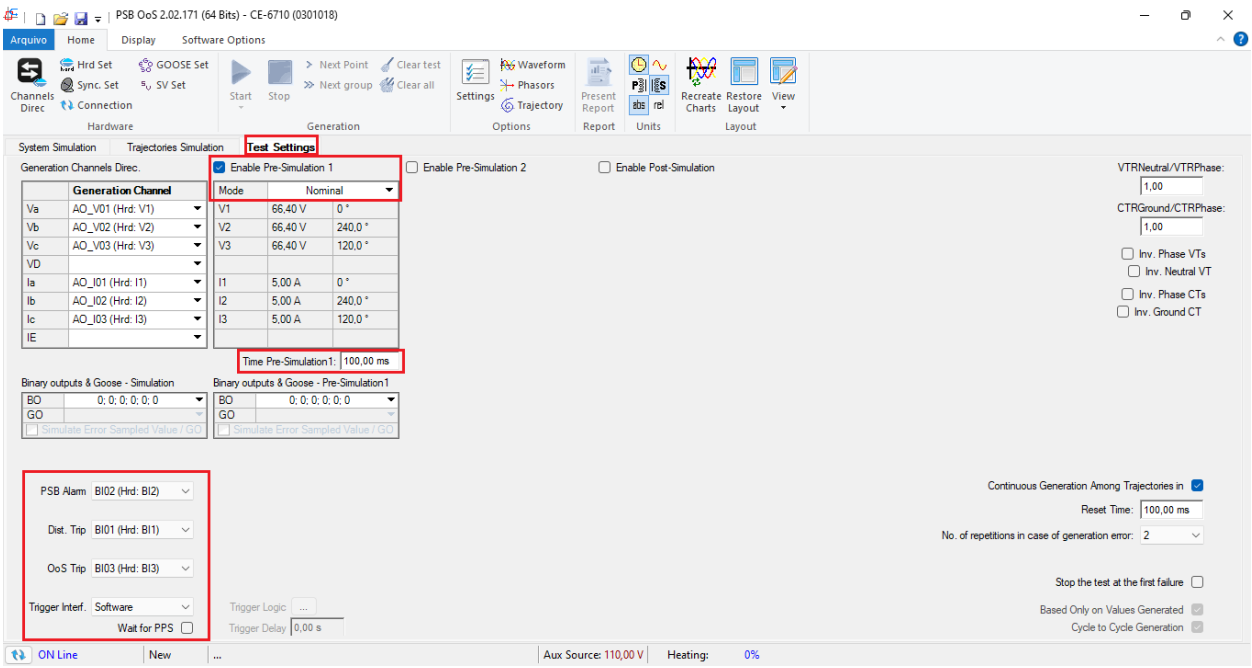

Figure 86

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 great advantage of not being tied to the real system settings, so that the user has complete freedom to control the impedance trajectory (dZ/dt). The key factor in detecting the types of oscillation is in the time adjustment of the parameter *"tP1"* in the relay, which in this case is set at 100ms.

Depending on the time the trajectory takes to pass from the external to the internal blinder, two situations arise:

1. Time greater than 0.1 seconds to cross the two blinders regardless of the side (right or left). Power swing block signal actuation.

2. Time less than 0.1 seconds to cross the two blinders regardless of the side. Distance trip actuation (provided it enters a zone and remains longer than the time set for zone operation).

Note: The difference between the external and internal blinder is 0.83Ω (Primary), provided that a trajectory parallel to the abscissa axis is adopted.

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 4.15Ω/s this ensures that the time to cross the two blinders is 0.2s (0.83/4.15), sufficiently greater than the one set (0.1s).

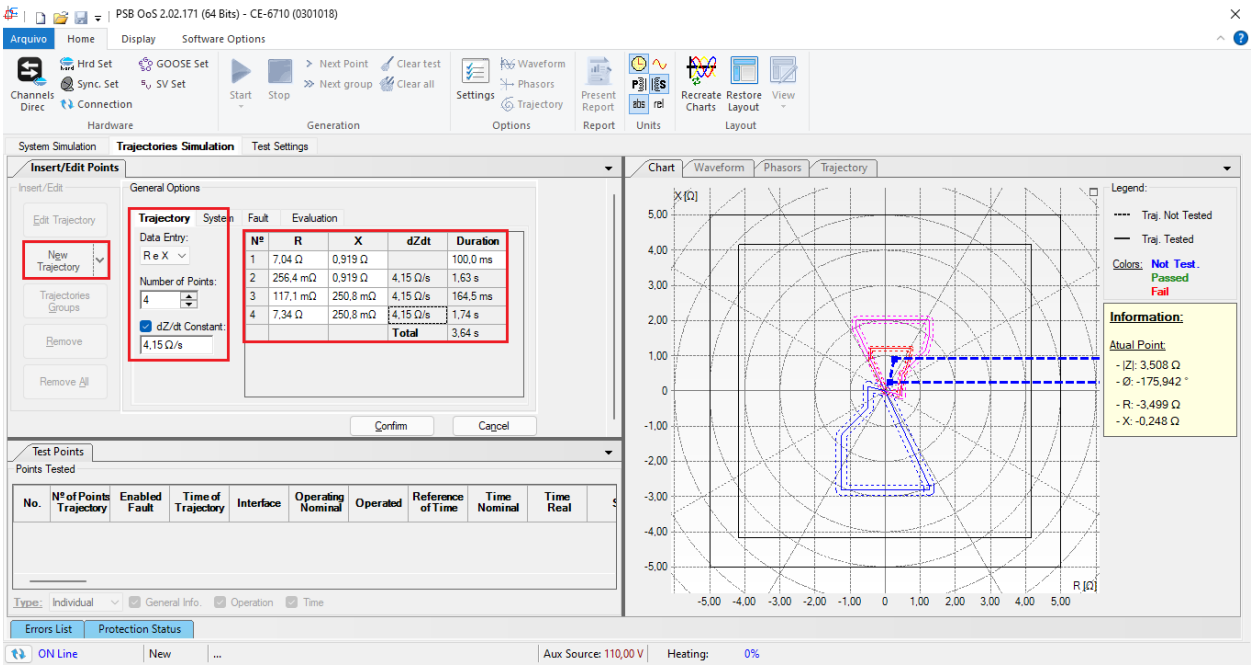

Figure 87

The next step is to configure the *"System"* tab.

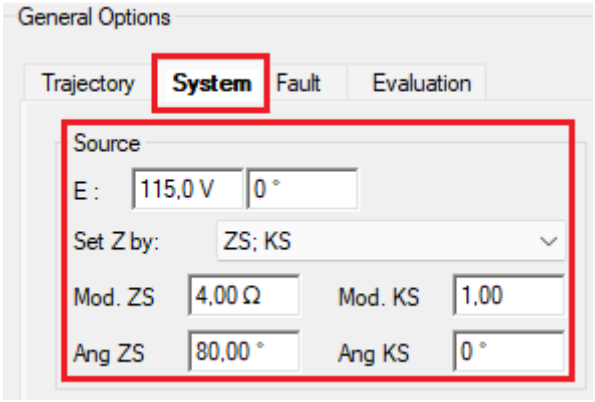

Figure 88

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"*.

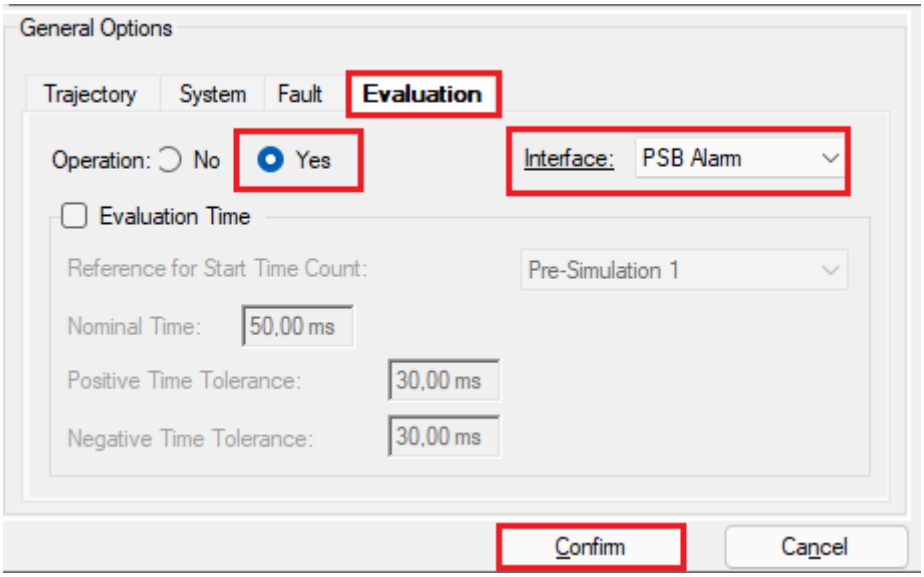

Figure 89

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

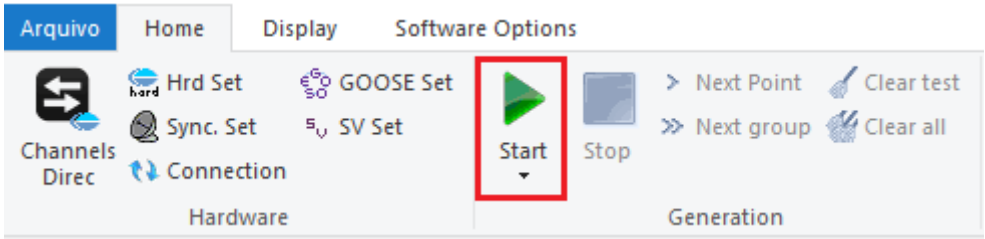

Figure 90

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

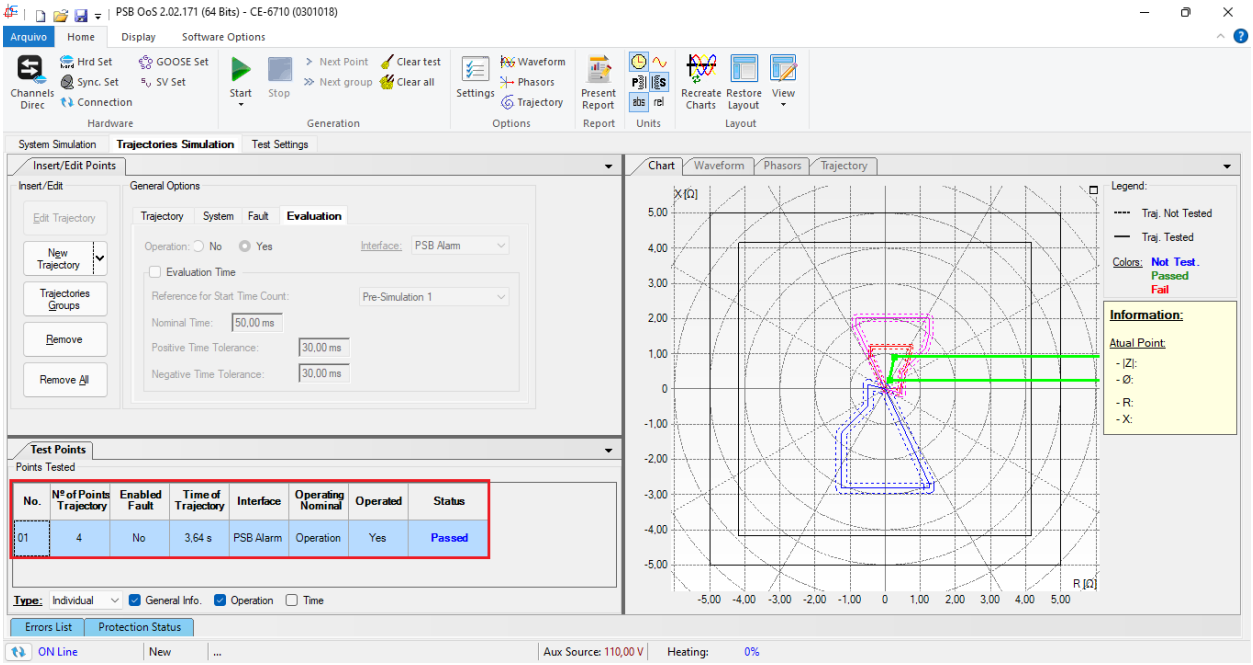

Figure 91

7.5 *Simulation of Three-Phase Fault Trajectories*

In this test, the performance of the distance trip is verified. A trajectory is simulated so that it crosses the blinders with a time less than 0.1sec. In this case, a dZ/dt of 16.60Ω/s is used so that the time is 0.05 seconds (8.3/16.6). To do this make the following adjustments:

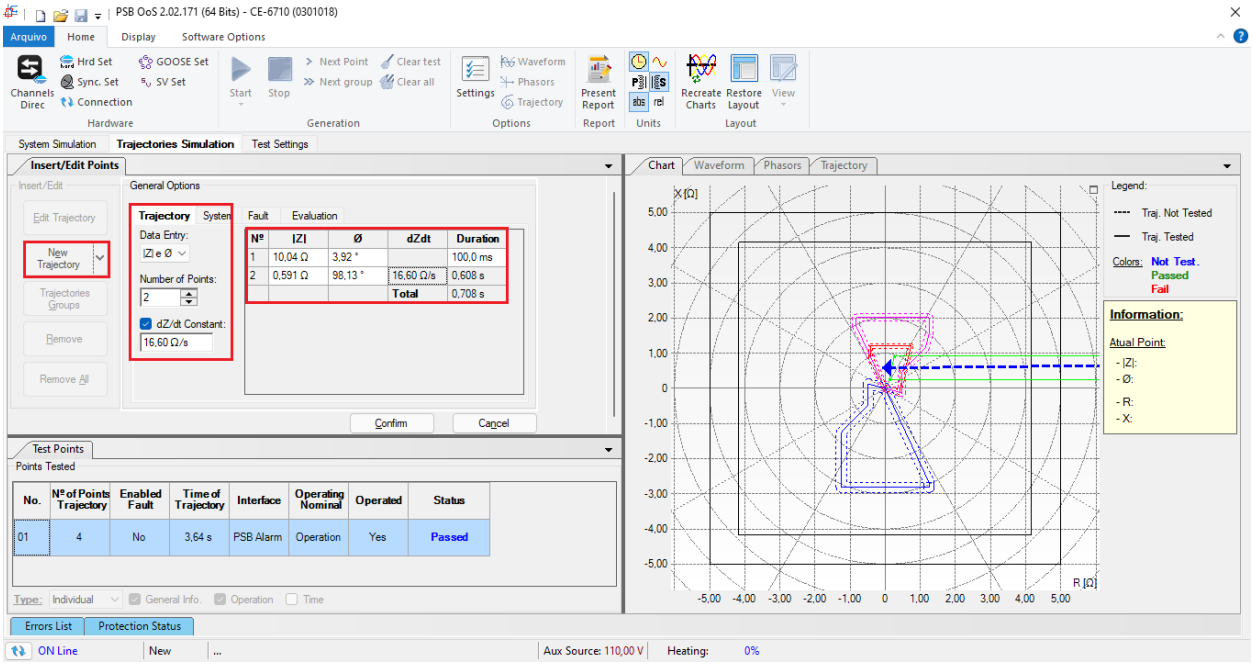

Figure 92

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:

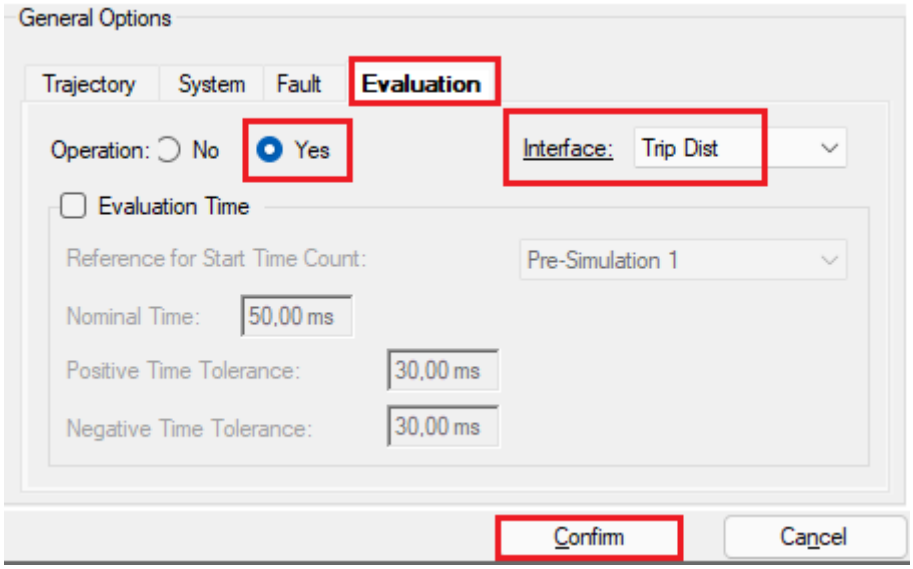

Figure 93

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.

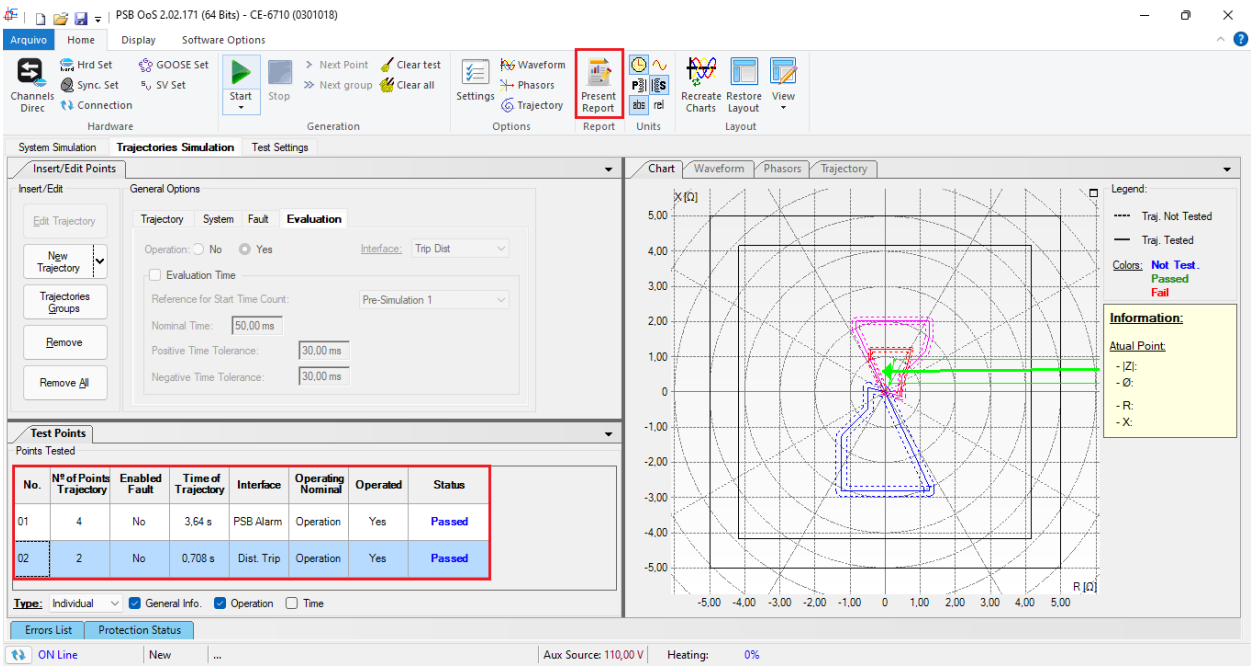

Figure 94

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.

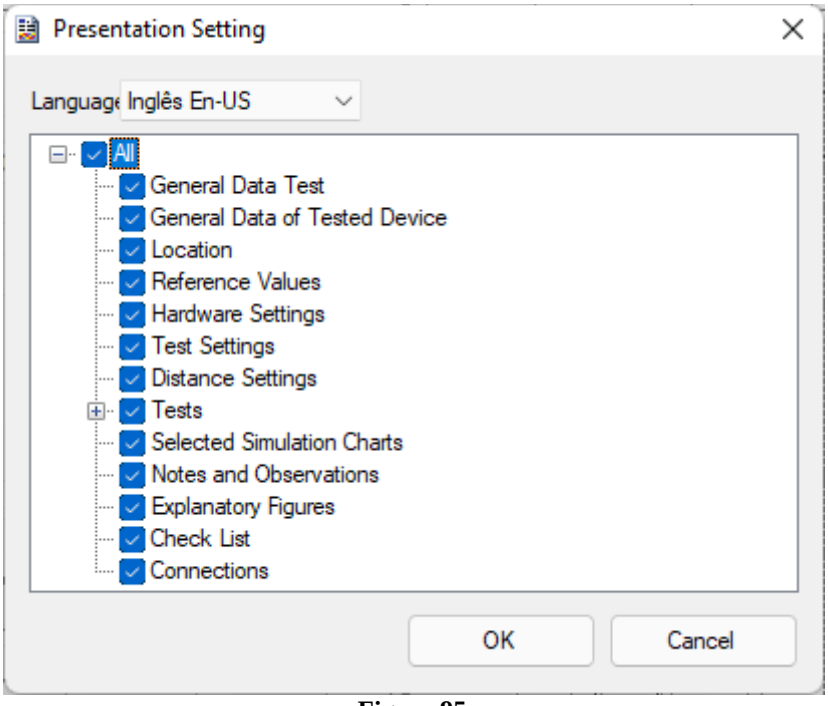

Figure 95

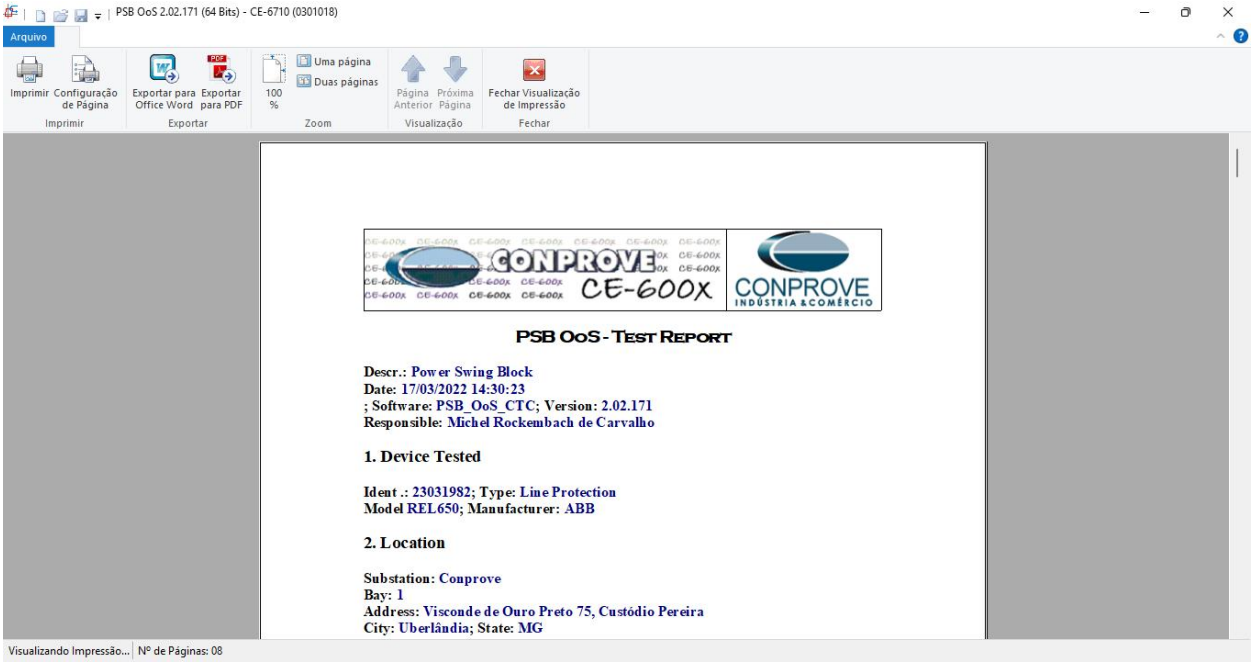
PSB OoS 2.02.171 (64 Bits) - CE-6710 (0301018)
Arquivo
Imprimir
Configuração de Página
Exportar para Office Word
Exportar para PDF
100 %
Uma página
Duas páginas
Página Anterior
Próxima Página
Fechar Visualização de Impressão
Imprimir
Exportar
Zoom
Visualização
Fechar
CONPROVE
CE-600X
CONPROVE
INDÚSTRIA & COMÉRCIO
PSB OoS - Test Report
Descr.: Power Swing Block
Date: 17/03/2022 14:30:23
; Software: PSB_OoS_CTC; Version: 2.02.171
Responsible: Michel Rockembach de Carvalho
1. Device Tested
Ident .: 23031982; Type: Line Protection
Model REL650; Manufacturer: ABB
2. Location
Substation: Conprove
Bay: 1
Address: Visconde de Ouro Preto 75, Custódio Pereira
City: Uberlândia; State: MG
Visualizando Impressão...
Nº de Páginas: 08

Figure 96

APPENDIX A

A.1 Terminal Designations

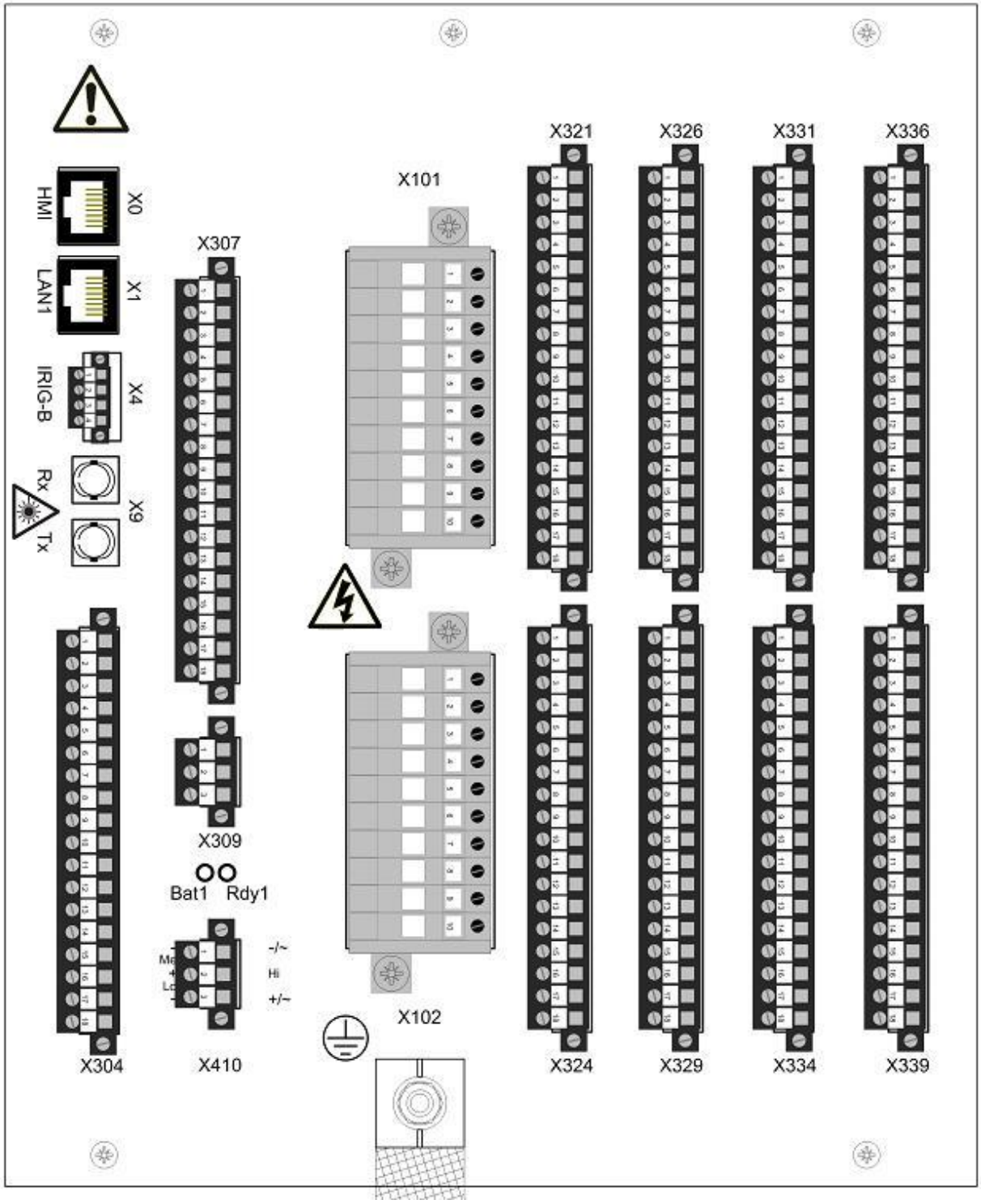

Figure 97

Table 527: Auxiliary voltage supply of 110...250 V DC or 100...240 V AC

Case	Terminal	Description
6U half 19"	X410-1	- Input
	X410–3	+ Input

Table 526: Analog input modules

Terminal	TRM 6I + 4U	TRM 8I + 2U	TRM 4I + 1I + 5U	AIM 6I + 4U	AIM 4I + 1I + 5U
X101-1, 2	1/5A	1/5A	1/5A	1/5A	1/5A
X101-3, 4	1/5A	1/5A	1/5A	1/5A	1/5A
X101-5, 6	1/5A	1/5A	1/5A	1/5A	1/5A
X101-7, 8	1/5A	1/5A	1/5A	1/5A	1/5A
X101-9, 10	1/5A	1/5A	0.1/0.5A	1/5A	0.1/0.5A
X102-1, 2	1/5A	1/5A	100/220V	1/5A	100/220V
X102-3, 4	100/220V	1/5A	100/220V	100/220V	100/220V
X102-5, 6	100/220V	1/5A	100/220V	100/220V	100/220V
X102-7, 8	100/220V	100/220V	100/220V	100/220V	100/220V
X102-9, 10	100/220V	100/220V	100/220V	100/220V	100/220V

Terminal	Description	PCM600 info	
		Hardware module instance	Hardware channel
X307-5 X307-6	- +	PSM_102	BO3_PO_TCS
X307-7 X307-8	Power output 4, normally open	PSM_102	BO4_PO
X307-9 X307-10	Power output 5, normally open	PSM_102	BO5_PO
X307-11 X307-12	Power output 6, normally open	PSM_102	BO6_PO

Table 539: Output contacts X307, 6U half 19"

Terminal	Description	PCM600 info	
		Hardware module instance	Hardware channel
X307-13 X307-14	Signal output 1, normally open	PSM_102	BO7_SO
X307-15 X307-16	Signal output 2, normally open	PSM_102	BO8_SO
X307-17 X307-18	Signal output 3, normally open	PSM_102	BO9_SO

A.2 Technical data

Technical data

Table 19: ZQDPDIS Technical data

Function	Range or value	Accuracy
Number of zones	5 with selectable direction	-
Minimum operate residual current	(5-30)% of IBase	± 1,0 % of I_r
Minimum operate current, phase-to-phase and phase-to-earth	(10-30)% of IBase	± 1,0 % of I_r
Positive sequence impedance reach for zones	0.005 - 3000.000	± 5.0% static accuracy ± 2.0 degrees static angular accuracy Conditions: Voltage range: (0.1-1.1) x U_r Current range: (0.5-30) x I_r Angle: at 0 degrees and 85 degrees
Fault resistance, phase-to-earth	(1.00-9000.00) Ω/loop	
Fault resistance, phase-to-phase	(1.00-3000.00) Ω/loop	
Line angle for zones	(0 - 180) degrees	
Magnitude of earth return compensation factor KN for zones	0.00 - 3.00	-
Angle for earth return compensation factor KN for zones	(-180 - 180) degrees	-
Dynamic overreach	<5% at 85 degrees measured with CVT's and 0.5<SIR<30	-
Impedance zone timers	(0.000-60.000) s	± 0.5% ± 10 ms
Operate time	30 ms typically	-
Reset ratio	105% typically	-
Reset time	35 ms typically	-

APPENDIX B

Equivalence of software parameters and the relay under test.

Distance Software		ABB REL650 Relay	
Parameter	**Figure**	**Parameter**	**Figure**
Secondary Current	68	CT sec	19
Secondary Voltage	68	VT sec	20
Zn01_LE		Zone 1	
Trigger Time	74	tPE1	55
Z	74	Z1	55
LineAng	74	LineAng	55
KNMag	74	KNMag1	55
KNAng	74	KNAng1	55
RFPE	74	RFPE1	15
Operationz<	74	OperationZ<	60
X1 phs	74	X1	60
X0 phs	74	X0	60
RFFwPE phs	74	RFFwPE	60
RFRvPE phs	74	RFRvPE	60
RLdFw phs	74	RLdFw	60
RLdRv phs	74	RLdRv	60
AngLd phs	74	AngLd	60
FORWARD	74	DirMode1	55
AngDir zd	74	AngDir	59
AngNegDir	74	AngNegRes	59
Zn01_FF		Zone 1	
Trigger Time	77	tPP1	55
Z	77	Z1	55
RFPP	77	RFPP1	55
X1 phs	77	X1	60
RFFwPP phs	77	RFFwPP	60
RFRvPP phs	77	RFRvPP	60
RLdFw phs	77	RLdFw	60
RLdRv phs	77	RLdRv	60
AngLd phs	77	AngLd	60
FORWARD	77	DirMode1	55
AngDir zd	77	AngDir	59
AngNegDir	77	AngNegRes	59

Distance Software		ABB REL650 Relay	
Parameter	Figure	Parameter	Figure
Zn01_ABC		Zone 1	
Trigger Time	80	tPE1	55
Z	80	Z1	55
LineAng	80	LineAng	55
KNMag	80	KNMag1	55
KNAng	80	KNAng1	55
RFPP	80	RFPE1	55
Operationz<	80	OperationZ<	60
X1 phs	80	X1	60
X0 phs	80	X0	60
RFFwPP phs	80	RFFwPP	60
RFRvPP phs	80	RFRvPP	60
RLdFw phs	80	RLdFw	60
RLdRv phs	80	RLdRv	60
AngLd phs	80	AngLd	60
FORWARD	80	DirMode1	55
AngDir zd	80	AngDir	59
AngNegDir	80	AngNegRes	59

Note: To register zones: LE, LL and ABC remember to register the Loop in the Distance software. Zones 2 and 3 have equivalence in the way they are parameterized, being analogous to Zone 1.