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INSTRUMENTOS PARA TESTES ELÉTRICOS

# Test Tutorial

**Equipment Type:** Protection Relay

**Brand:** ABB

**Model:** RET670

**Function:** 87 or PDIF Differential Percentage

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

**Objective:** Test Settings, Testing Point and Survey of Feature Slope

**Version control:**

Version	Descriptions	Date	Author	Reviewer
1.0	Initial release	19/08/2021	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 contacts 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 must always be consulted.



**ATTENTION!**

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

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

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**INSTRUMENTOS PARA TESTES ELÉTRICOS**  
Sequence for RET670 relay tests in DIFFERENTIAL software

**1. Relay connection to CE-6006**

Appendix A-1 shows the relay terminal designations.

**1.1 Auxiliary Source**

Connect the positive (red terminal) of the Vdc Aux. Source to pin 4 on relay terminal X11 and the negative (black terminal) of Vdc Aux. Source to pin 5 of relay terminal X11.

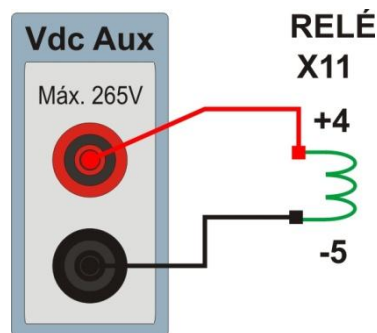


Figura 1

**1.2 Current Coils**

Connect the I1, I2 and I3 current channels of the CE-6006 to pins 1, 3 and 5 of the relay (slot 401) respectively, if the commons of the relay are short circuited, just connect the commons of the channels to that point, otherwise connect the three commons of the CE-6006 to pins 2, 4 and 6 of the relay then form the winding 1 connection. In the same way, to establish the winding 2 connection, connect I4, I5 and I6 current channels to pins 7, 9 and 11 of the relay respectively, connecting the three common ones to pin 8, 10 and 12 (slot 401).

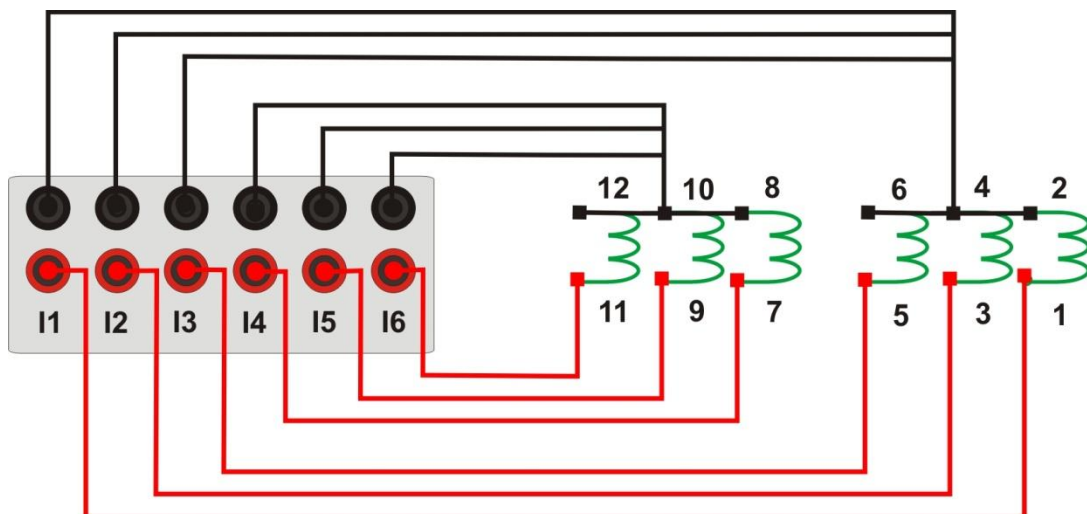


Figure 2

### 1.3 Binary Inputs

Connect the binary inputs of the CE-6006 to the binary outputs of the X31 relay slot.

- BI1 to pin 01 and its common to pin 02.

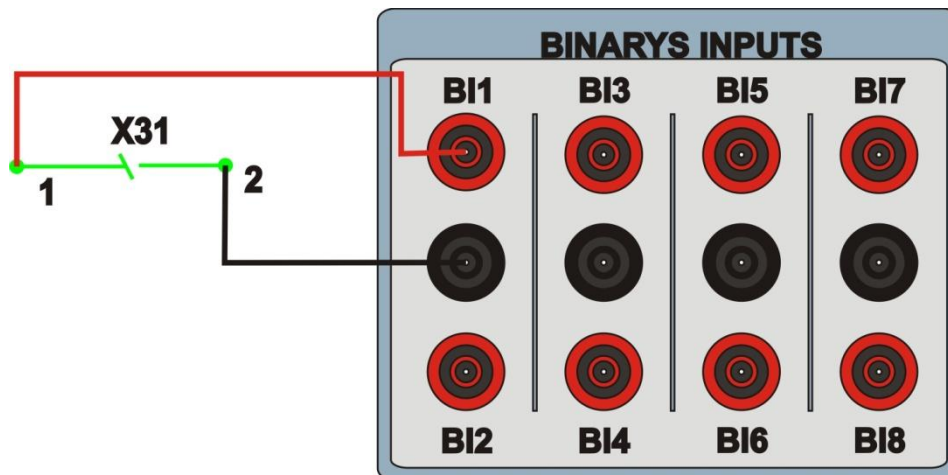


Figure 3

## 2. RET670 Relay Configuration

Connect an Ethernet cable from the notebook with the relay. Then open *PCM600* by double clicking on the software icon.



Figure 4

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

### 2.1 Creating a new file

First, a new project must be included. Click on the “*File*” option and then “*New Project ...*”.

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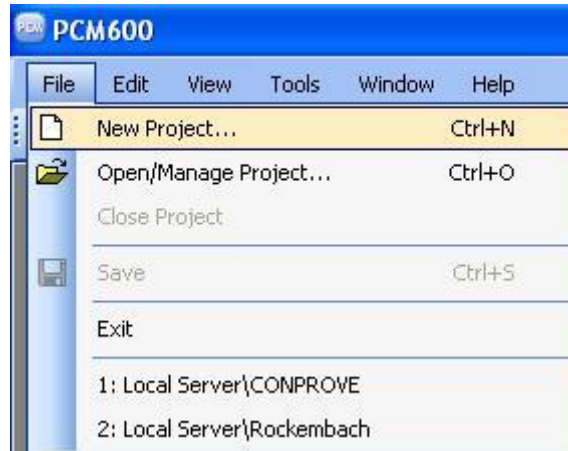


Figure 5

Choose a name for the project, in this case “PDIF” was used and then click on “Create”.

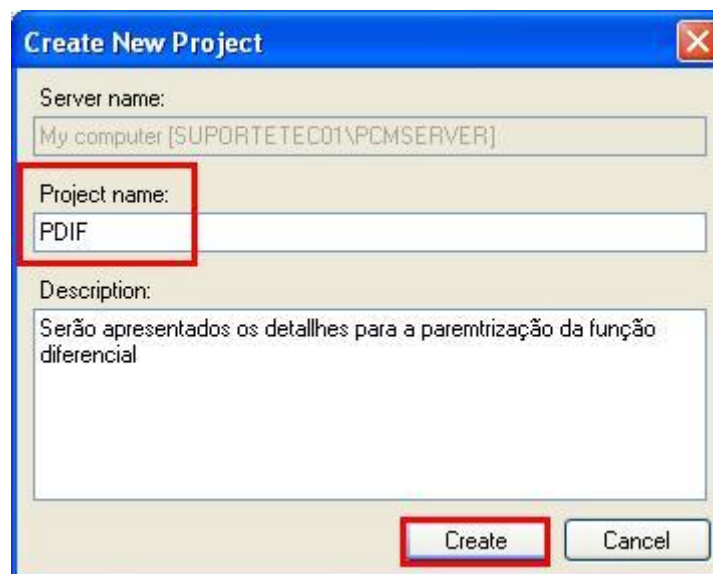
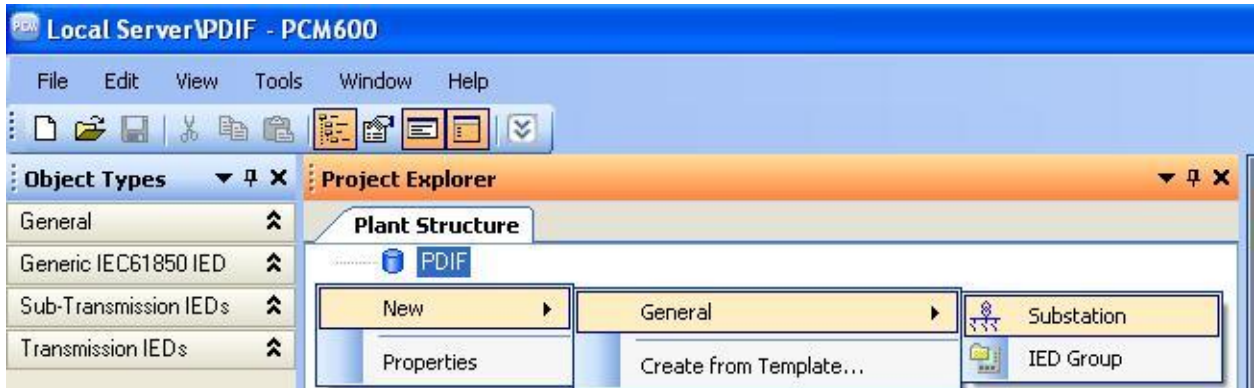


Figure 6

Right-click on the created plant and insert a substation.

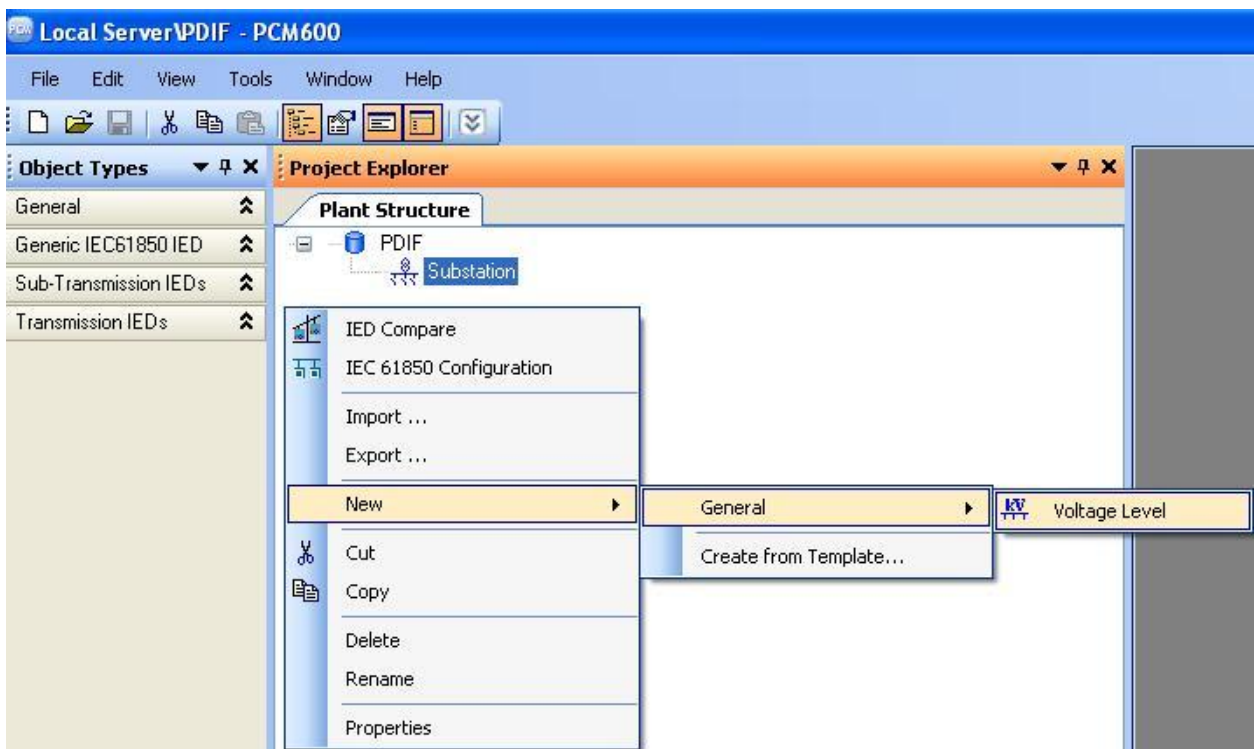


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**Figure 7**

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

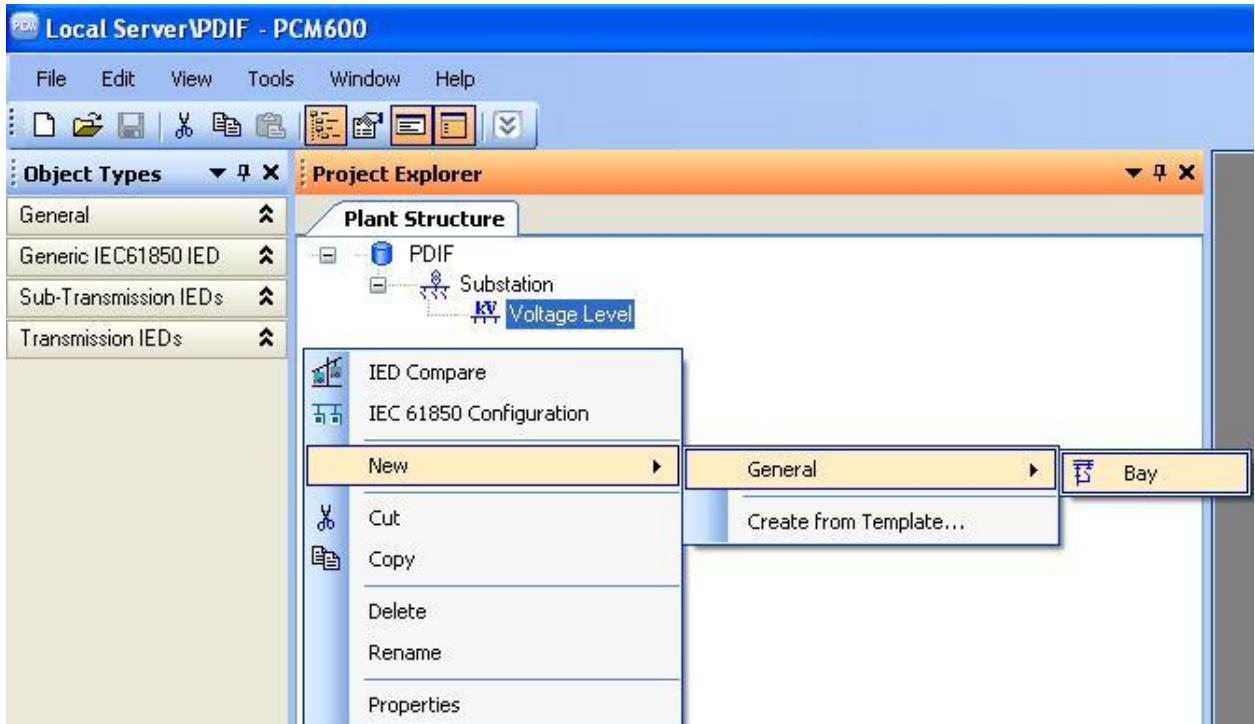


**Figure 8**

Within the voltage level a bay must be inserted.

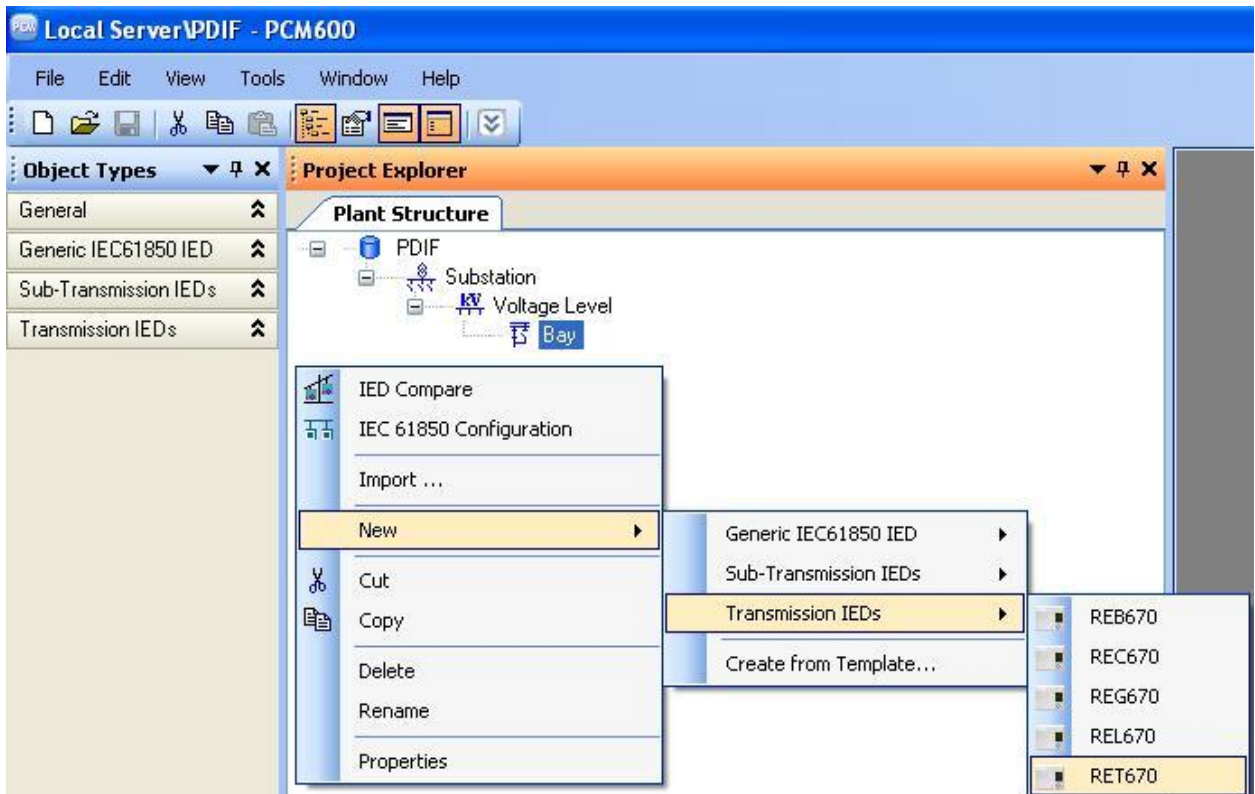


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**Figure 9**

The RET670 relay is inserted inside the bay.



**Figure 10**

## 2.2 Setting up communication

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

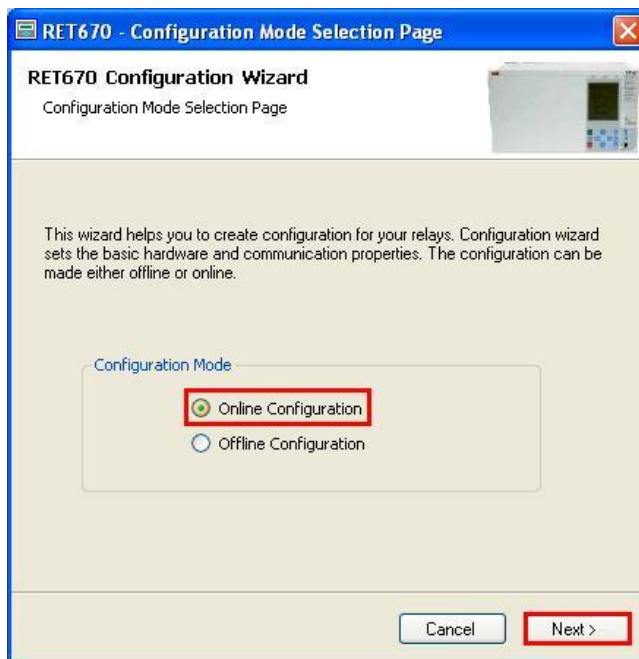


Figure 11

Choose the “*Next >*” option again.



Figure 12

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On the next screen, the user chooses between two options “LANI” or “Front Port”, then you must see in the relay which IP is configured. To do this, go to “Settings > General settings > Communication > Ethernet configuration” and view the desired IP. Adjust this value in PCM and in this tutorial the option “Front Port” was chosen.

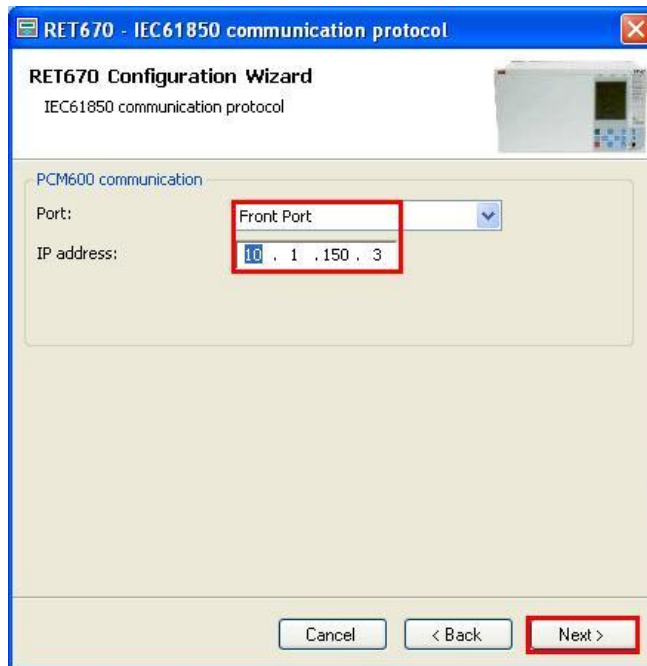


Figure 13

Then click on “Next >” and on the next screen on “Scan”.

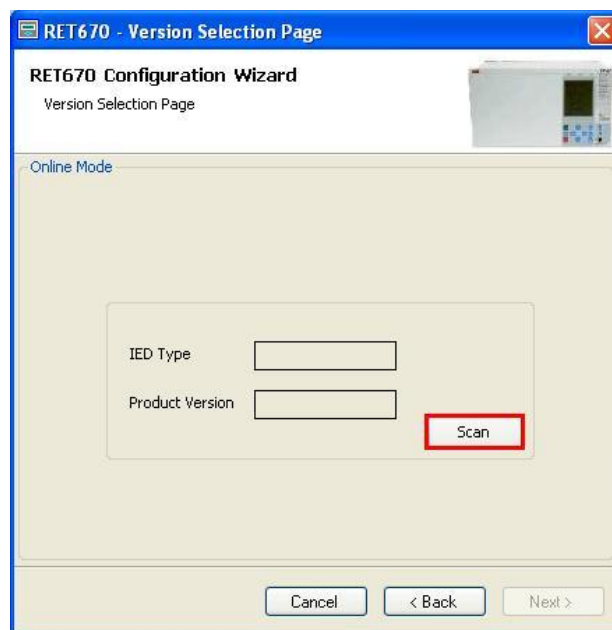
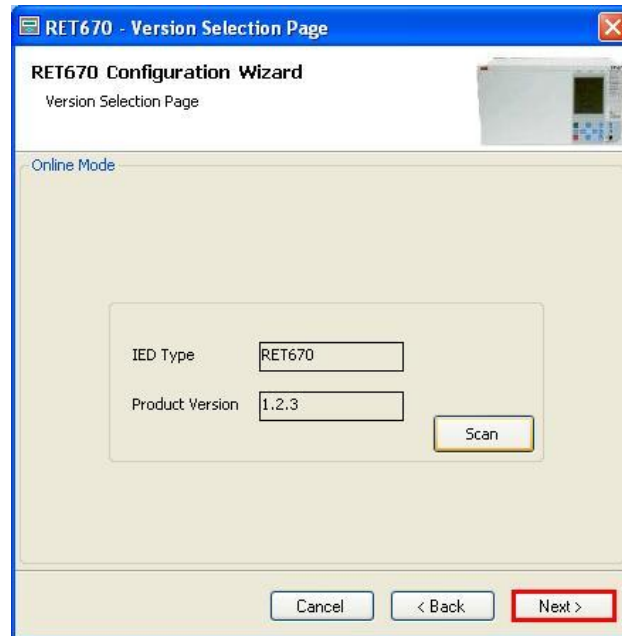


Figure 14

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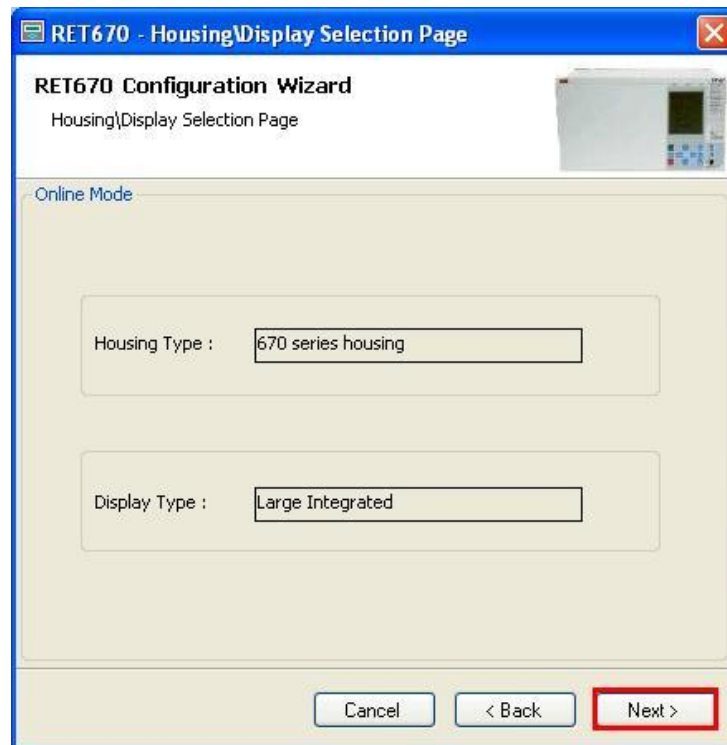
**INSTRUMENTOS PARA TESTES ELÉTRICOS**

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



**Figure 15**

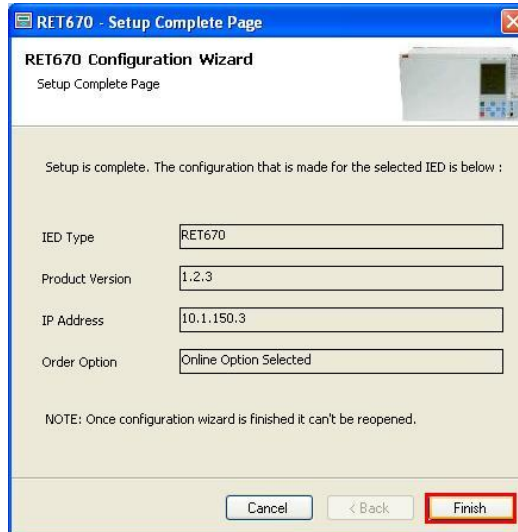
On the next screen, the relay identifies the type of housing and display.



**Figure 16**

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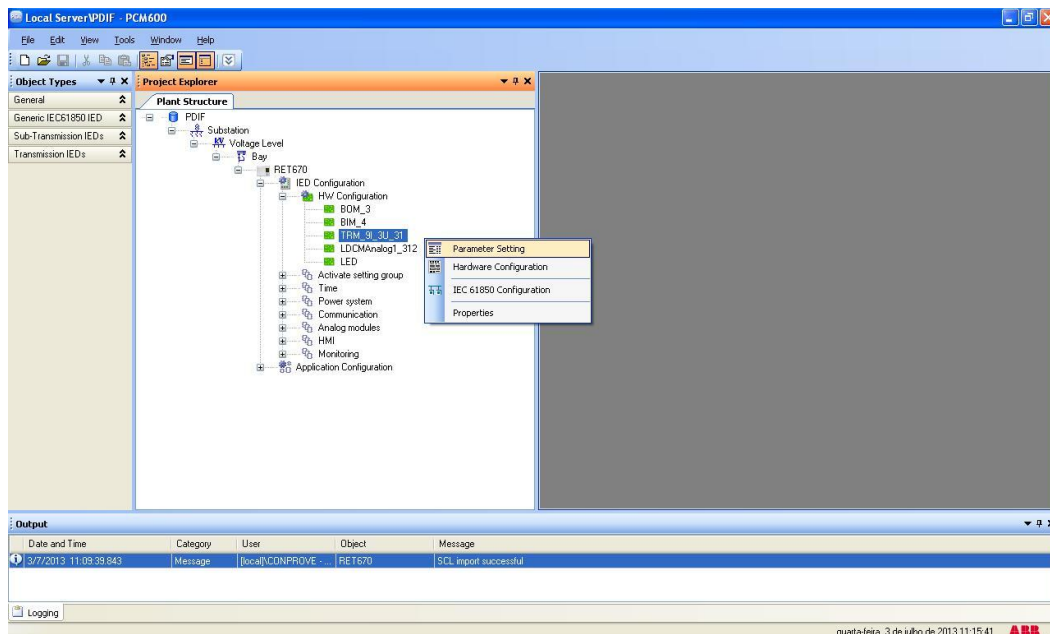
Finally, the complete relay information.



**Figure 17**

**2.3 TRM\_9I\_3U\_31**

Click on the “+” signs near to “*IED Configuration*” and “*HW Configuration*”. Within the last option the relay shows all slots that are inserted in the relay. Right click on the “*TRM\_9I\_3U\_31*” option and select “*Parameter Setting*”.



**Figure 18**

In this window, the relations of current and voltage transformations must be configured. In this case, only the first six current channels will be configured since the protection to be analyzed is the differential.



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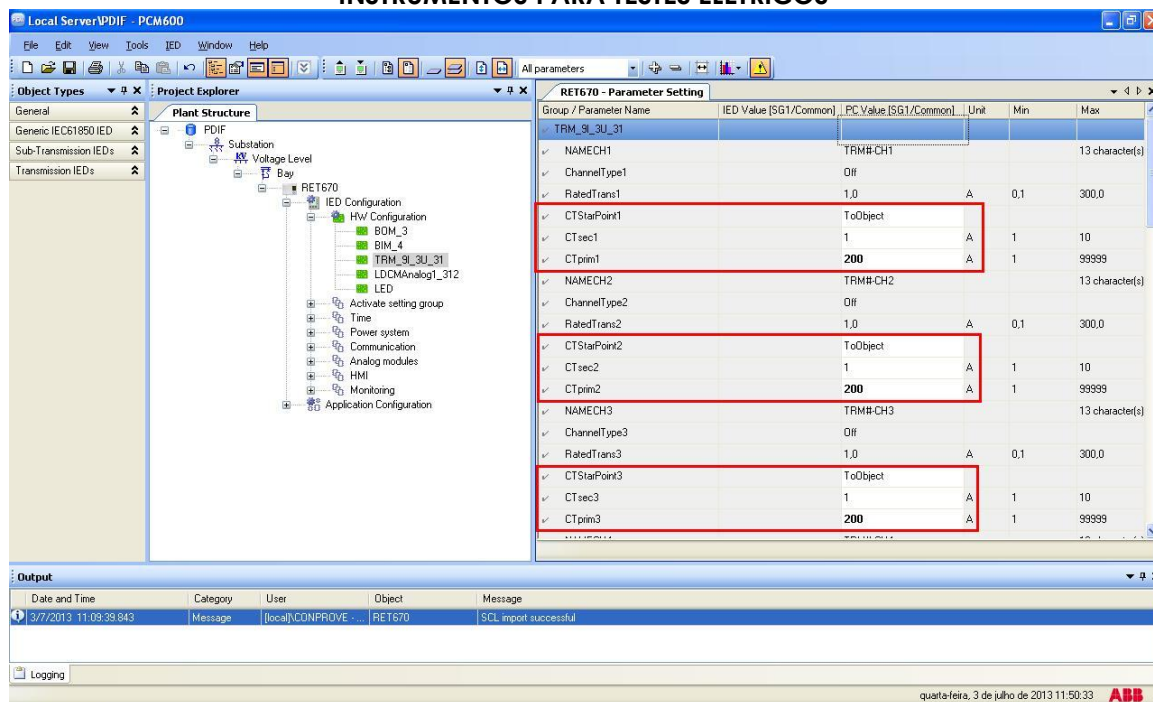


Figure 19

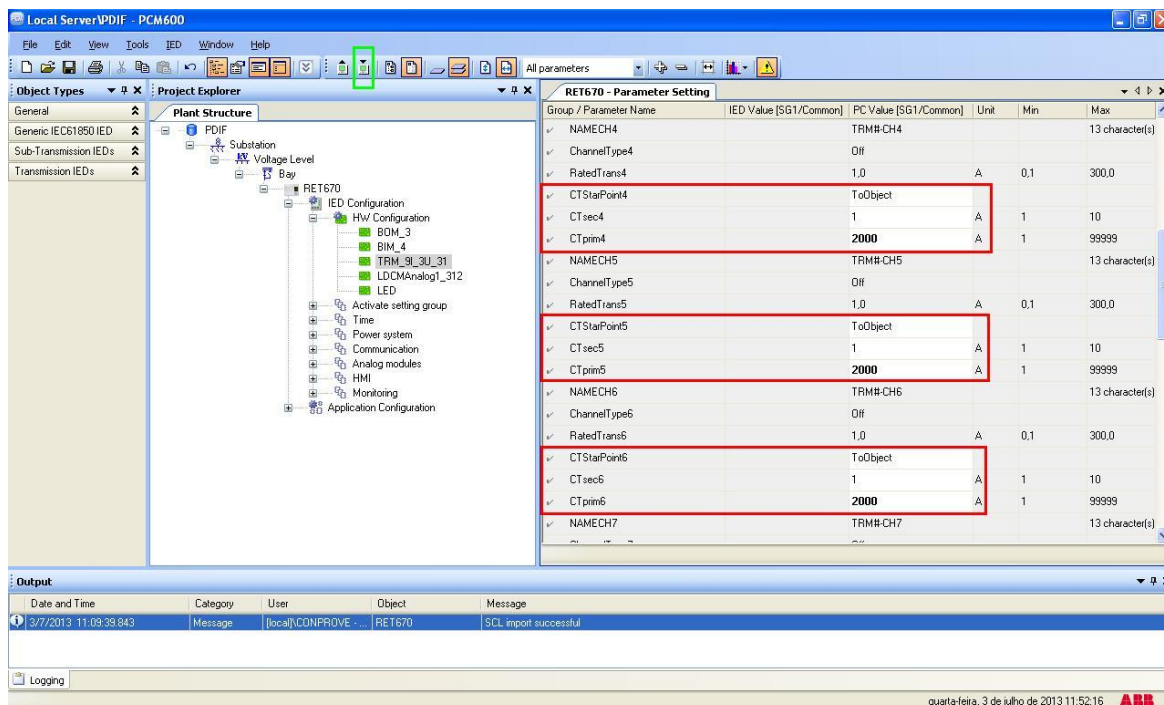


Figure 20

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.

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3. Send all parameterized settings within the group.

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

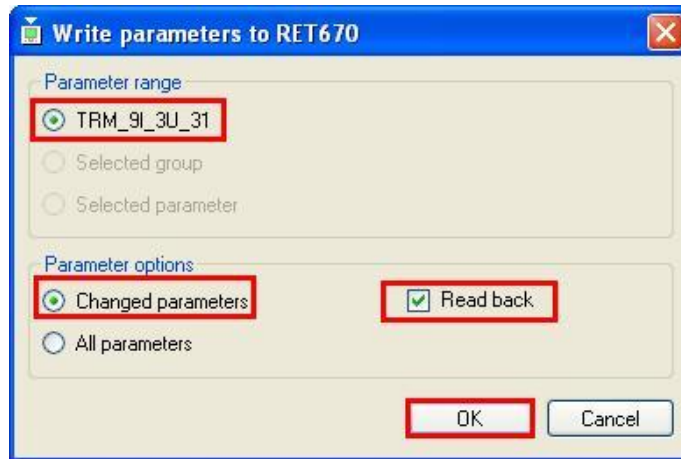


Figure 21

**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.

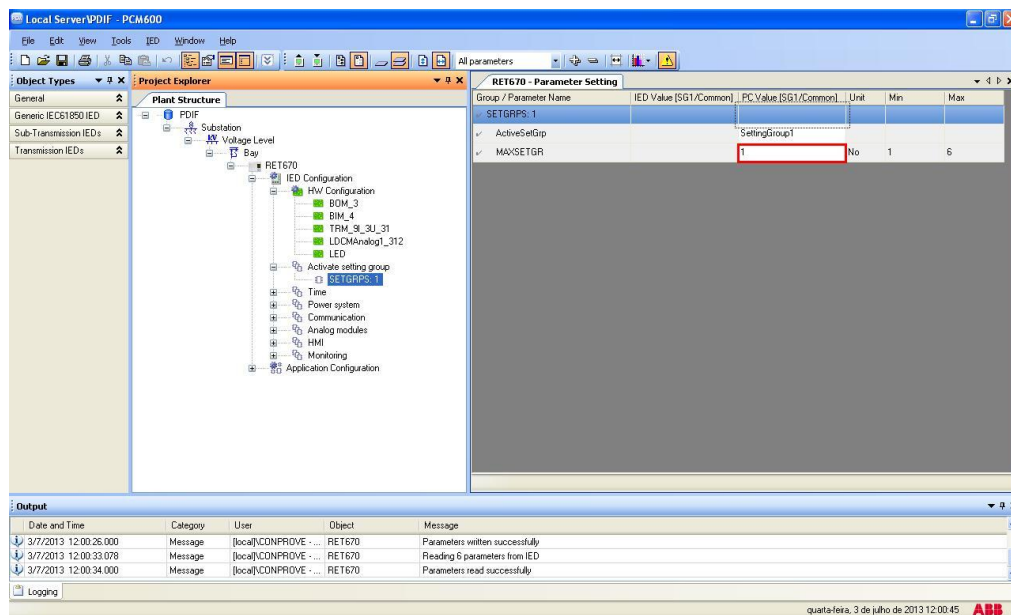


Figure 22



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### 2.5 PRIMVAL: 1

Click on the “+” sign near to “Power System” and select the “PRIMVAL:1” option. In this group the frequency value is adjusted, being in this standard 50.0Hz relay. Change the value to 60.0Hz and send the settings to the relay.

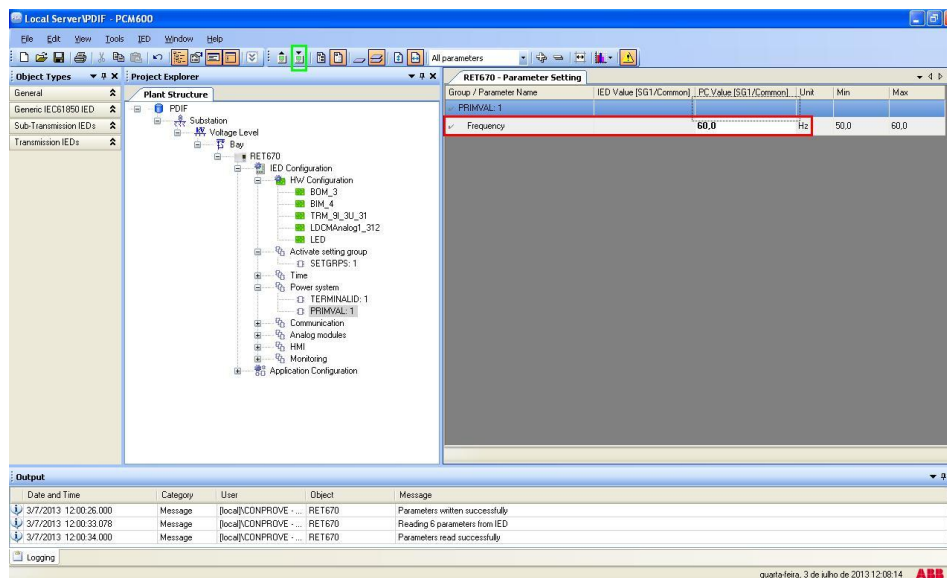


Figure 23

### 2.6 AISVBAS: 1

Click on the “+” signs near to “Analog modules” and select the option “AISVBAS: 1” and set as the reference channel the channel “TRM40-Ch1” which is equivalent to the current phase A.

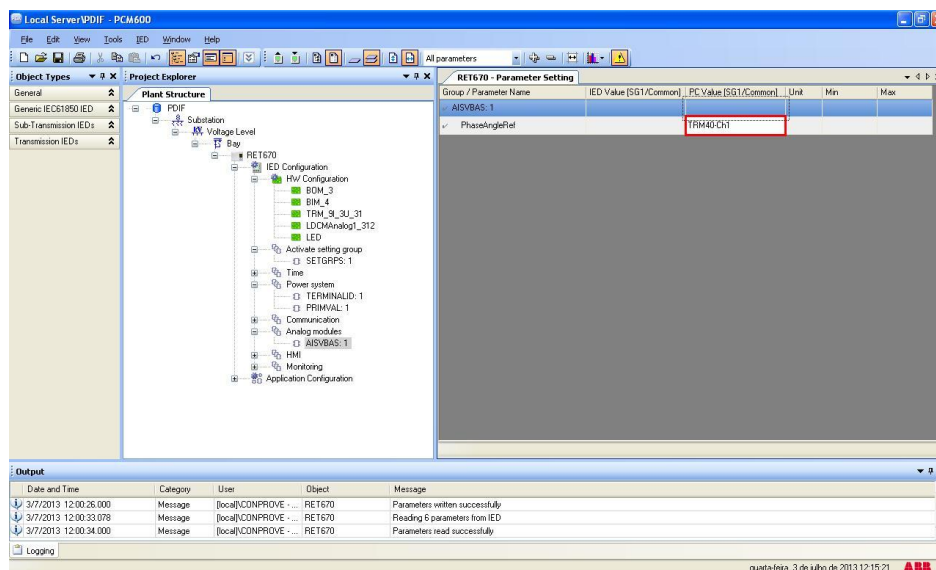


Figure 24

## 2.7 Application Configuration

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

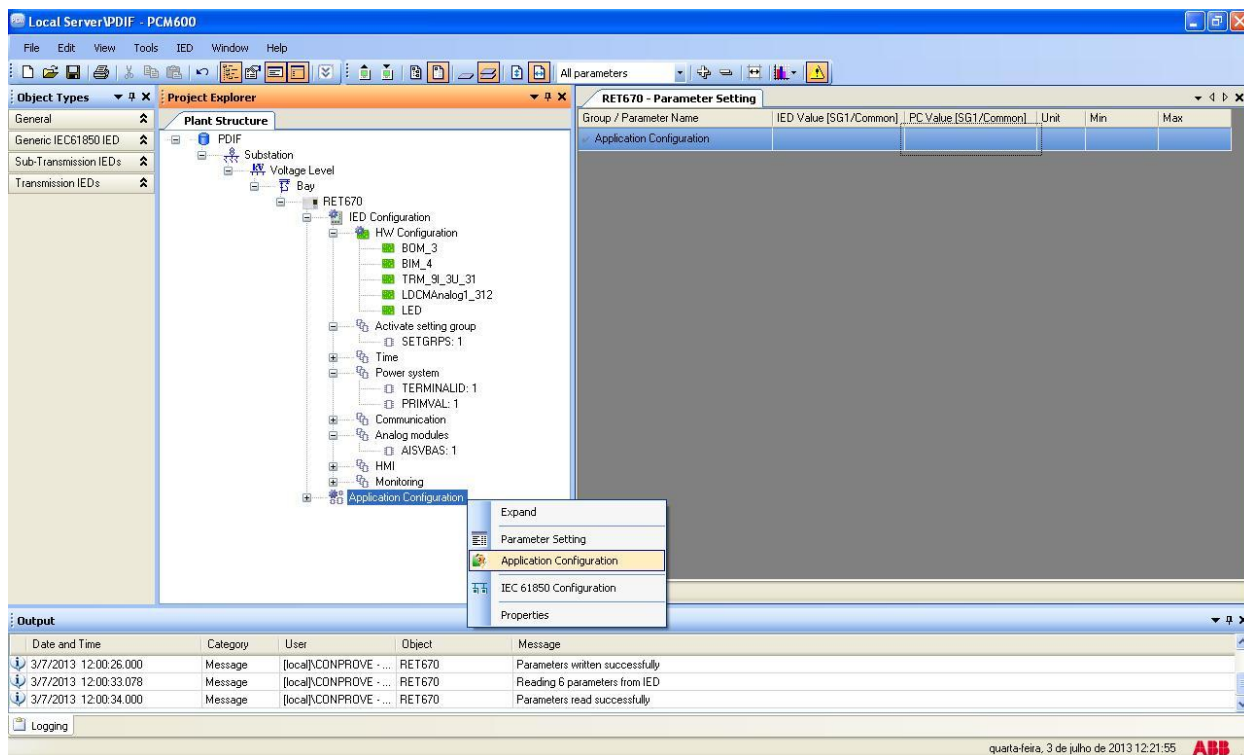


Figure 25

On the screen that opens, click with the right button and then choose the option “*Insert FunctionBlock*”.

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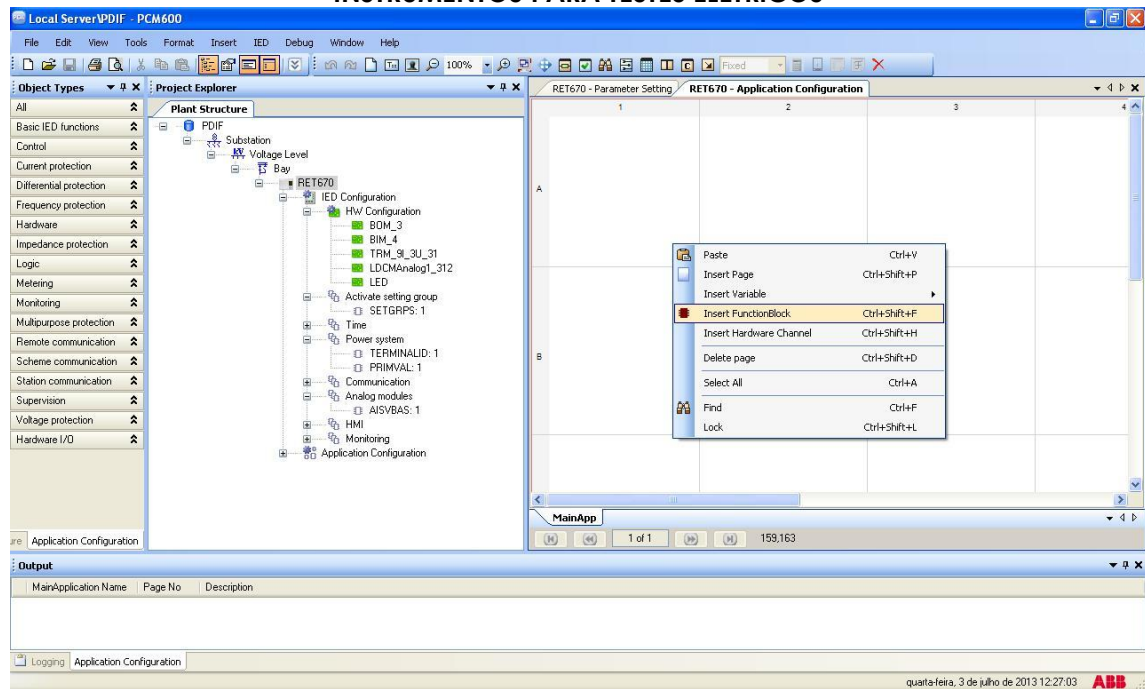


Figure 26

### 2.8 SMA11 (Winding 1 Currents)

Click on the “+” sign near to “Basic IED functions” and insert the “SMA11” block that will be responsible for the current channels of the first winding. To understand the perfect functioning of the different blocks, consult the RET 670 manual.

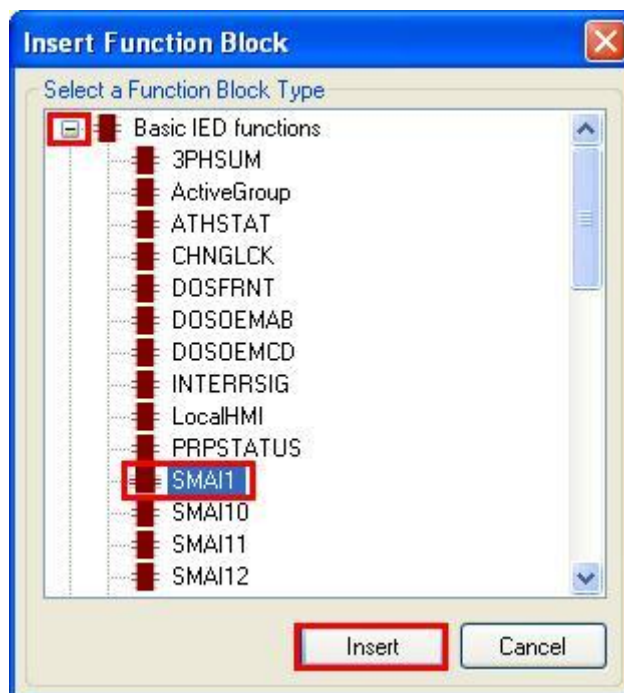


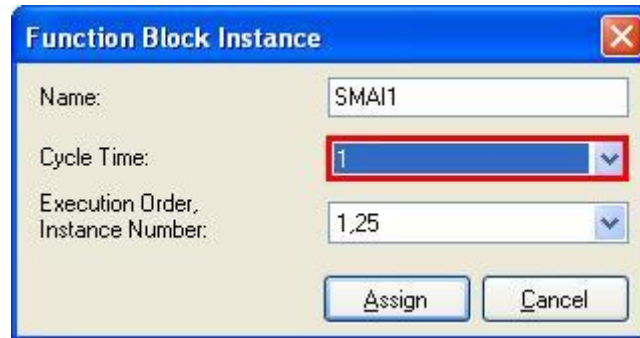
Figure 27

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**INSTRUMENTOS PARA TESTES ELÉTRICOS**

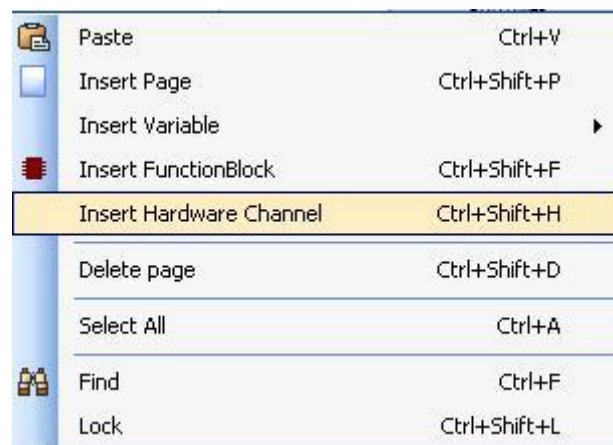
---

On the next screen set the “*Cycle Time*” to 1.



**Figure 28**

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



**Figure 29**

Choose the option “*Analog Input*” and click on “*Insert*”.

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Figure 30

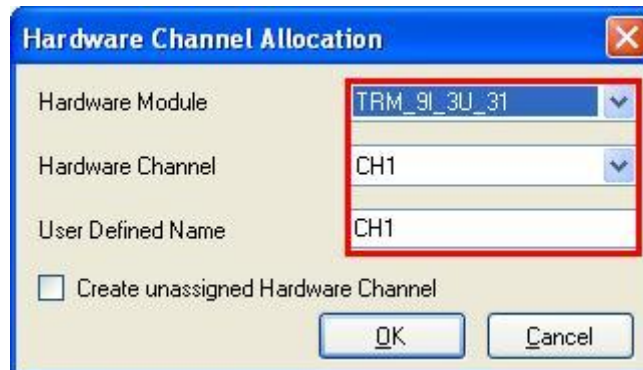
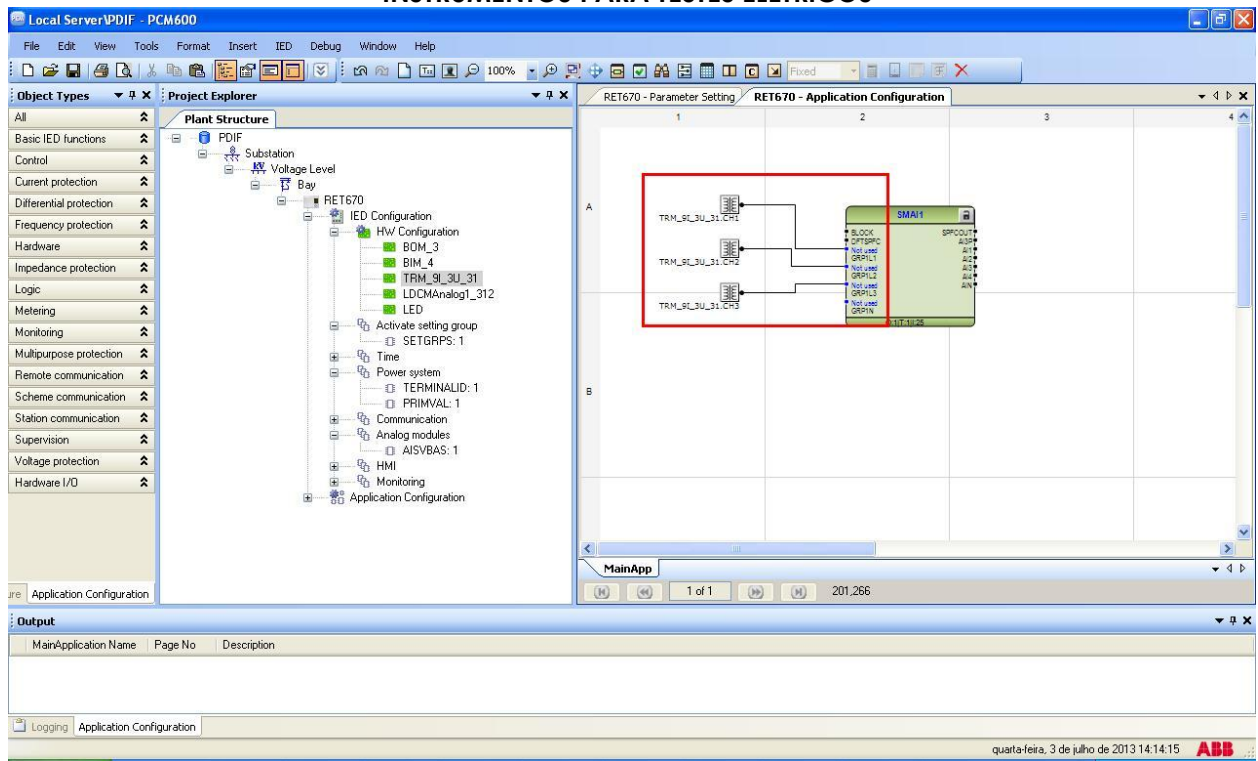


Figure 31

Repeat the procedure of the previous 3 figures changing the option of “*Hardware Channel*” to CH2 and CH3. Then make the connections with the block.

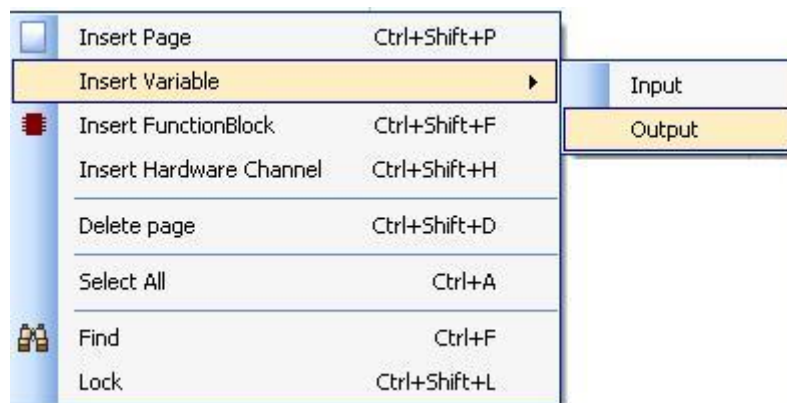


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**Figure 32**

Assign an output to the “AI3P” option. Right click and choose “Insert Variable > Output”.



**Figure 33**

Choose a name for this variable, in this case, “AI3P\_WI” and connect with the output “AI3P”.

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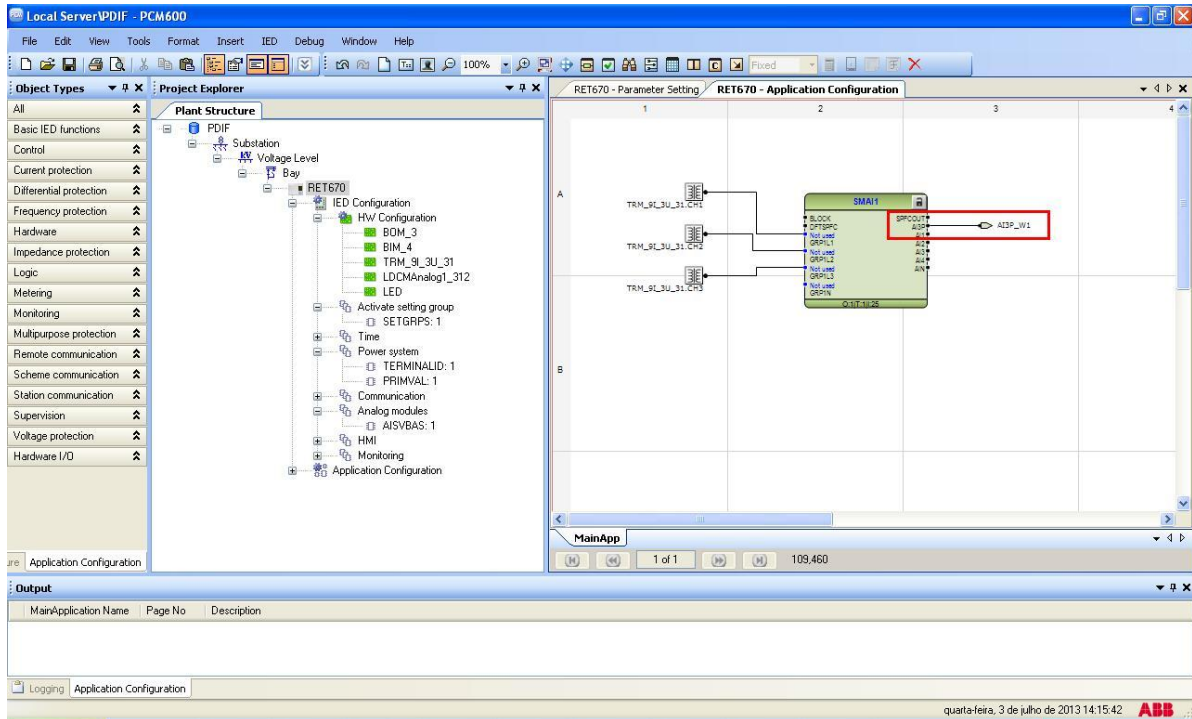


Figure 34

### 2.9 SMA12 (Winding 2 Currents)

Repeat the procedure from figures 26 to 34 changing the used block to “SMA12”, the channels to CH6, CH7 and CH8 and the output variable to “AI3P\_W2”.

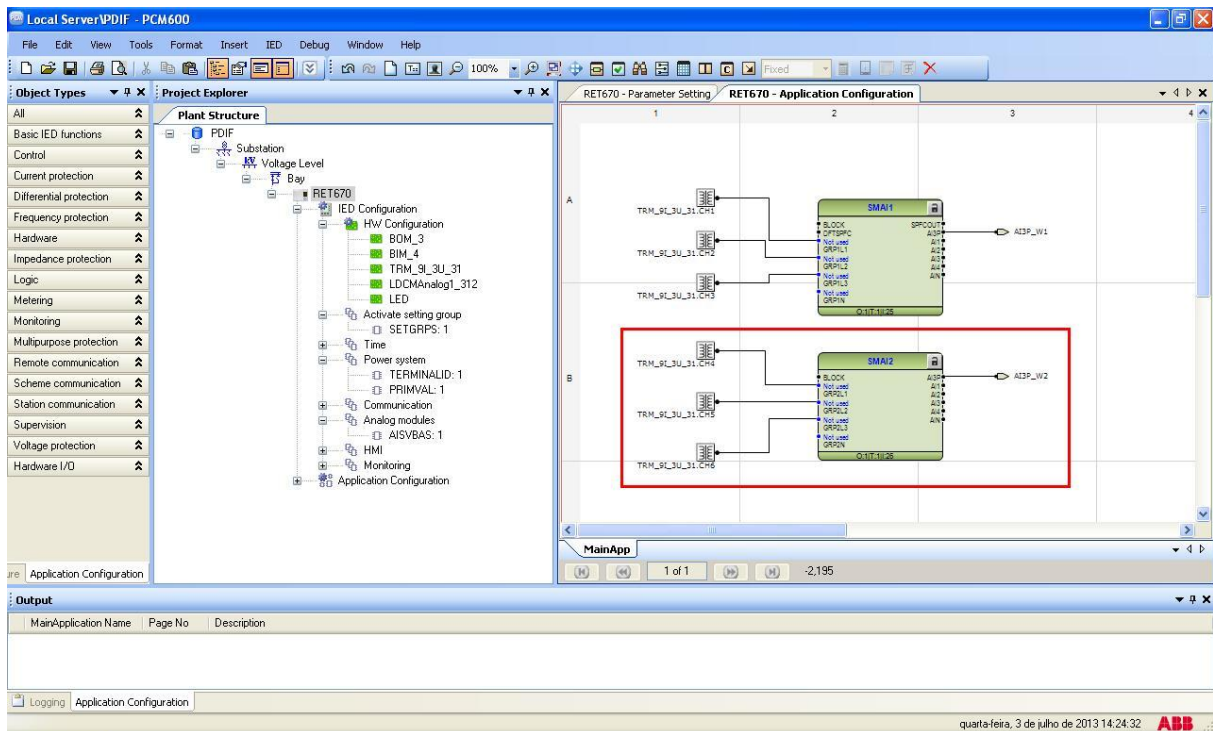


Figure 35



## INSTRUMENTOS PARA TESTES ELÉTRICOS

### 2.10 *FXDSIGN (Fixed Signals)*

Right-click on the new tab, choose “*Insert Function Block*”, click on the “+” sign near to “*Logic*” and finally choose the “*FXDSIGN*” block. In this block a group signal equal to zero is set.

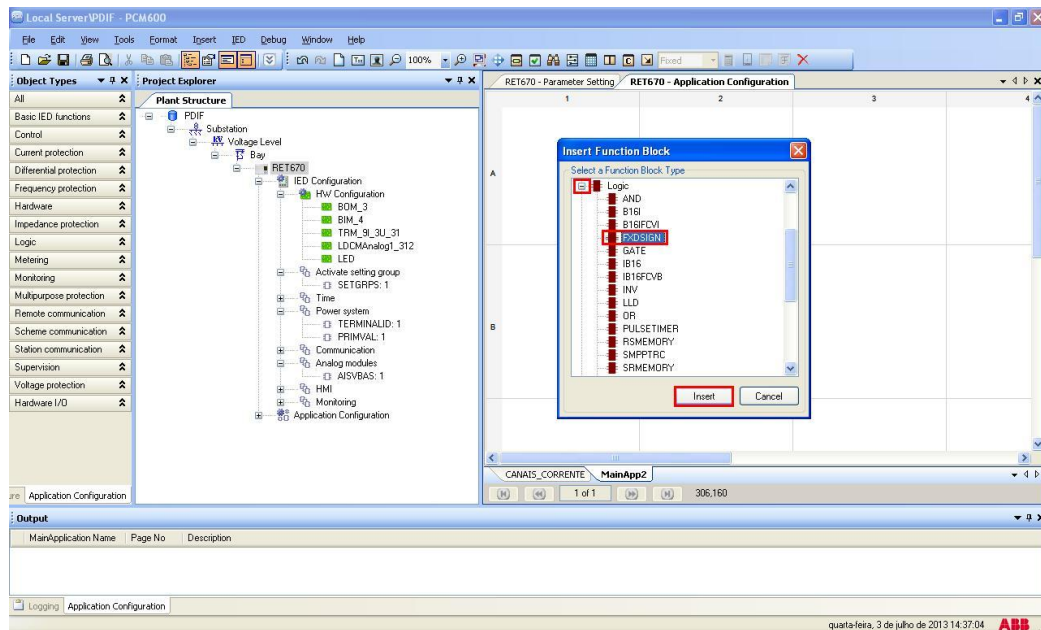


Figure 36

Click “*Assign*” in the next figure (not shown) and assign an output variable to the “*GRP\_OFF*” signal. This signal is required for the next differential block.

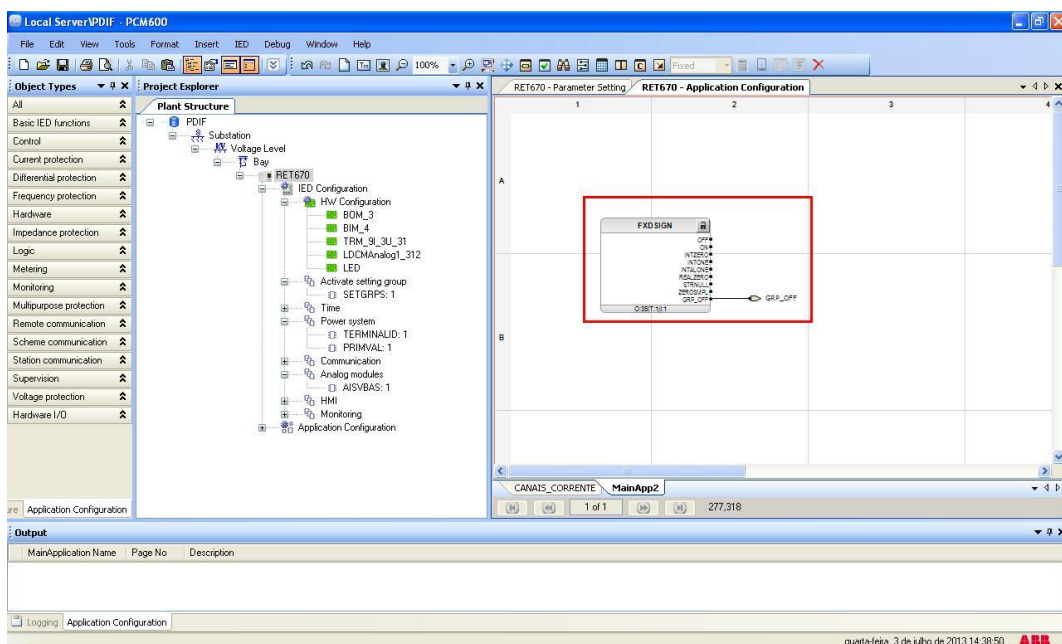


Figure 37

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Change the name of the tab to “SINAL\_FIXO”.

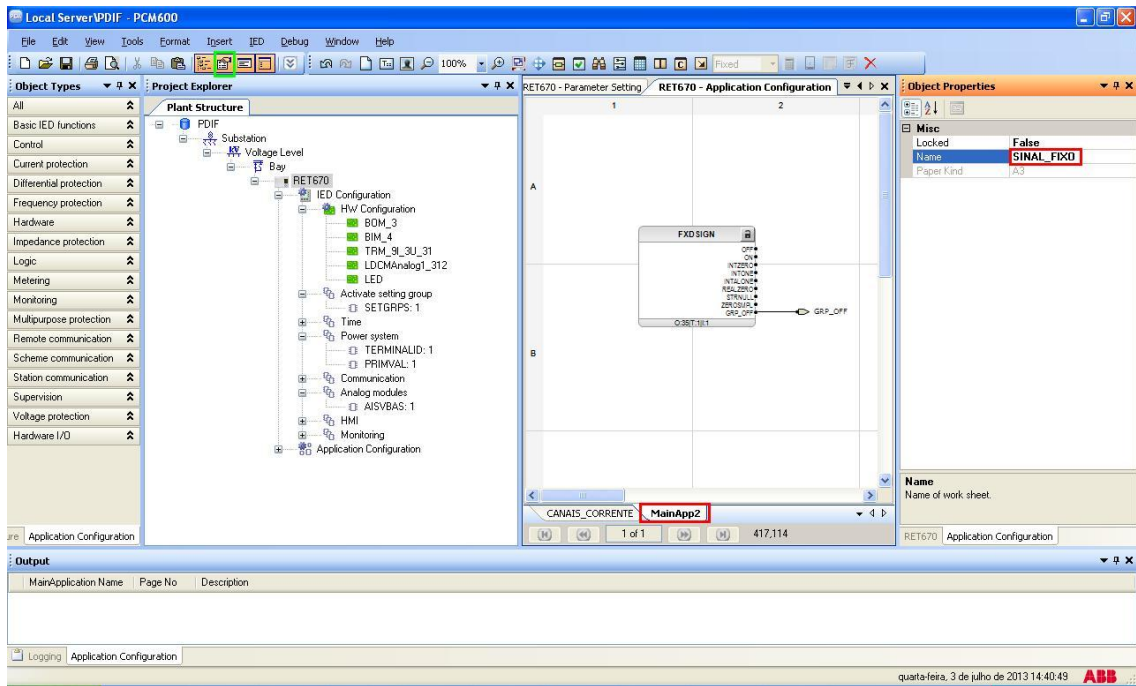


Figure 38

Close the “Object Properties” window then click “Insert > MainApplication”.

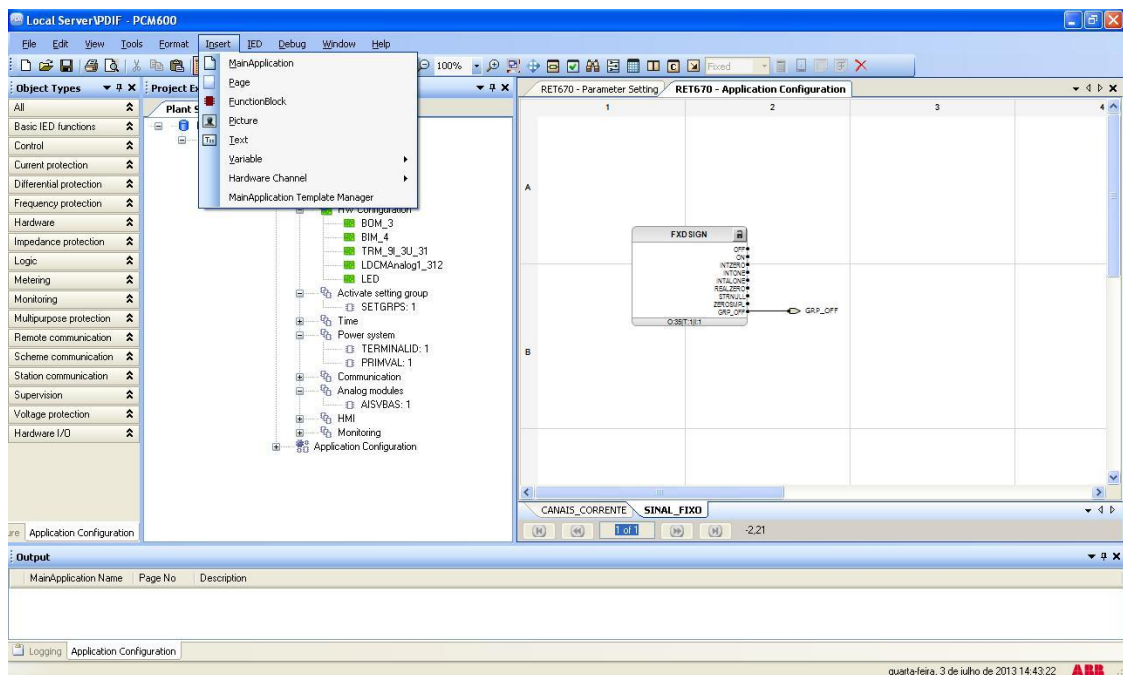
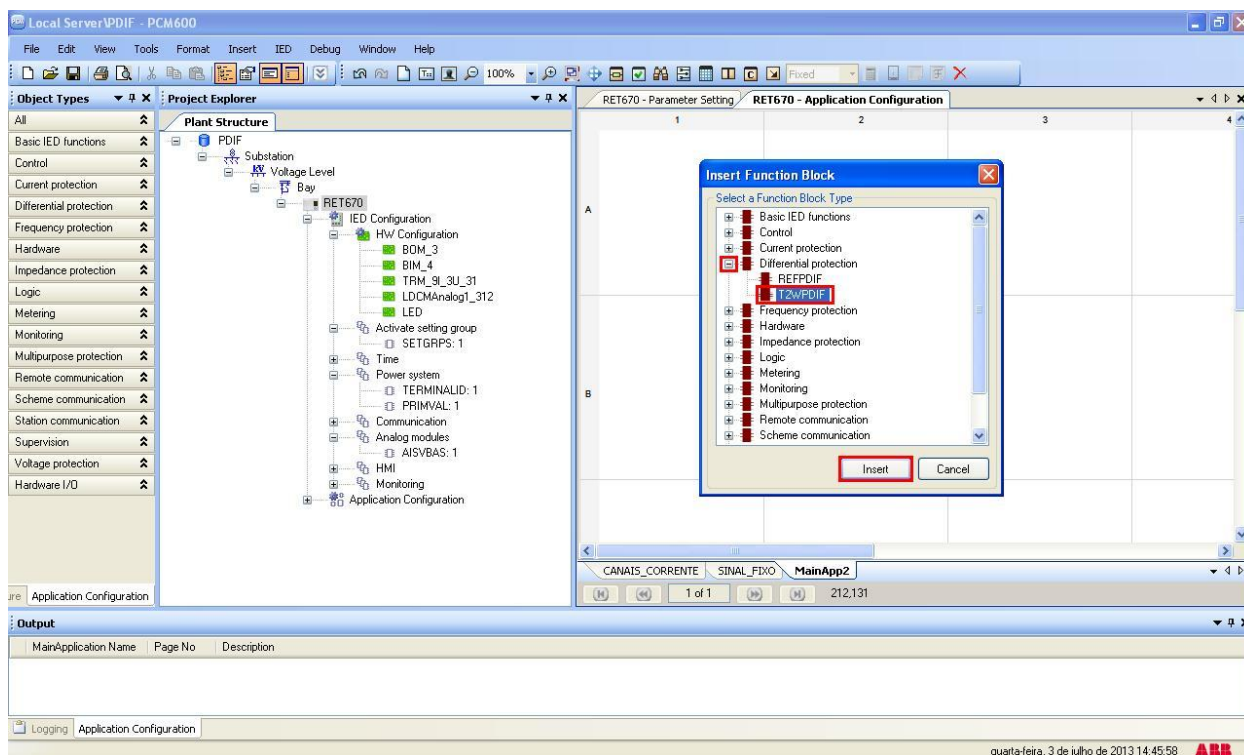


Figure 39

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**2.11 TW2PDIF (Differential)**

Right-click on the new tab, choose “Insert Function Block”, click the “+” sign next to “Differential protection” and finally choose the “TW2PDIF” block.



**Figure 40**

Insert two input variables using the same names given for the outputs of the current blocks, two input variables with the name of the fixed output and link with the current inputs of the current block. Create an output variable with the following naming.

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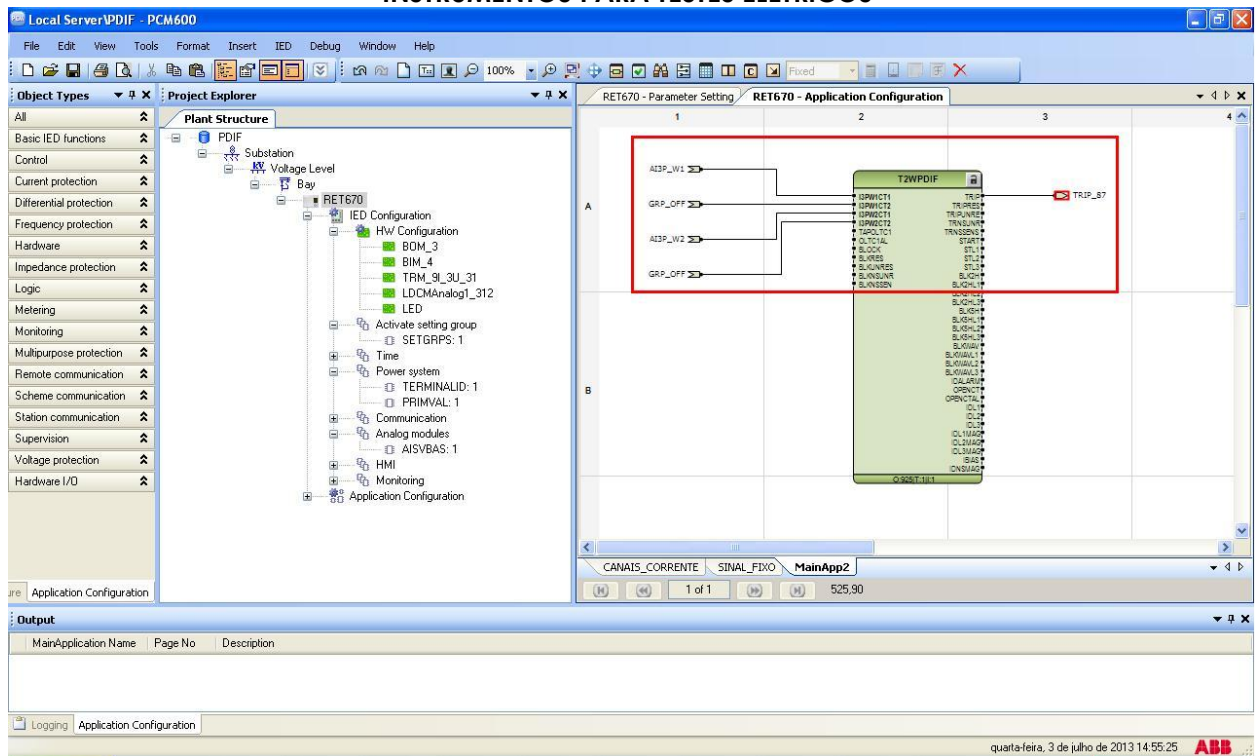


Figure 41

Change the tab name to “DIFERENCIAL”.

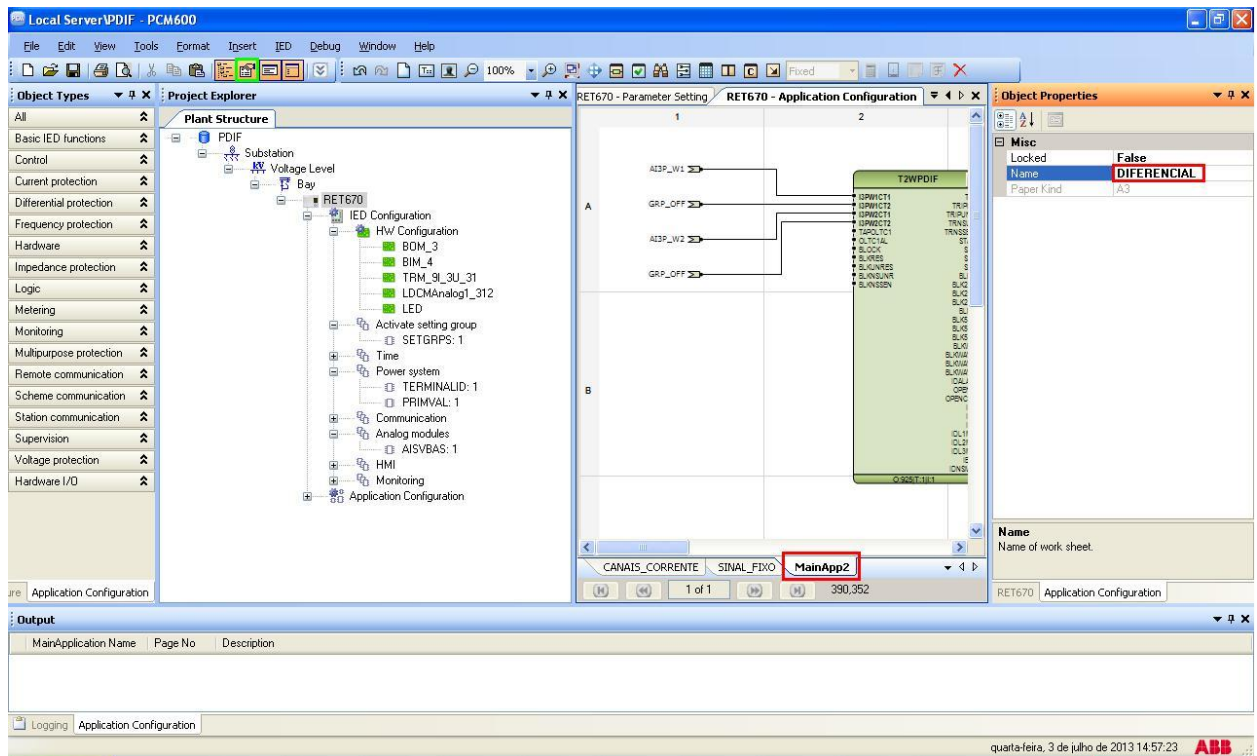


Figure 42



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2.12 *Binary Outputs*

The last block to be created is the binary output block. So create a new tab as shown below.

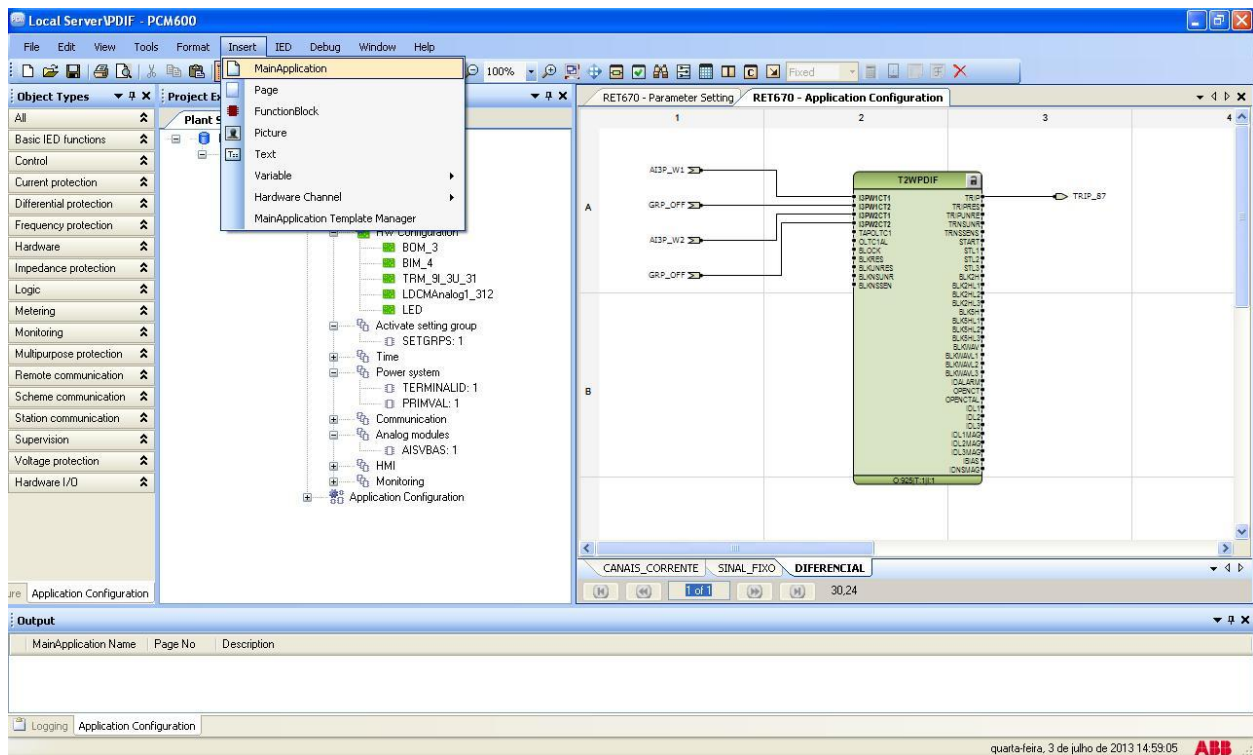


Figure 43

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

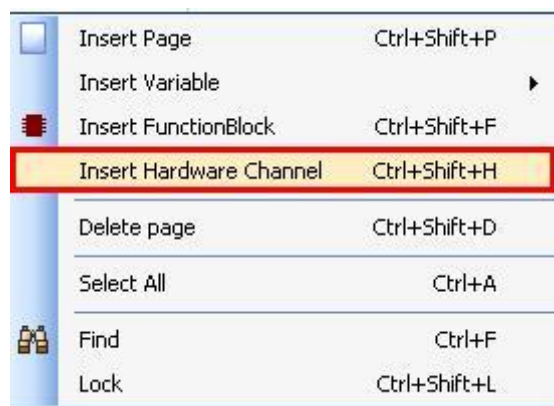
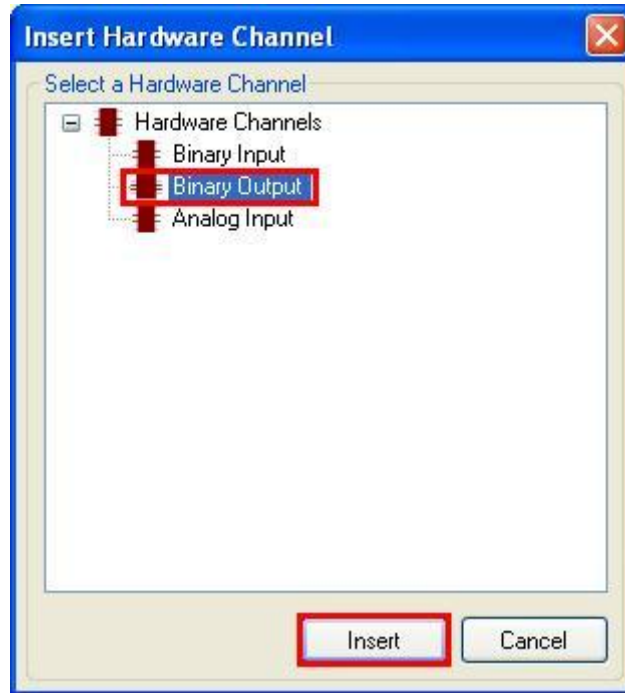


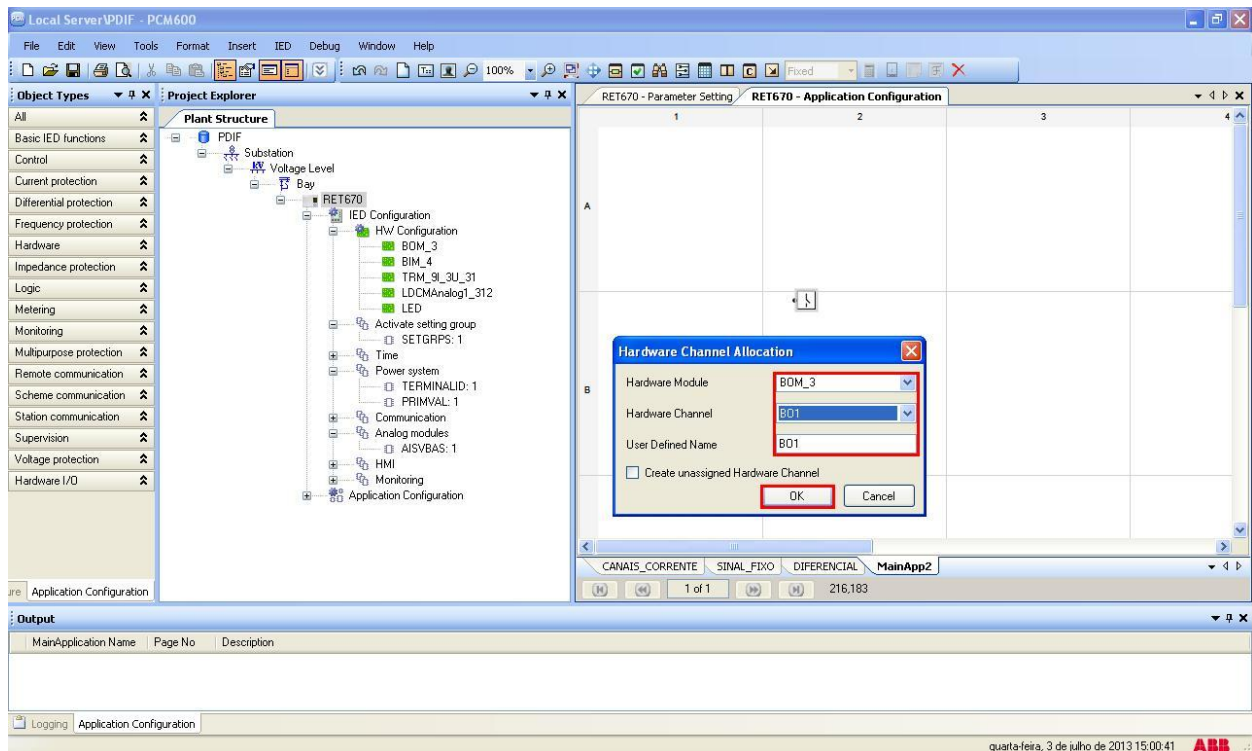
Figure 44

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**Figure 45**

The next step is to choose the channel module “*BOM\_3*” and the binary output “*BO1*”.



**Figure 46**

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Create an input variable using the same name as the differential block output variable and associate it with each binary output. Change the tab name to “SAÍDA\_BINÁRIA”.

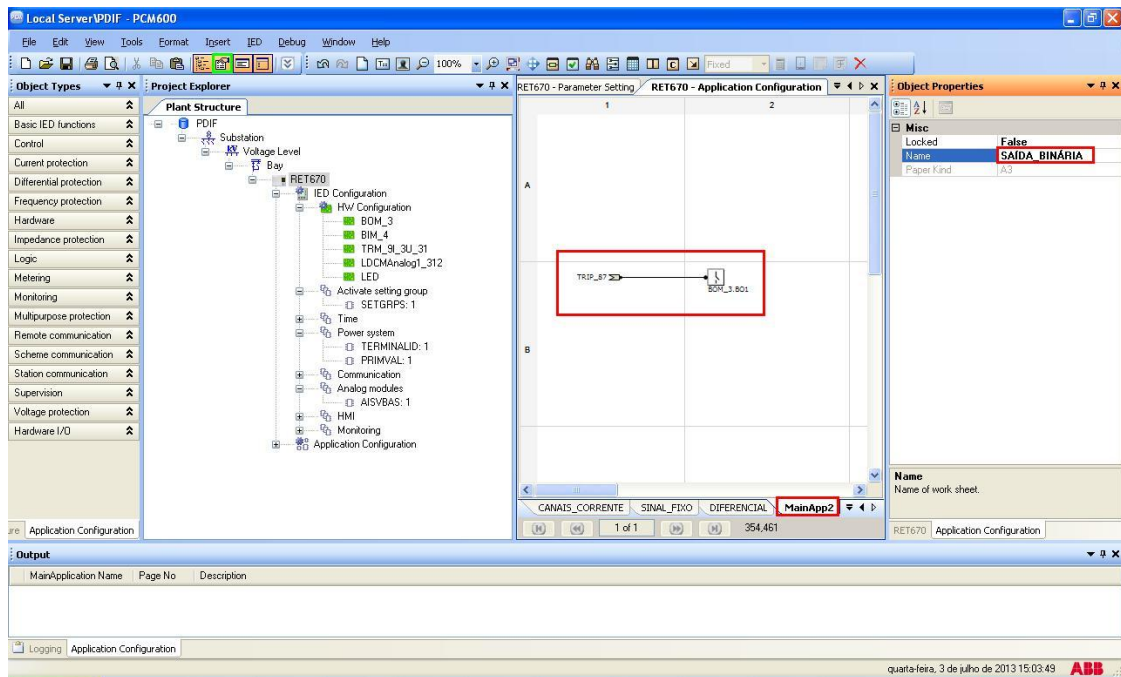


Figure 47

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

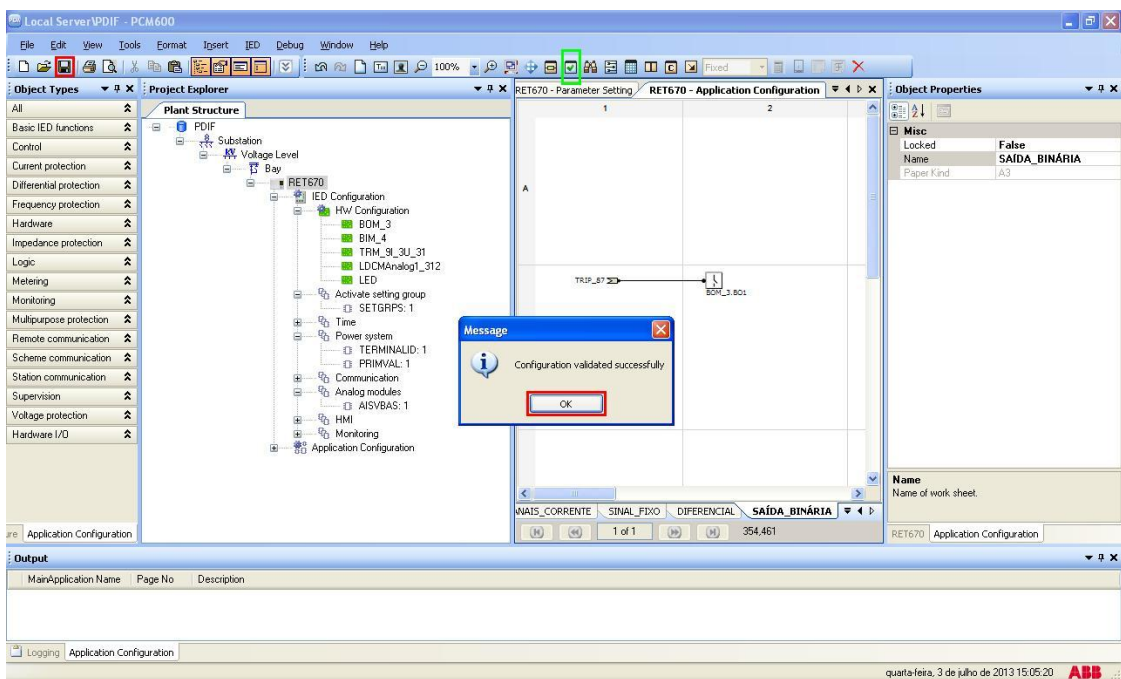


Figure 48



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### 3. Parameterization of the ABB RET 670 relay

#### 3.1 RET670 Parameter Setting

Choose the top tab “RET670 Parameter Setting” and click on the “+” signs near to “Application Configuration > DIFFERENTIAL > Differential protection > TransformerDiff2Wind(PDIF, 87T)” and finally “T2WPDIF:1”.

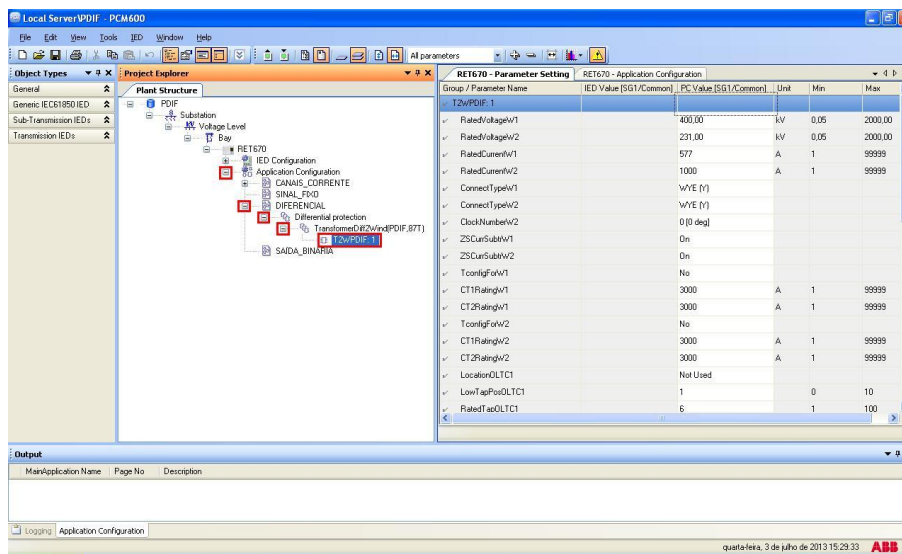


Figure 49

Make the following adjustments for differential function.

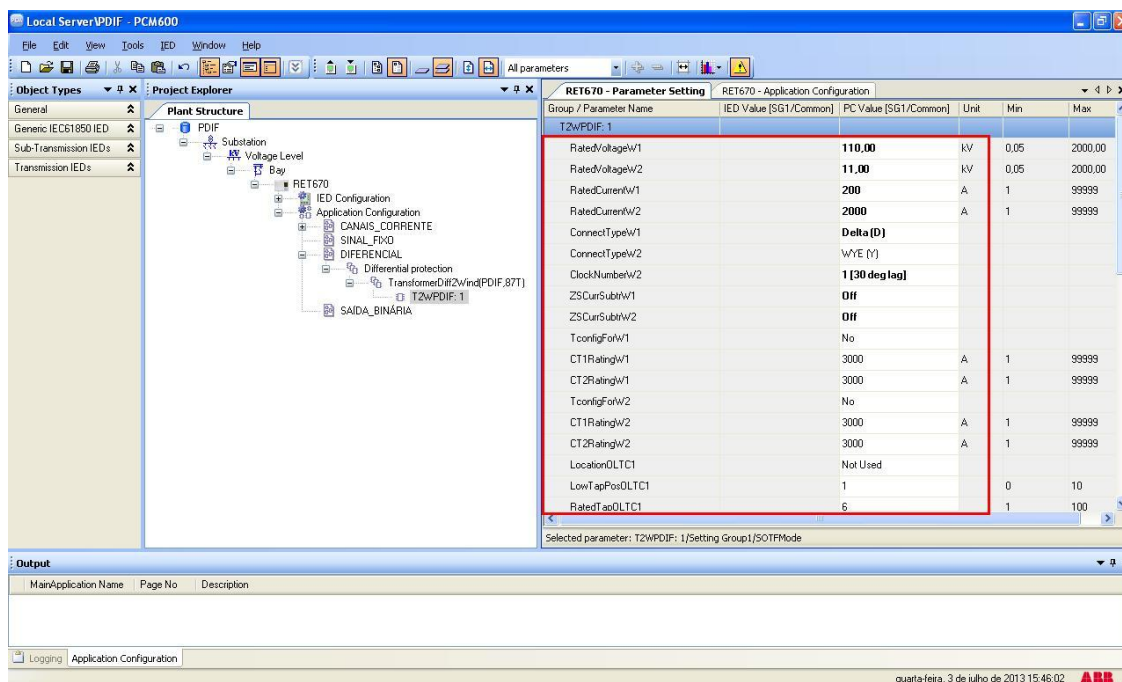
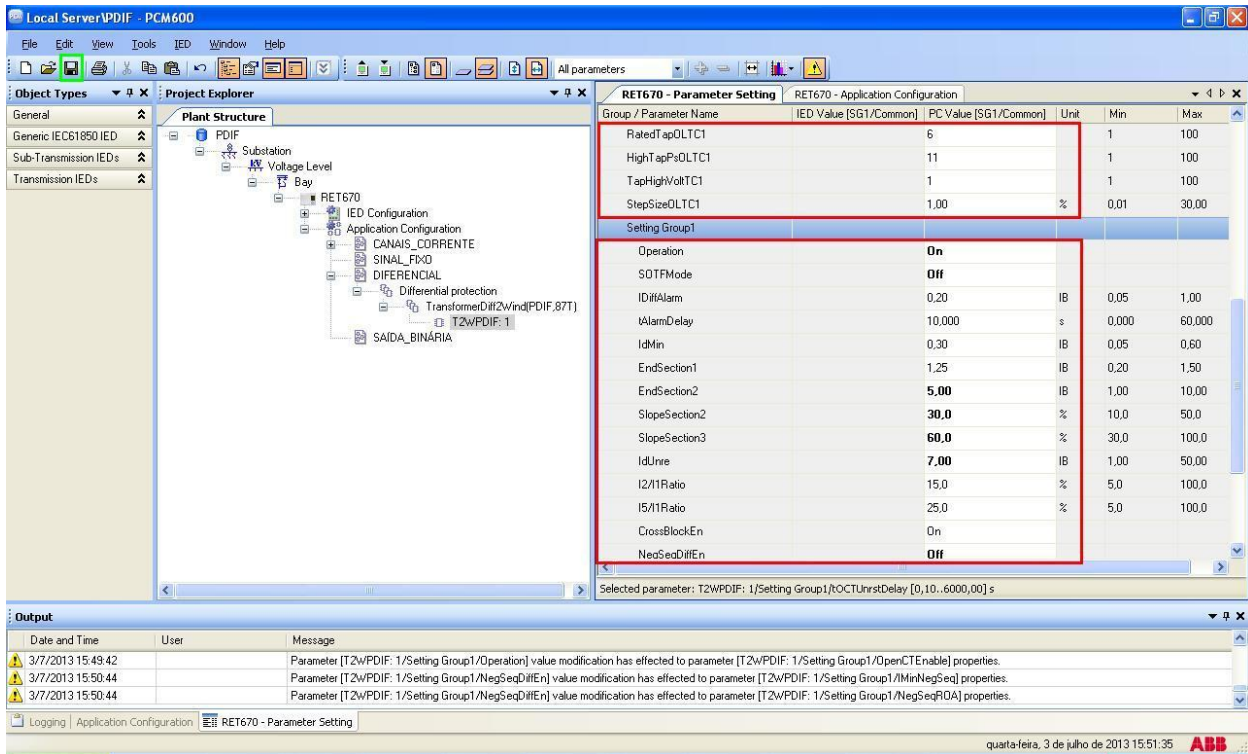


Figure 50

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**Figure 51**

Save the parameterization by clicking on the icon highlighted in green in the previous figure. Then click on the relay icon with the right button and submit the changes. In the following message click “Yes”.

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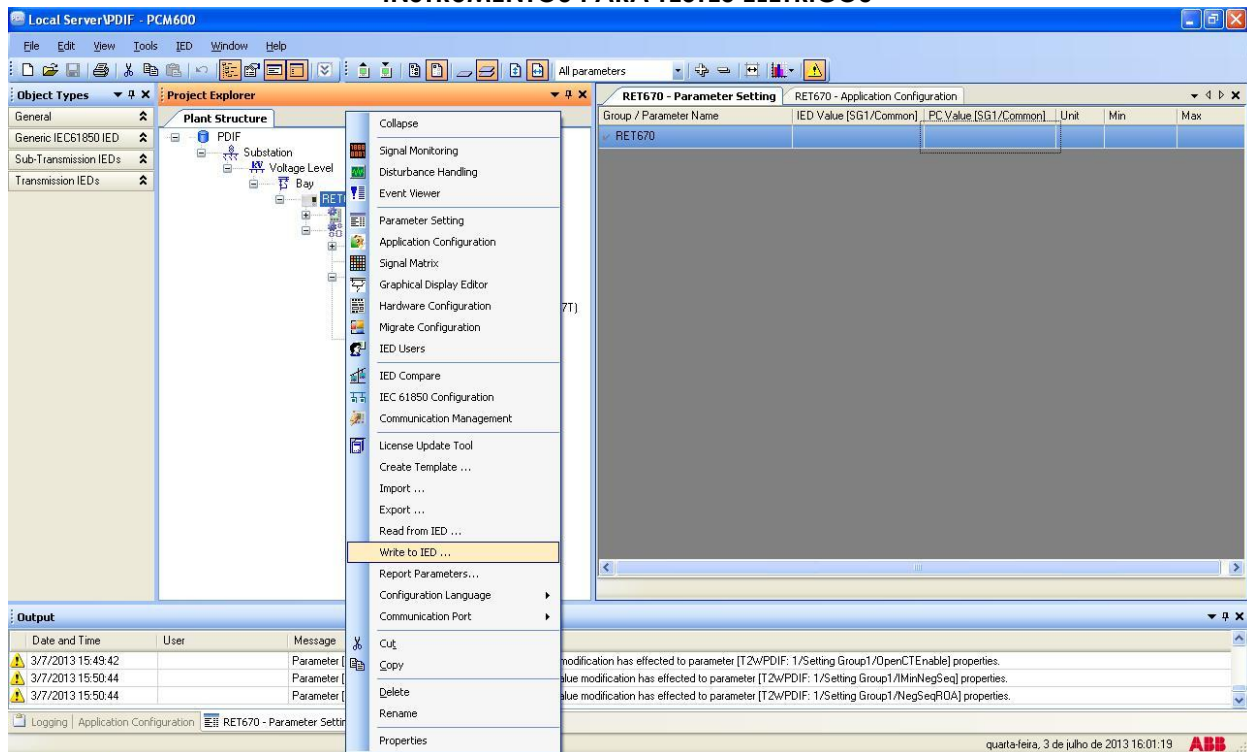


Figure 52



Figure 53

### 4. Differential software settings

#### 4.1 Opening the Differential

Click on the CTC application manager icon.



Figure 54

Click on the “Differential” software icon.

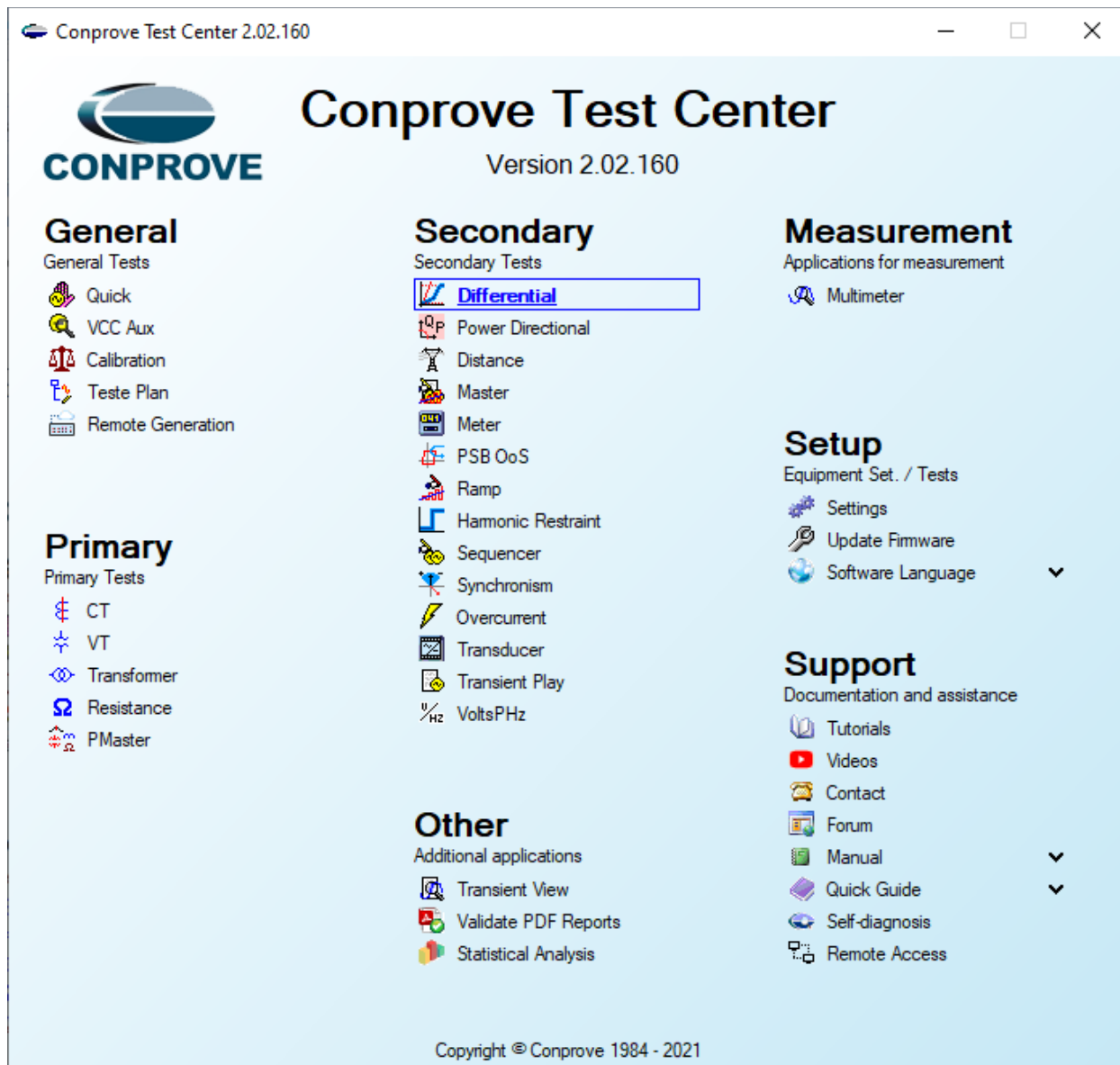


Figure 55

## INSTRUMENTOS PARA TESTES ELÉTRICOS

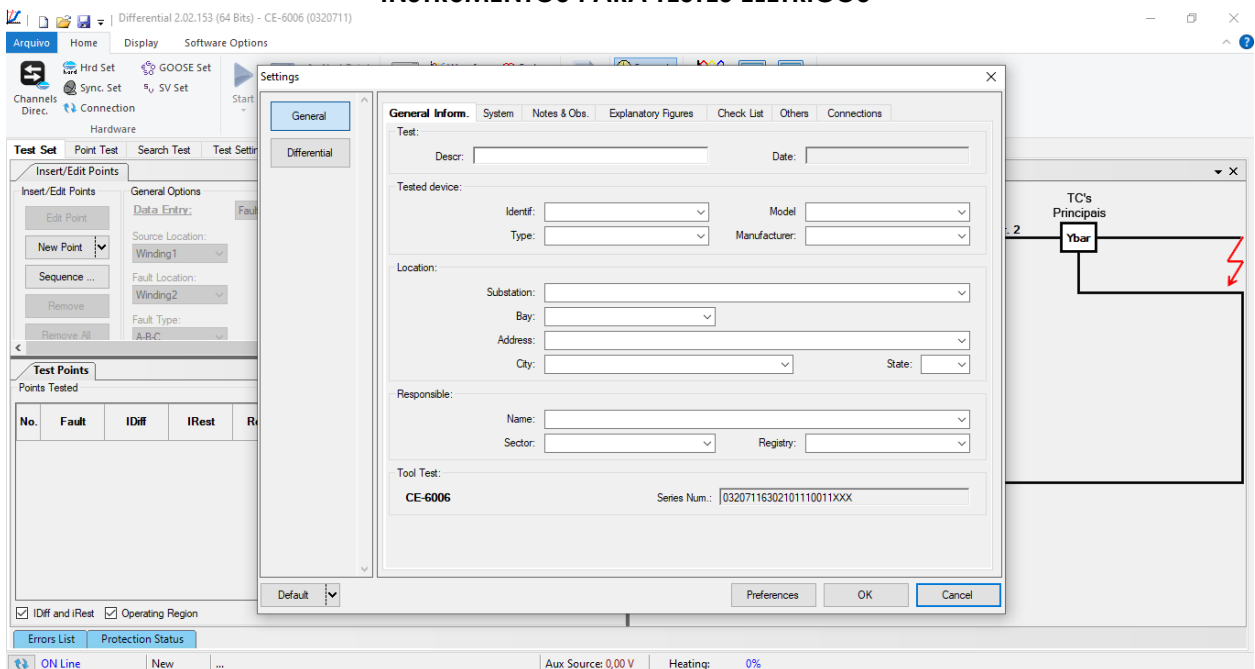


Figure 56

### 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.

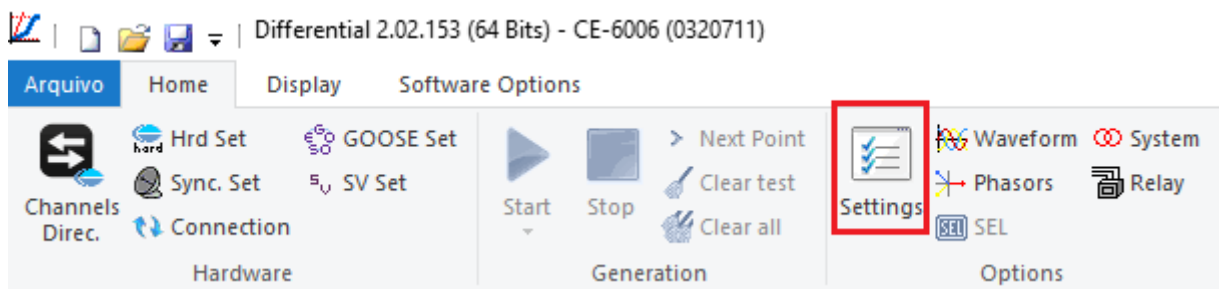


Figure 57

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

Differential

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

Test:  
 Descr: Differential Function Date:

Tested device:  
 Identif: 23031982 Model: RET670  
 Type: Transformer Protection Manufacturer: ABB

Location:  
 Substation: CONPROVE  
 Bay: 1  
 Address: Visconde de Ouro Preto 75 - Neighborhood Custódio Pereira  
 City: Uberlândia State: MG

Responsible:  
 Name: Michel Rockembach de Carvalho  
 Sector: Engineering Registry: 00001

Tool Test:  
 CE-6006 Series Num.: 03207116302101110011XXX

Default Preferences OK Cancel

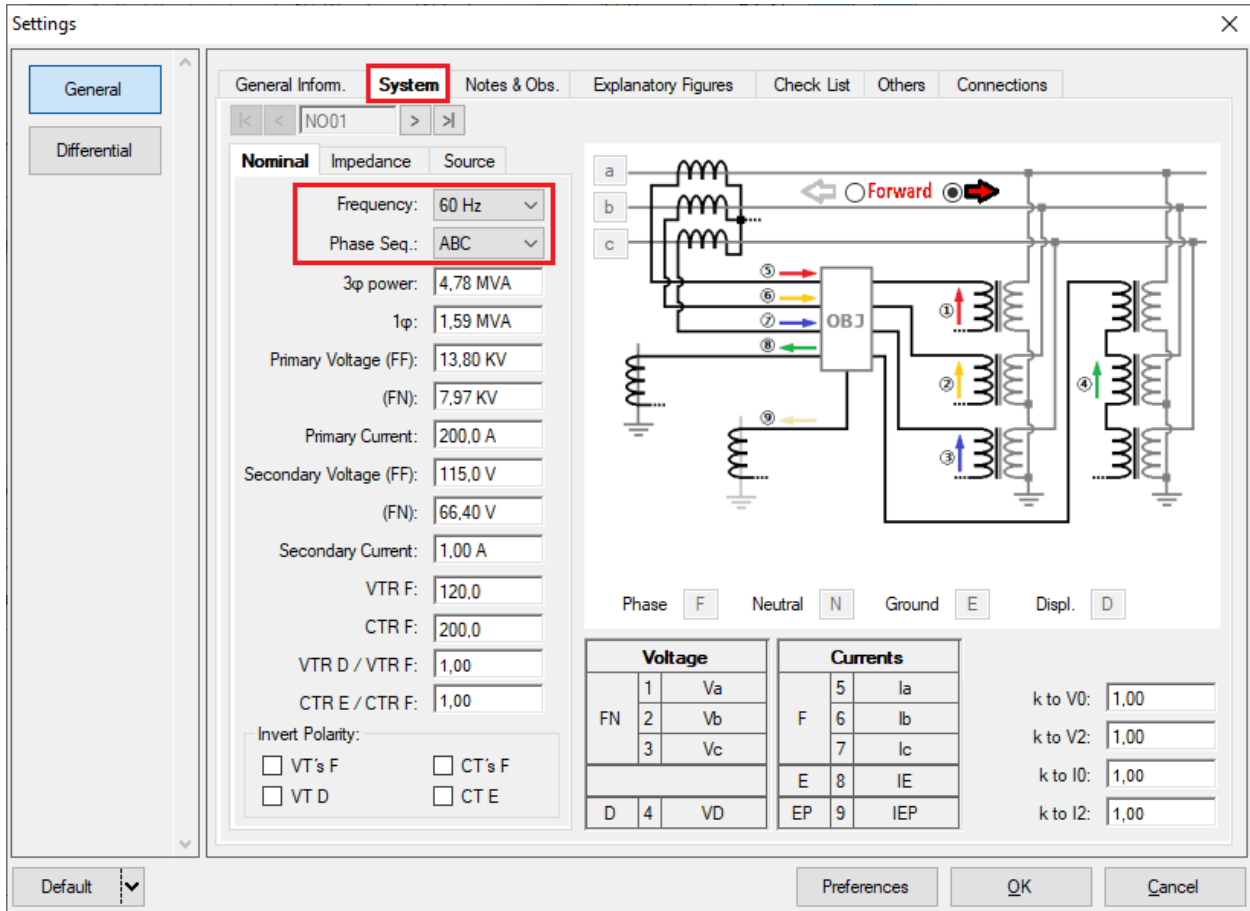
**Figure 58**

### 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 VT’s and CT’s are configured. There are also two sub-tabs “Impedance” and “Source” whose data are not relevant for this test.



**INSTRUMENTOS PARA TESTES ELÉTRICOS**



**Figure 59**

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. Differential Adjustments

### 5.1 “Differential” Screen > “Protected Equipment / CT's”

In this tab you must inform the protected equipment, the number of windings, rated voltages, rated powers, the primary and secondary currents of the main CT's and the currents of the auxiliary CT's if necessary. This test uses the settings for a relay that is protecting a 2-winding transformer. However, it is possible to test, in addition to the differential protection of transformers, the busbar, generator, motor and line protections. For transformer protection there is the possibility of testing up to four windings, using two test sets simultaneously.



INSTRUMENTOS PARA TESTES ELÉTRICOS

Settings

General

Differential

**Protected Equipment/CTs** Adjust Prot. Differential

Protected Equipment

Equipment: Transformer/AutoTransf N° of Phases: 3Ø N° of Wnd.: 2

Description	Voltage	Power	Connection	Vector Group	Grounded
Wnd. 1	110,0 KV	38,10 MVA	D		
Wnd. 2	11,00 KV	38,10 MVA	y	1 (30°)	<input checked="" type="checkbox"/> Yes

CTs

Main CTs Auxiliary CTs  Enable Auxiliary CTs

Description	I Nom	I Prim	I Sec	Connection	Vector Group
Wnd. 1	200,0 A	200,0 A	1,00 A	Yobj	
Wnd. 2	2,00 kA	2,00 kA	1,00 A	Yobj	

Default

Preferences OK Cancel

Figure 60

5.2 “Differential” screen > “Adjust Prot. Differential” > “Adjustment”

The initial default for the “Data Input” field is defined as “User”, thus all other settings such as TAP, lag compensation, mismatch correction, measurement current type, reference winding for calculations and zero sequence elimination options are enabled so that the user can, according to the relay, perform the adjustment correctly (Free Configuration). This method allows the user to test any type of differential relay, but it requires more knowledge of the relay.

To facilitate data entry, the settings of the main relays available on the market have already been standardized. When selecting one of the lists of relays, only the configurable settings are enabled.

INSTRUMENTOS PARA TESTES ELÉTRICOS

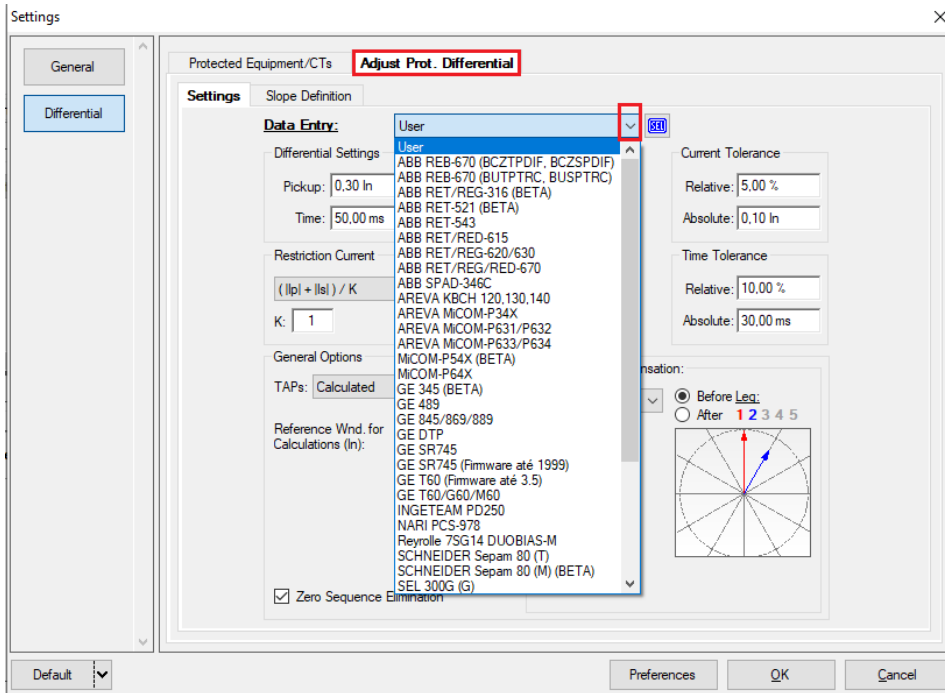


Figure 61

Choosing the “ABB RET/REG/RED-670” mask makes adjustments easier. Current and time tolerances are taken from Appendix A.

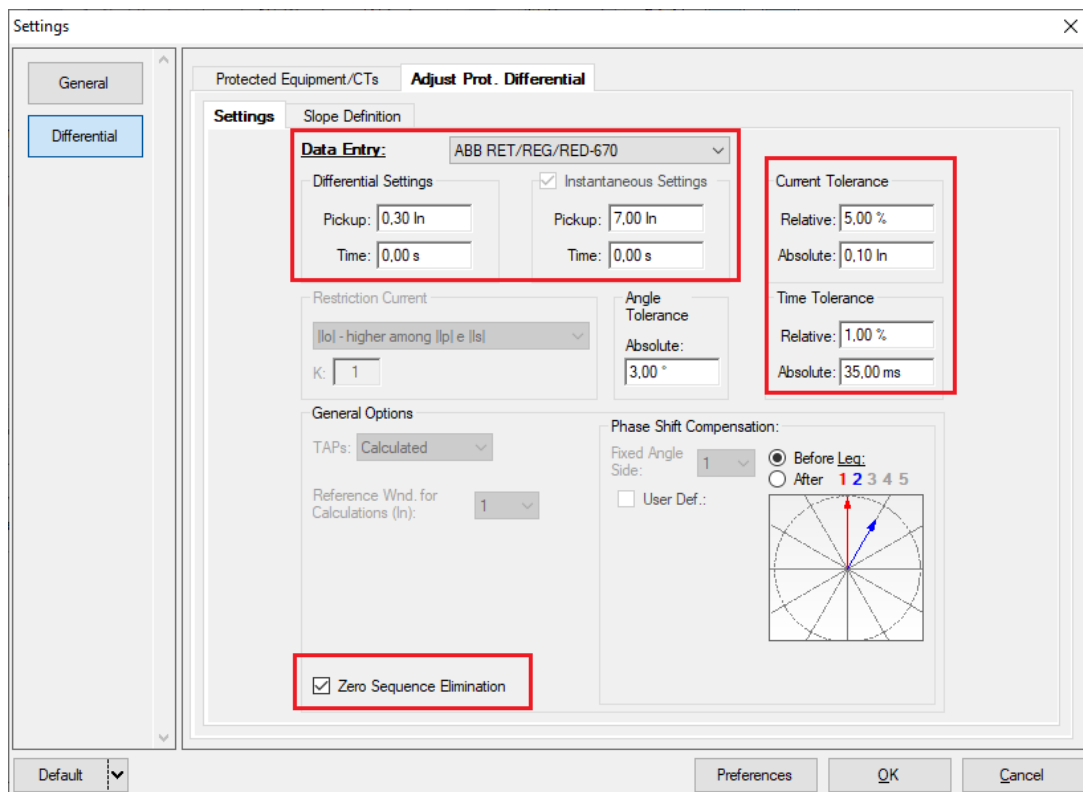


Figure 62

INSTRUMENTOS PARA TESTES ELÉTRICOS

5.3 “Differential” screen > “Adjust Prot. Differential” > “Slope Definition”

On this screen, the values of the “Slopes” and the “End Points” must be entered.

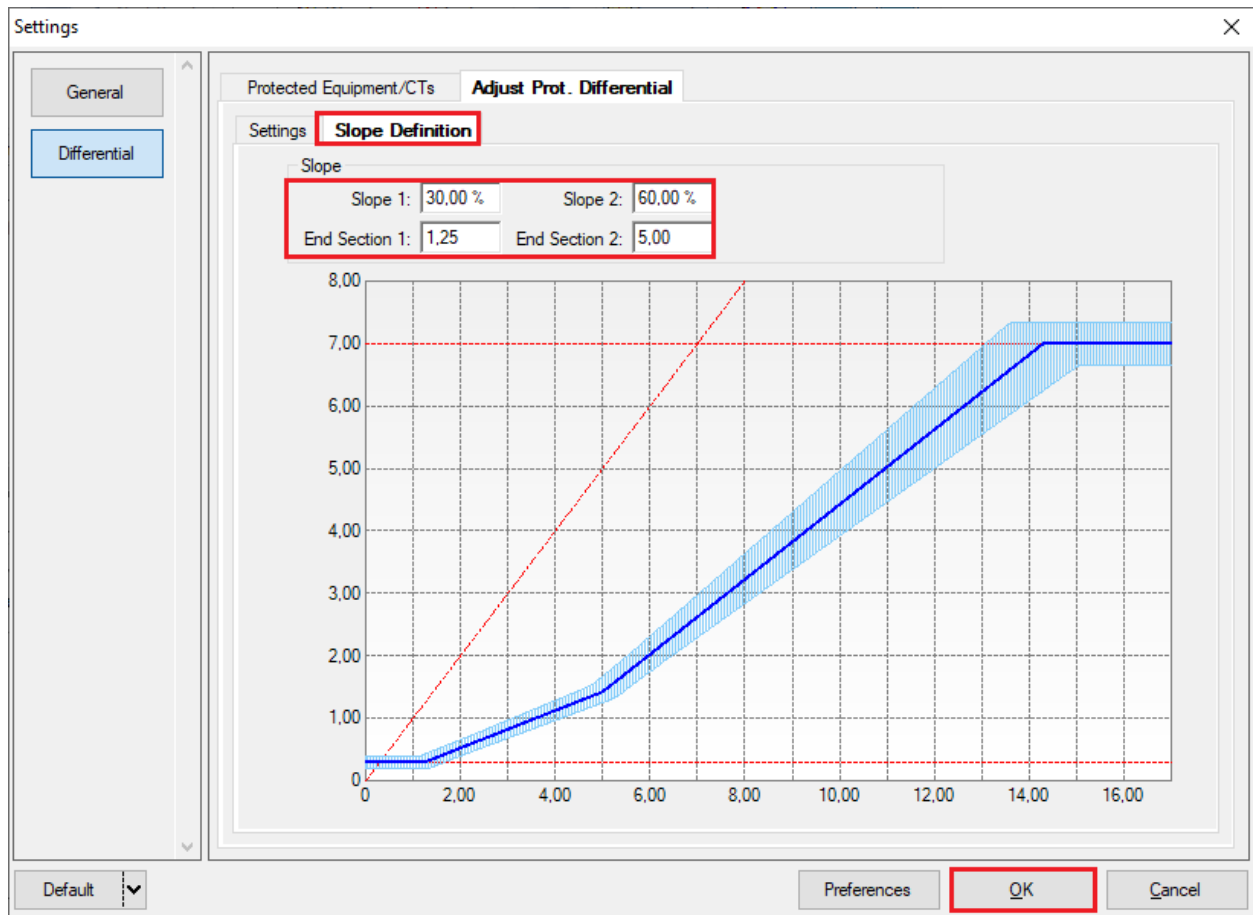


Figure 63

6. Channel Targeting and Hardware Configurations

Click on the icon illustrated below.

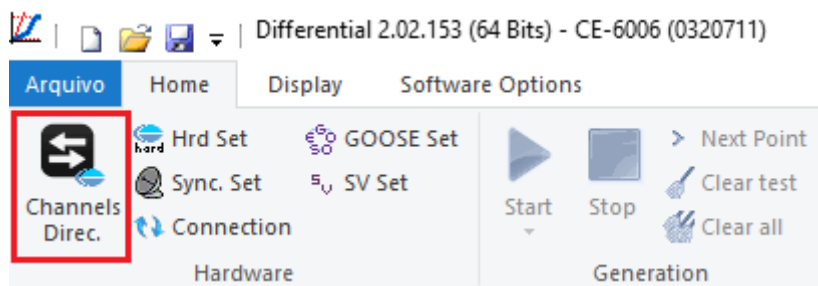


Figure 64

In then click on the highlighted icon to configure the hardware.

### INSTRUMENTOS PARA TESTES ELÉTRICOS

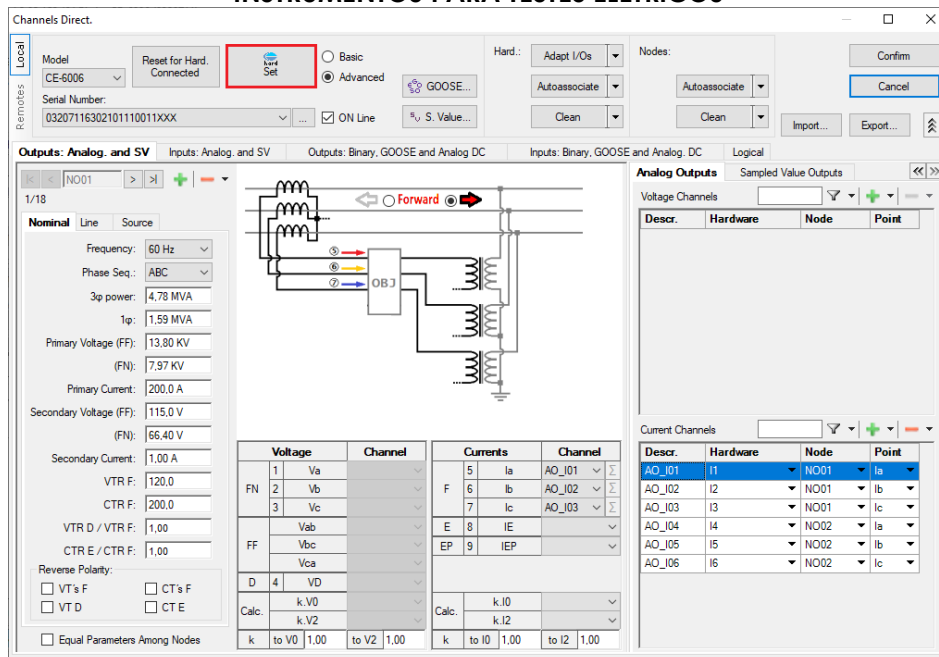


Figure 65

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

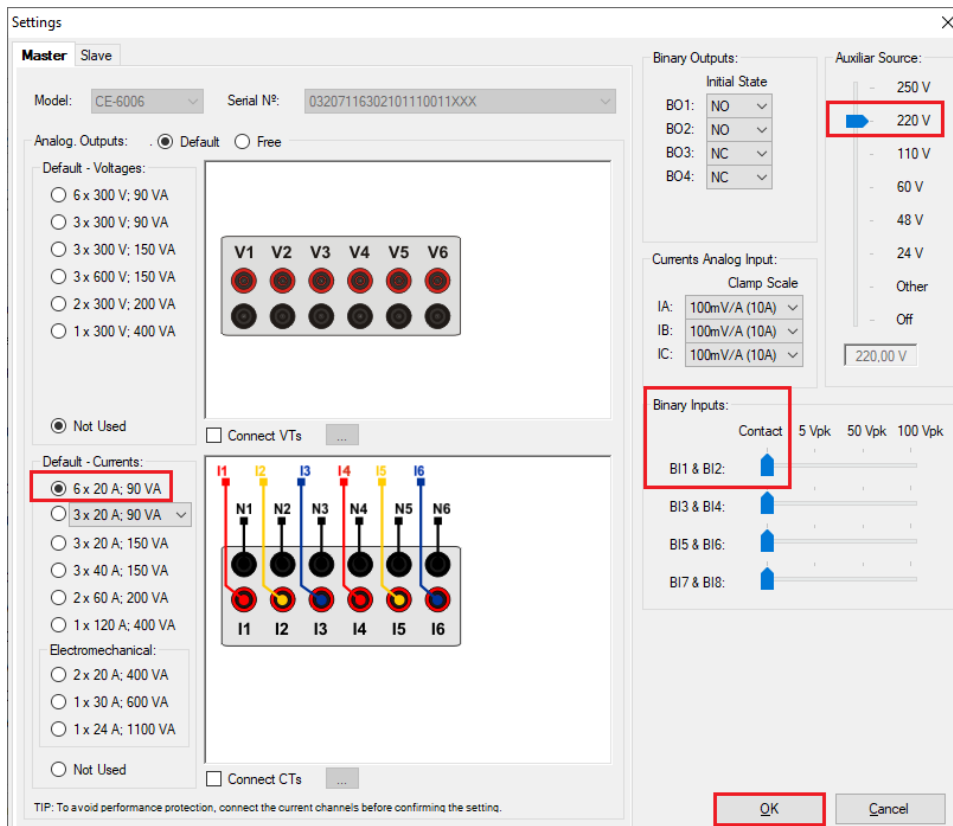


Figure 66

## INSTRUMENTOS PARA TESTES ELÉTRICOS

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

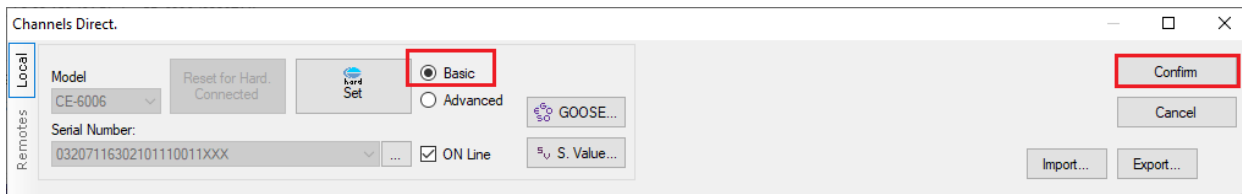


Figure 67

### 7. Test Settings

In the settings tab, the important thing is the correct direction of the generation channels, the selection of the stop interface to “B101” and enables a pre-fault with nominal values.

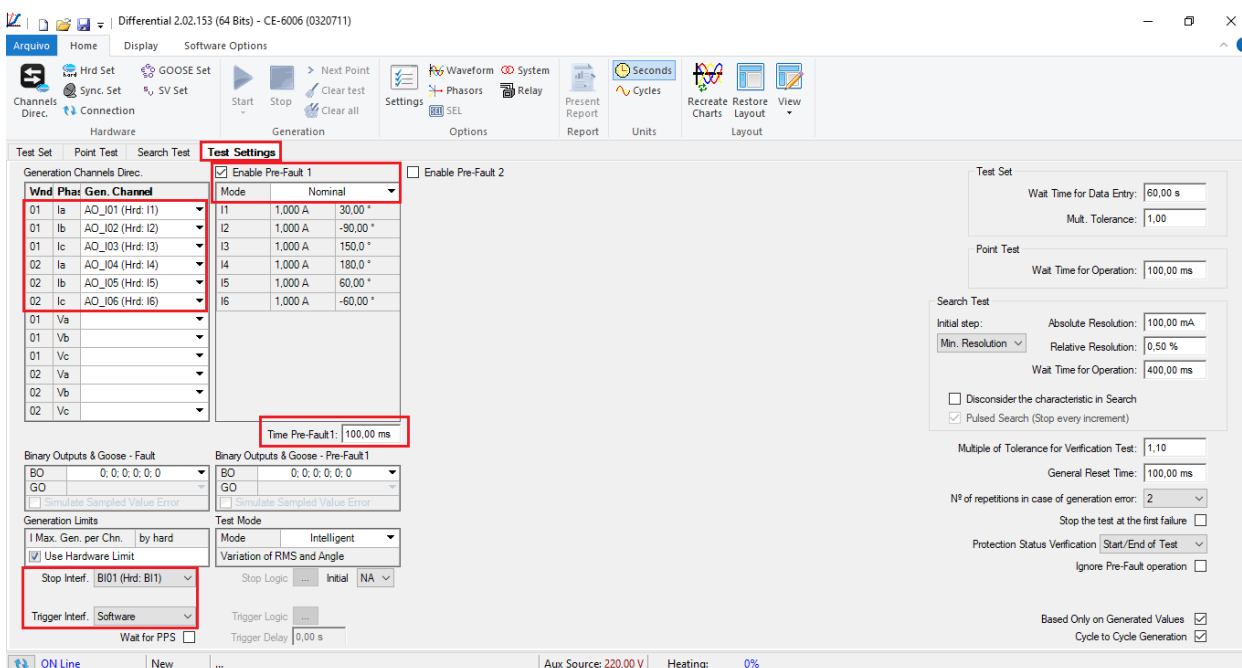


Figure 68

### 8. Point Test

For the point test, click on the “New Point” field and choose the fault type, and the differential and restraint current values. Then click on the confirm button. To visualize the point, click on the “Graphic” tab.



## INSTRUMENTOS PARA TESTES ELÉTRICOS

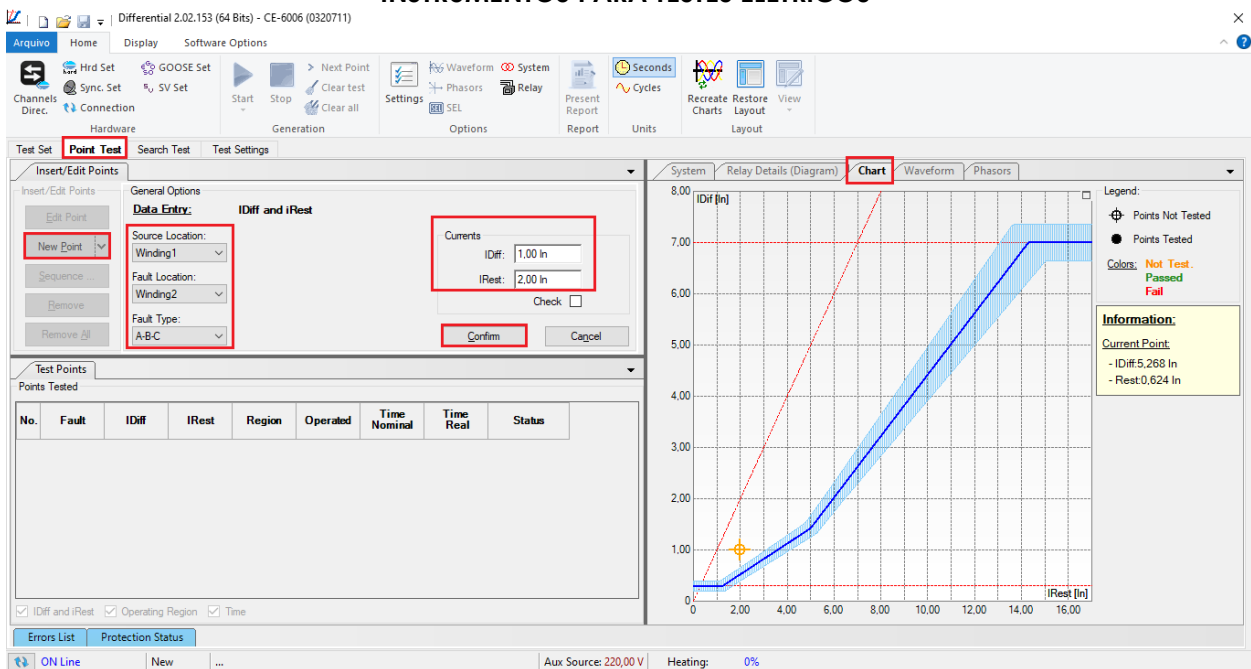


Figure 69

Another way is to use the “Sequence” feature of points by choosing the values of “Initial”, “Final” and “Step”. This way the software automatically creates the points.

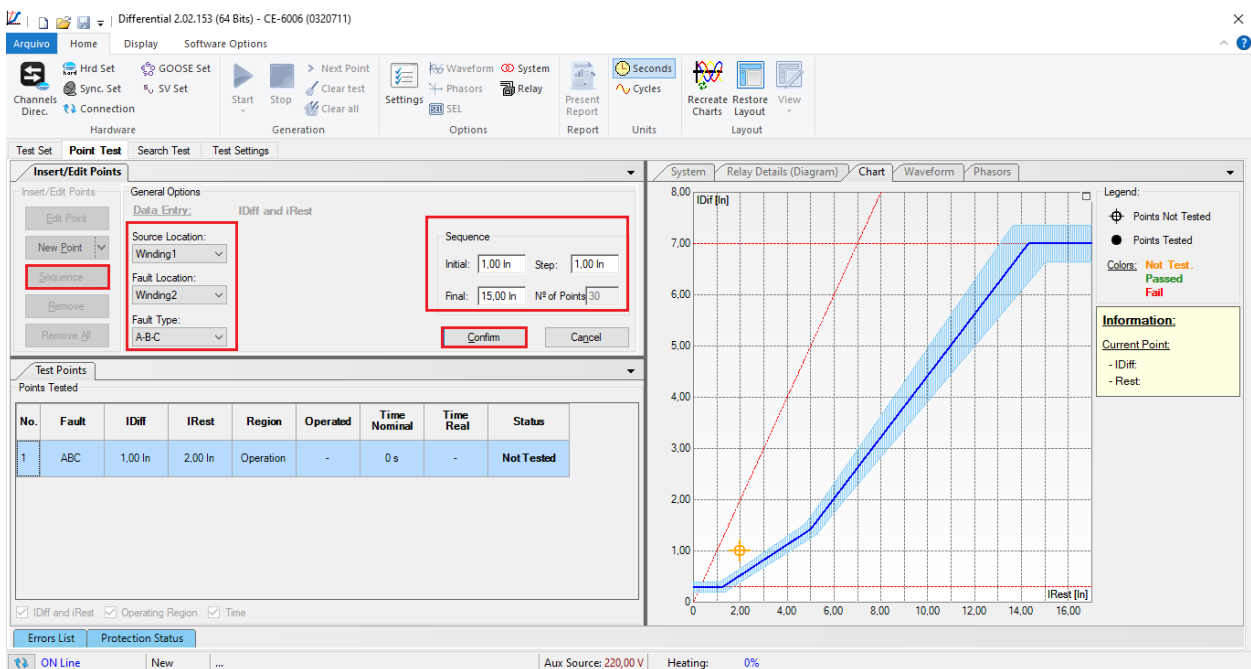


Figure 70

Click on the icon highlighted below or use the command “Alt + G”.

## INSTRUMENTOS PARA TESTES ELÉTRICOS

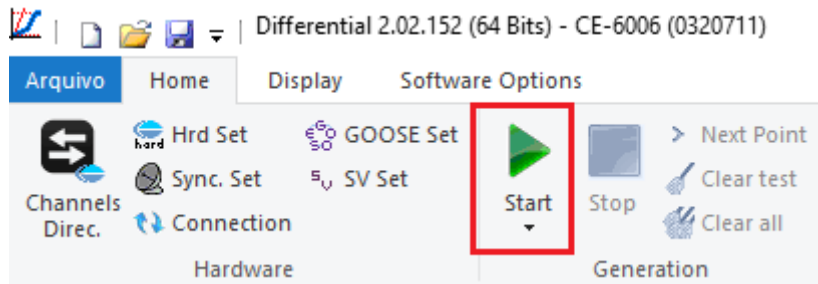


Figure 71

It is verified that all points were successfully approved.

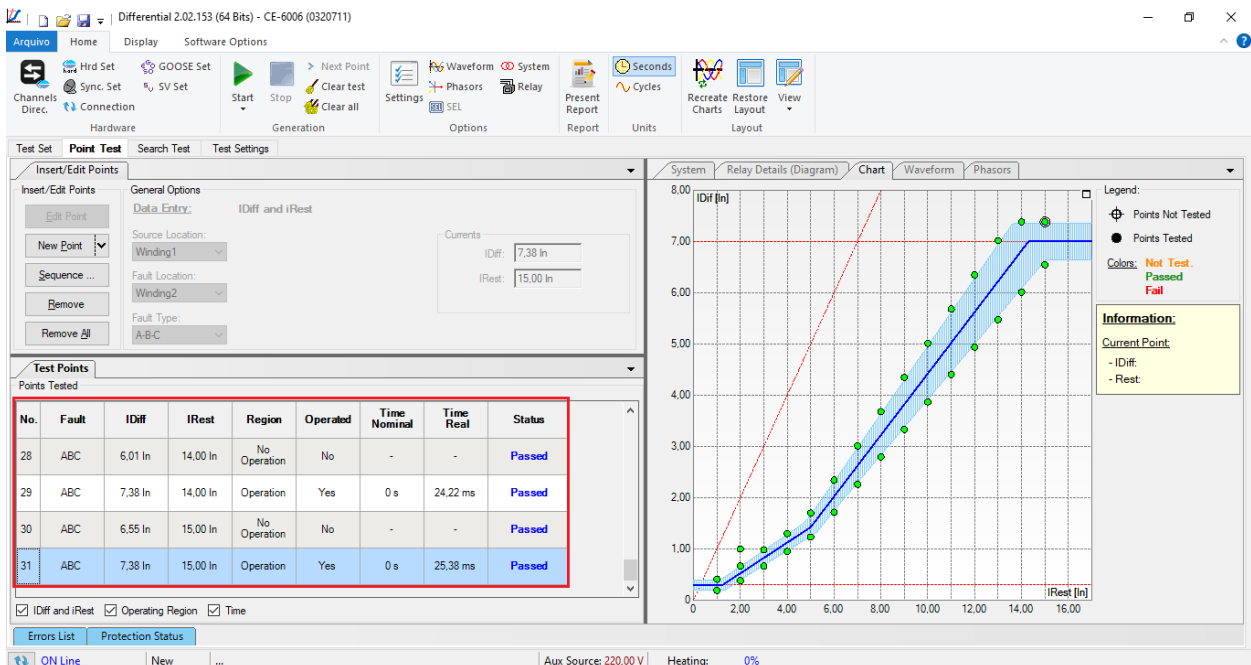
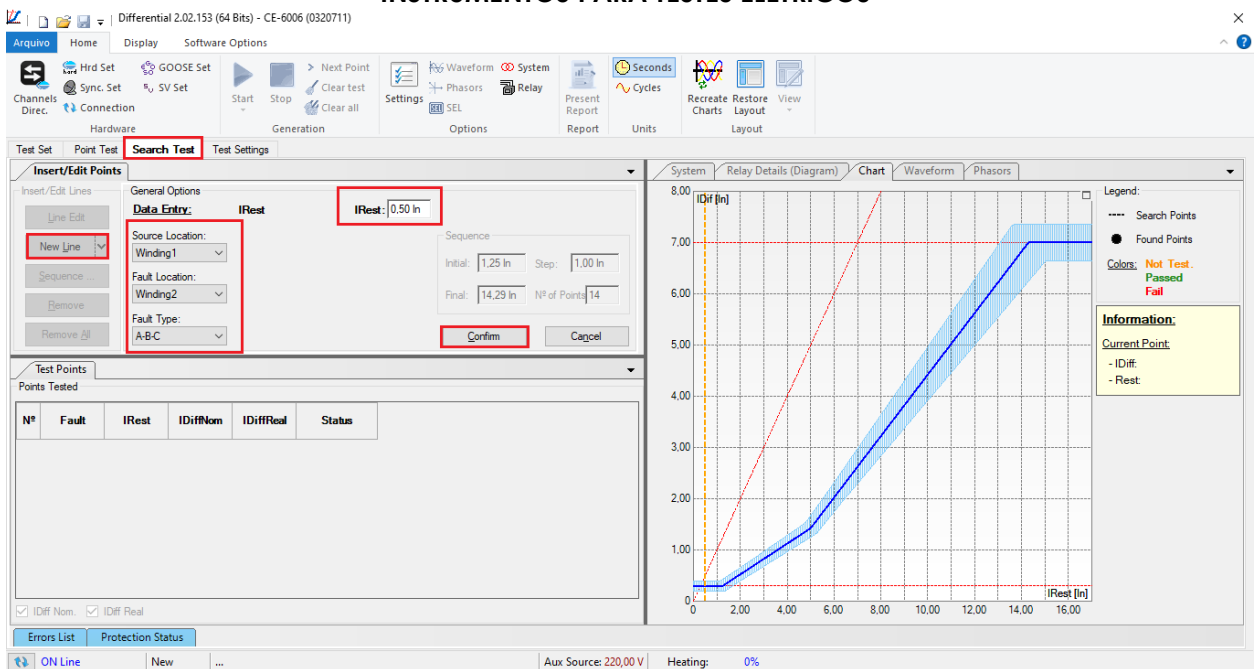


Figure 72

## 9. Search Test

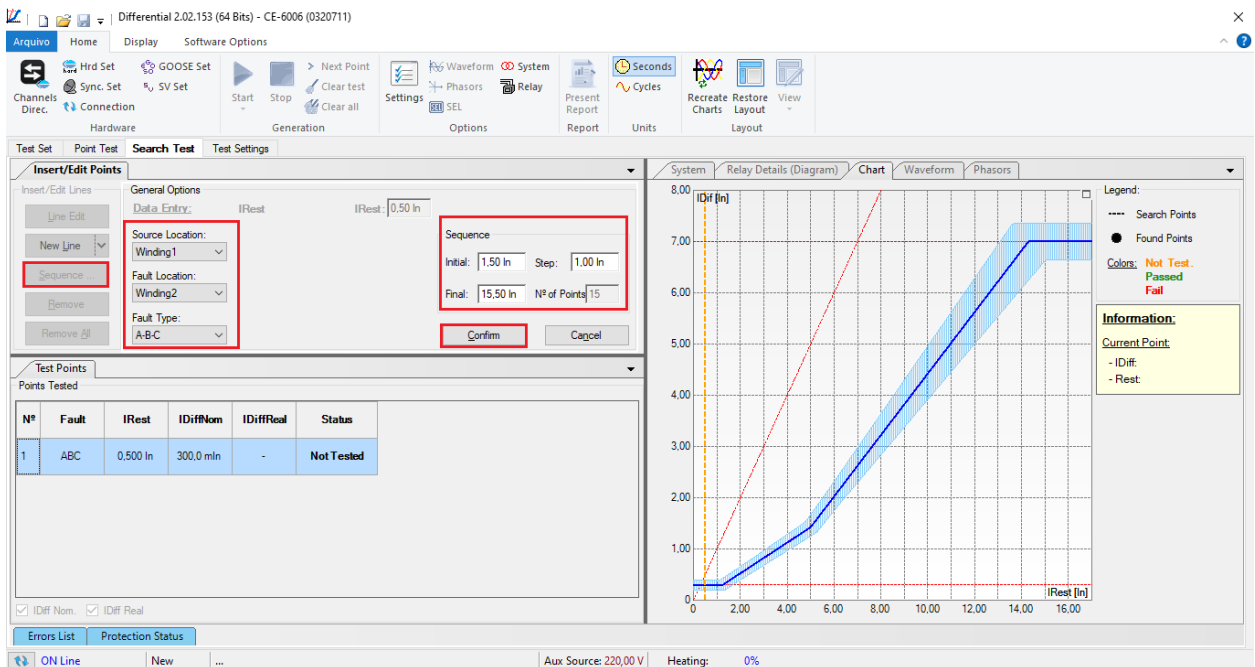
To carry out the search test, click on the “New Line” field, choose the fault type, the source location, the short location, the restraint current value and confirm.

## INSTRUMENTOS PARA TESTES ELÉTRICOS



**Figure 73**

There is also another way to add test lines, by adding a search string. To do this, just click on the “Sequence” button and select the initial and final restriction currents of the search and the step between them.



**Figure 74**

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

## INSTRUMENTOS PARA TESTES ELÉTRICOS

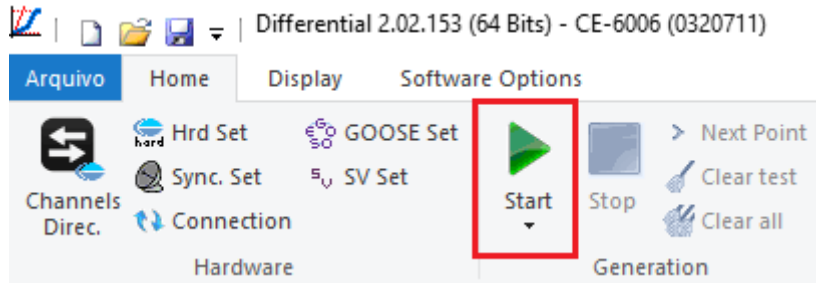


Figure 75

### 9.1 Final Search Test Result

In this test, the values found for differential current can be viewed, if they are within the tolerance range given by the manufacturer, they are approved, otherwise they are disapproved.

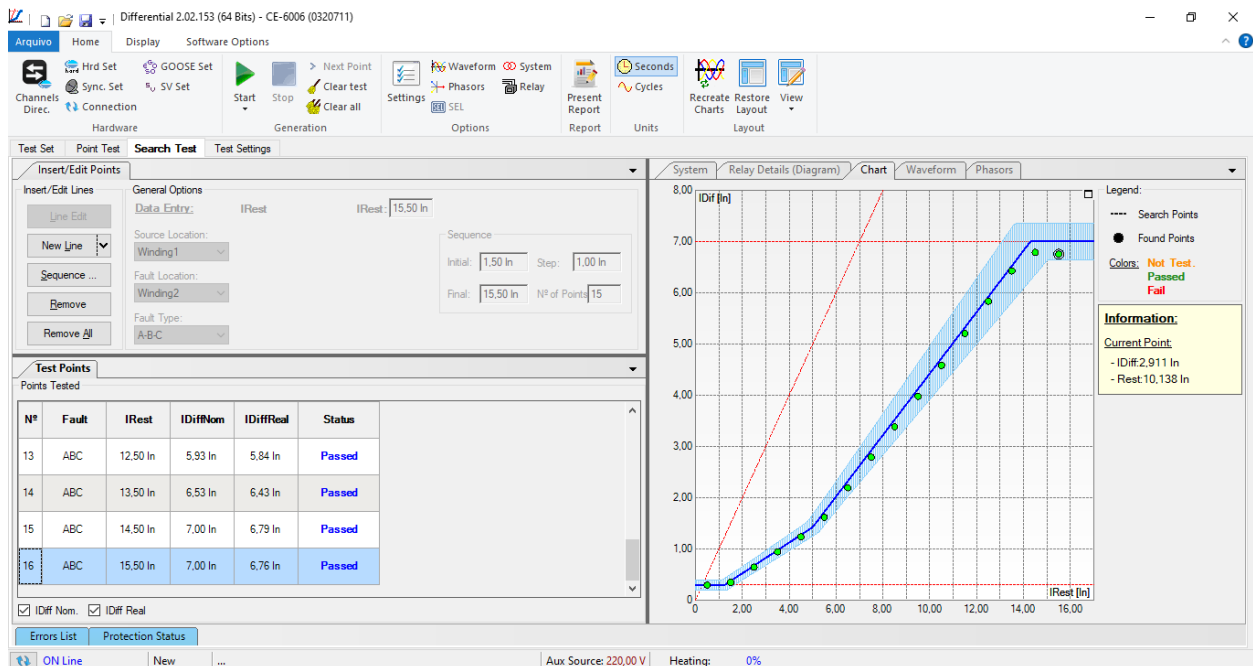


Figure 76

## 10. 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**

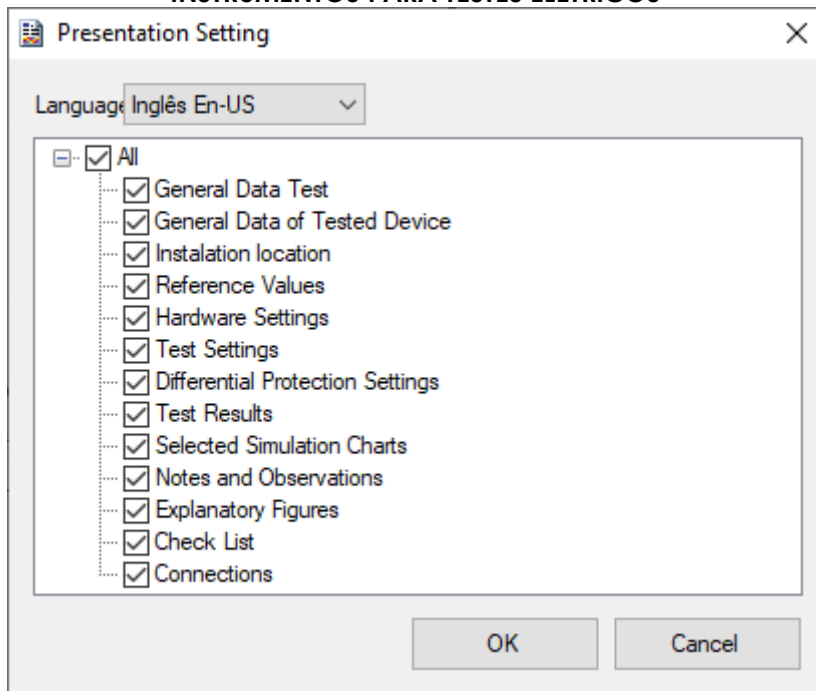


Figure 77

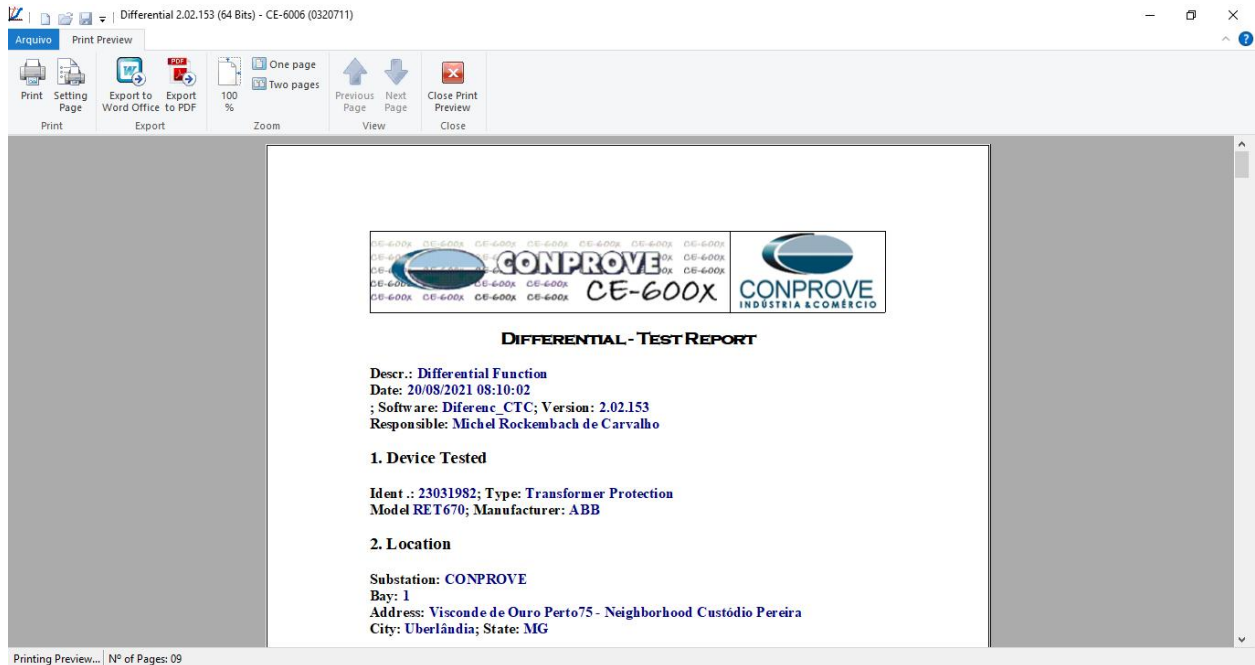
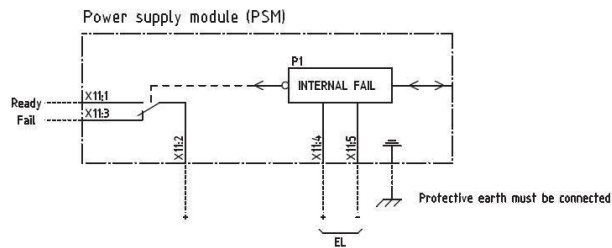


Figure 78



APPENDIX A

A.1 Terminal Designations



Power supply module (PSM)

Figure 79

Transformer input module (TRM)

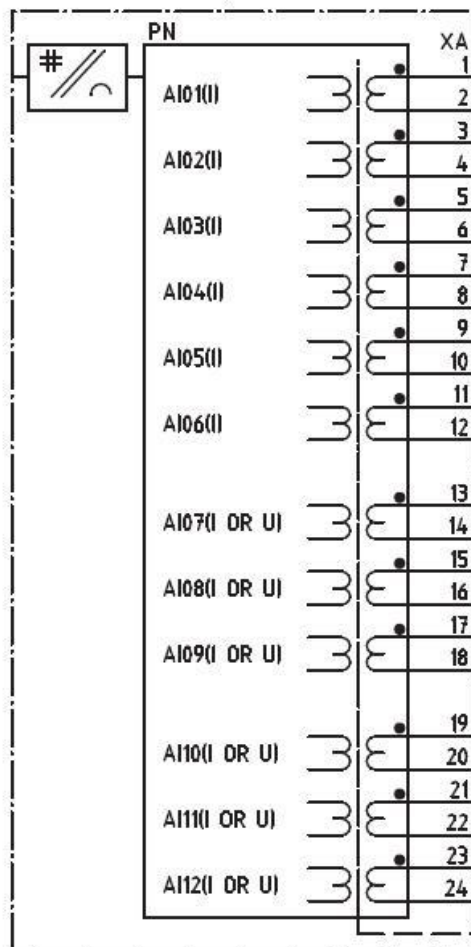
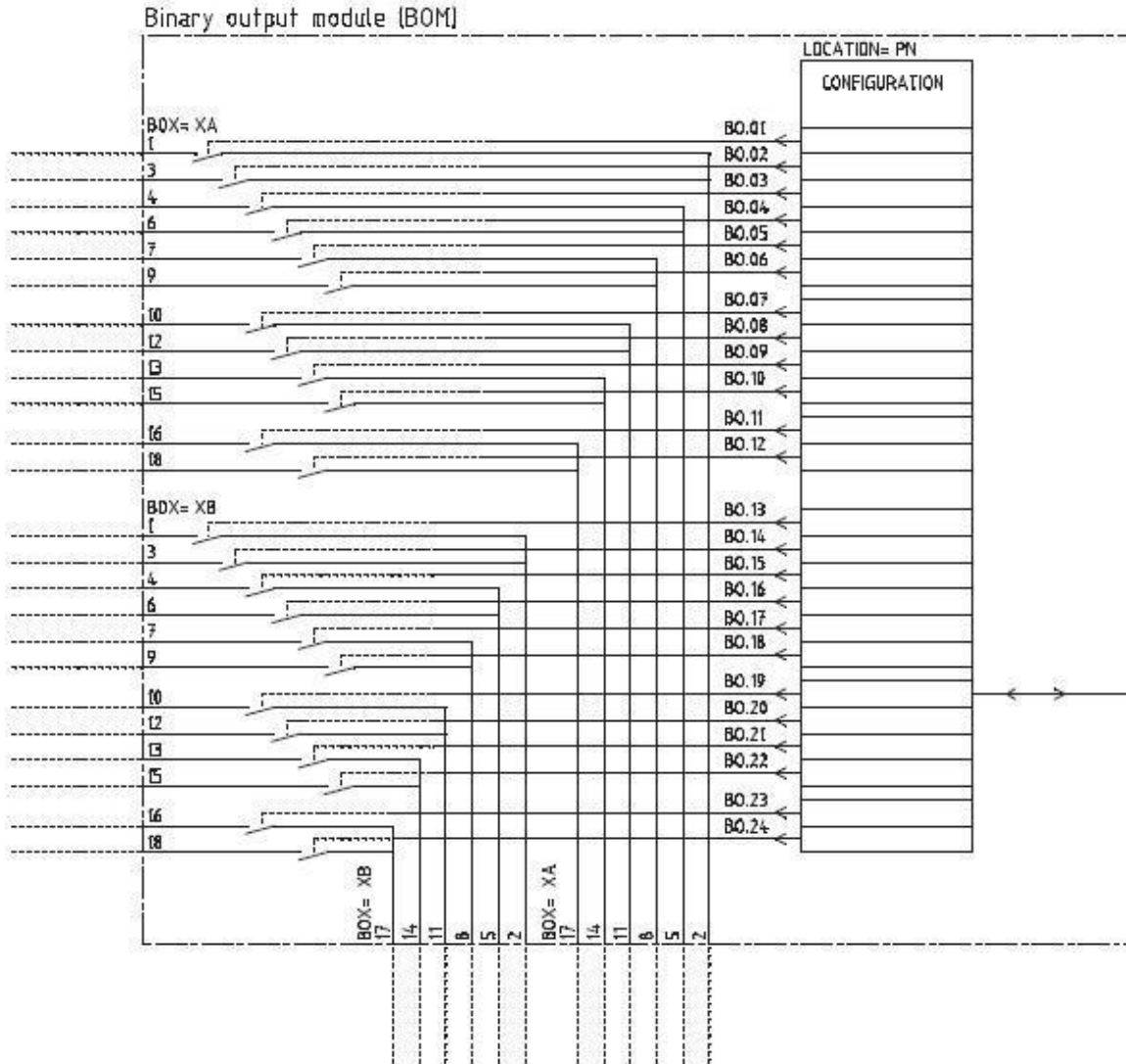


Figure 80

**INSTRUMENTOS PARA TESTES ELÉTRICOS**



INSTRUMENTOS PARA TESTES ELÉTRICOS

A.2 Technical data

Function	Range or value	Accuracy
Operating characteristic	Adaptable	$\pm 1.0\%$ of $I_r$ for $I < I_r$ $\pm 1.0\%$ of $I$ for $I > I_r$
Reset ratio	>95%	-
Unrestrained differential current limit	(100-5000)% of $I_{Base}$ on high voltage winding	$\pm 1.0\%$ of set value
Base sensitivity function	(10-60)% of $I_{Base}$	$\pm 1.0\%$ of $I_r$
Second harmonic blocking	(5.0-100.0)% of fundamental differential current	$\pm 2.0\%$ of applied harmonic magnitude
Fifth harmonic blocking	(5.0-100.0)% of fundamental differential current	$\pm 5.0\%$ of applied harmonic magnitude
Connection type for each of the windings	Y or D	-
Phase displacement between high voltage winding, W1 and each of the windings, W2 and W3. Hour notation	0-11	-
Operate time, restrained function	25 ms typically at 0 to 2 x set level	-
Reset time, restrained function	20 ms typically at 2 to 0 x set level	-
Operate time, unrestrained function	12 ms typically at 0 to 5 x set level	-
Reset time, unrestrained function	25 ms typically at 5 to 0 x set level	-
Critical impulse time	2 ms typically at 0 to 5 x $I_b$	-

APPENDIX B

Equivalence of software parameters and the relay under test.

Table 1

Differential Software		ABB RET670 Relay	
Parameter	Figure	Parameter	Figure
Voltage (Wind. 1)	60	RatedVoltageW1	50
Voltage (Wind. 2)	60	RatedVoltageW2	50
Power (Wind. 1)	60	$\sqrt{3} * (\text{RatedVoltageW1}) * (\text{Rated CurrentW1})$	50
Power(Wind. 2)	60	$\sqrt{3} * (\text{RatedVoltageW2}) * (\text{Rated CurrentW2})$	50
Connection (Wind. 1)	60	ConnectTypeW1	50
Connection (Wind. 2)	60	ConnectTypeW2	50
Vector Group (Wind. 2)	60	ClockNumberW2	50
I Prim (Wind. 1)	60	CT prim	19
I Prim (Wind. 2)	60	CT prim	20
I Sec (Wind. 1)	60	CT sec	19
I Sec (Wind. 2)	60	CT sec	20
Connection CT (Wind. 1)	60	CTStartPoint	19
Connection CT (Wind. 2)	60	CTStartPoint	20
Differential Settings Pickup	62	IdMin	51
Instantaneous Settings Pickup	62	IdUnre	51
Slope 1	63	SlopeSection2	51
End Section 1	63	EndSection1	51
Slope 2	63	SlopeSection3	51
End Section 2	63	EndSection1	51