



INSTRUMENTOS PARA TESTES ELÉTRICOS

Test Tutorial

Equipment Type: Protection Relay

Brand: ABB

Model: REL650

Function: 81u or PTUF – Underfrequency & 81o or PTOF – Overfrequency

Tool Used: CE-6003, CE-6006, CE-6707, CE-6710, CE-7012 or CE-7024

Objective: Testing the pickup and operating time of the underfrequency and overfrequency elements using the Ramp software.

Version Control:

Version	Descriptions	Date	Author	Reviewer
1.0	Initial Version	27/10/2022	M.R.C.	G.C.D.P.

INSTRUMENTOS PARA TESTES ELÉTRICOS

Summary

1. Relay connection to CE-6710	5
1.1 <i>Auxiliary Source</i>	5
1.2 <i>Voltage Coils</i>	5
1.3 <i>Binary Inputs</i>	6
2. REL650 relay configuration	6
2.1 <i>Creating a new file</i>	6
2.2 <i>Setting up communication</i>	10
2.3 <i>TRM_2</i>	13
2.4 <i>SETGRPS: 1</i>	15
2.5 <i>PRIMVAL: 1</i>	15
2.6 <i>GBASVAL: 1</i>	16
2.7 <i>AISVBAS: 1</i>	17
2.8 <i>Application Configuration</i>	17
2.9 <i>SMAI_20_2 (Voltages)</i>	19
2.10 <i>SAPTOF (Overfrequency)</i>	23
2.11 <i>SAPTUF (Underfrequency)</i>	25
2.12 <i>Binary Outputs</i>	27
3. Parameterization of the ABB REL650 relay	30
3.1 <i>REL 650 Parameter Setting</i>	30
4. Ramp software adjustments	33
4.1 <i>Opening the ramp</i>	33
4.2 <i>Configuring the Settings</i>	34
4.3 <i>System</i>	35
5. Channel Direction and Hardware Configurations	36
6. Restore Layout	38
7. Test structure for function 81	39
7.1 <i>Main Screen 81-1</i>	40
7.2 <i>Screen for incrementing 81-1</i>	41
7.3 <i>Main screen 81-2</i>	42
7.4 <i>Screen for incrementing 81-2</i>	43
7.5 <i>Evaluation of pick-ups</i>	44
7.6 <i>Adjusting graphics</i>	45
7.7 <i>Time analysis</i>	48



INSTRUMENTOS PARA TESTES ELÉTRICOS	
7.8 <i>Inserting markup</i>	48
7.9 <i>Time evaluation</i>	50
8. Report.....	53
APPENDIX A	54
A.1 Terminal Designation	54
A.2 Technical data.....	56
APPENDIX B	57

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

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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Sequence for testing REL650 relay in the Ramp 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 3 on the relay terminal X410 and the negative (black terminal) of the Aux Vdc Source to pin 1 of the relay terminal X410.

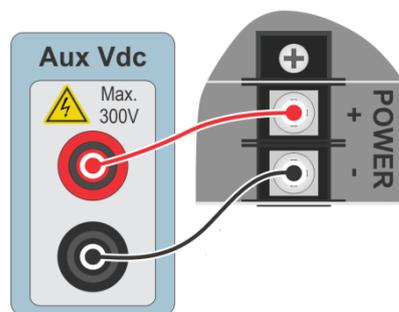


Figure 1

1.2 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.

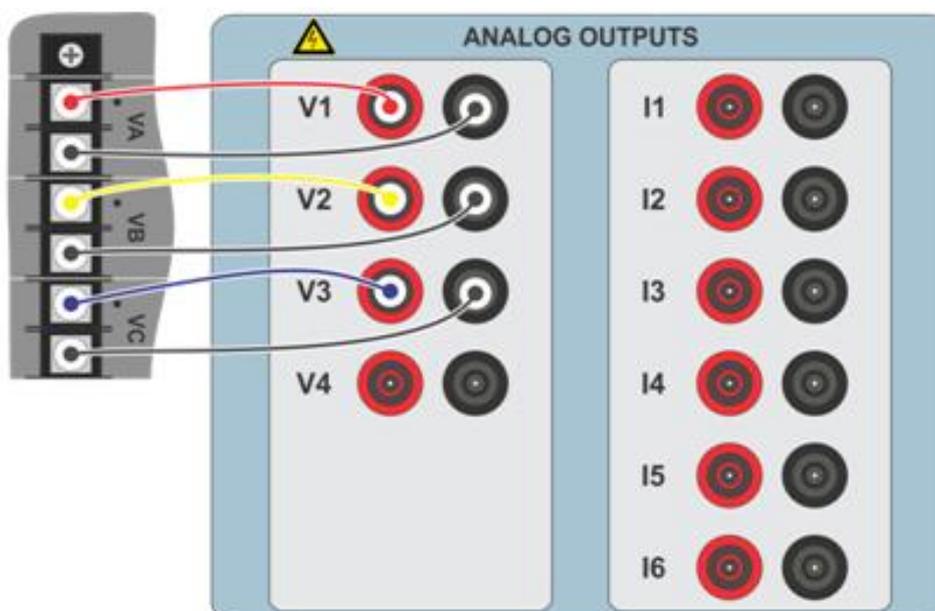


Figure 2

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.

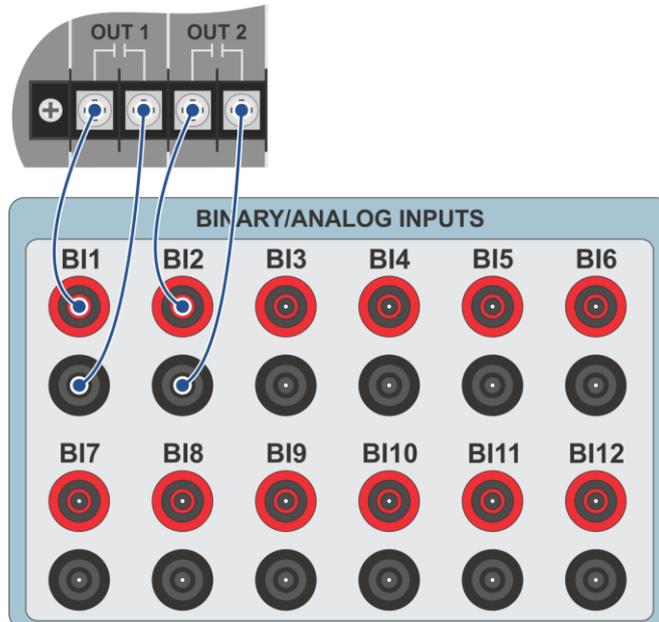


Figure 3

2. REL650 relay configuration

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



Figure 4

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.

2.1 Creating a new file

First, a new project must be added. Click on “File” and then “New Project...”.

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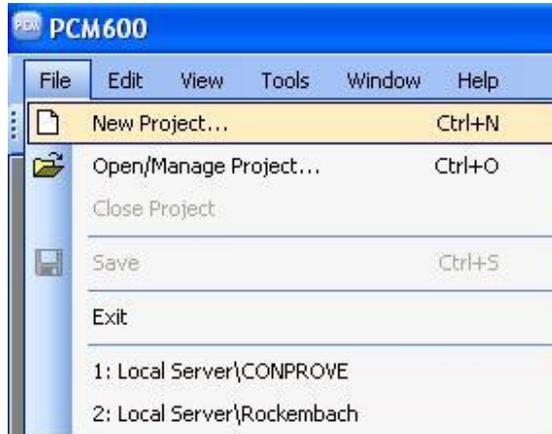


Figure 5

Choose a name for the project, in which case “81o81u” was used and then click on “Create”.

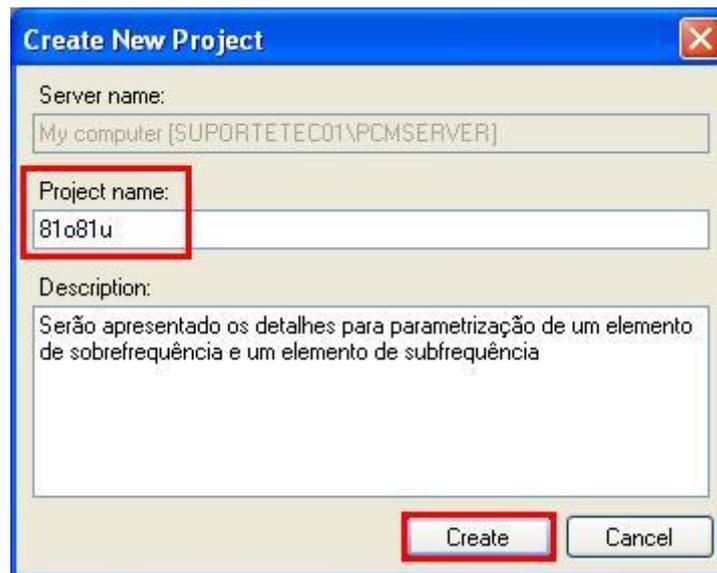


Figure 6

Right click on the created plant and insert a substation.

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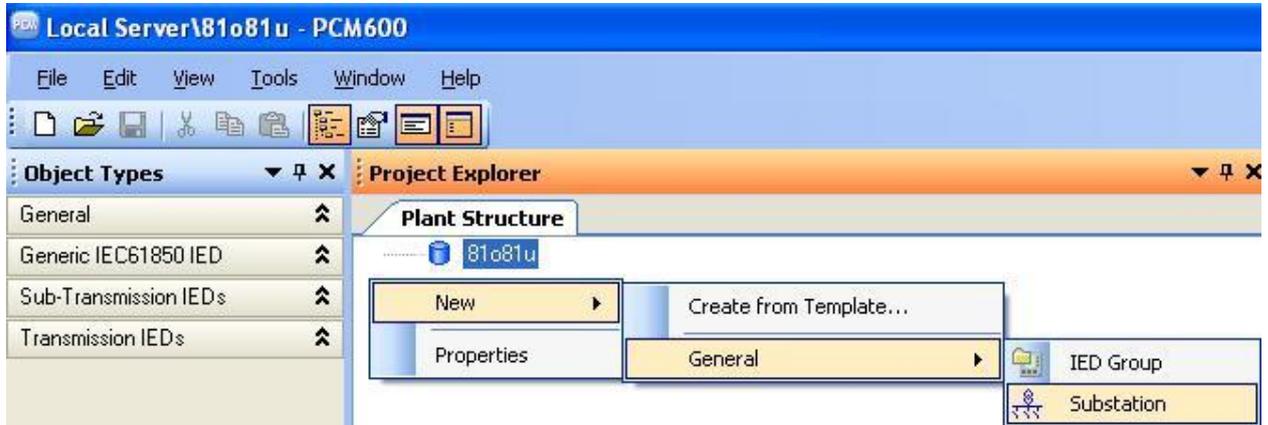


Figure 7

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

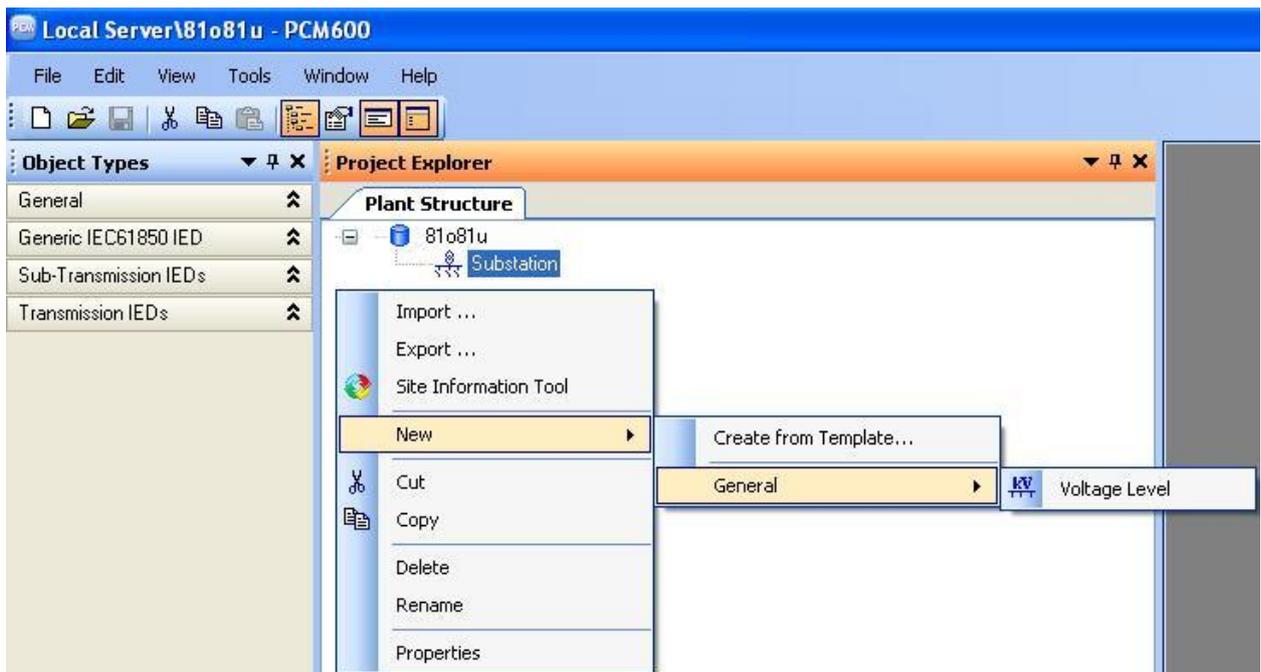


Figure 8

Within the voltage level, a bay must be inserted.

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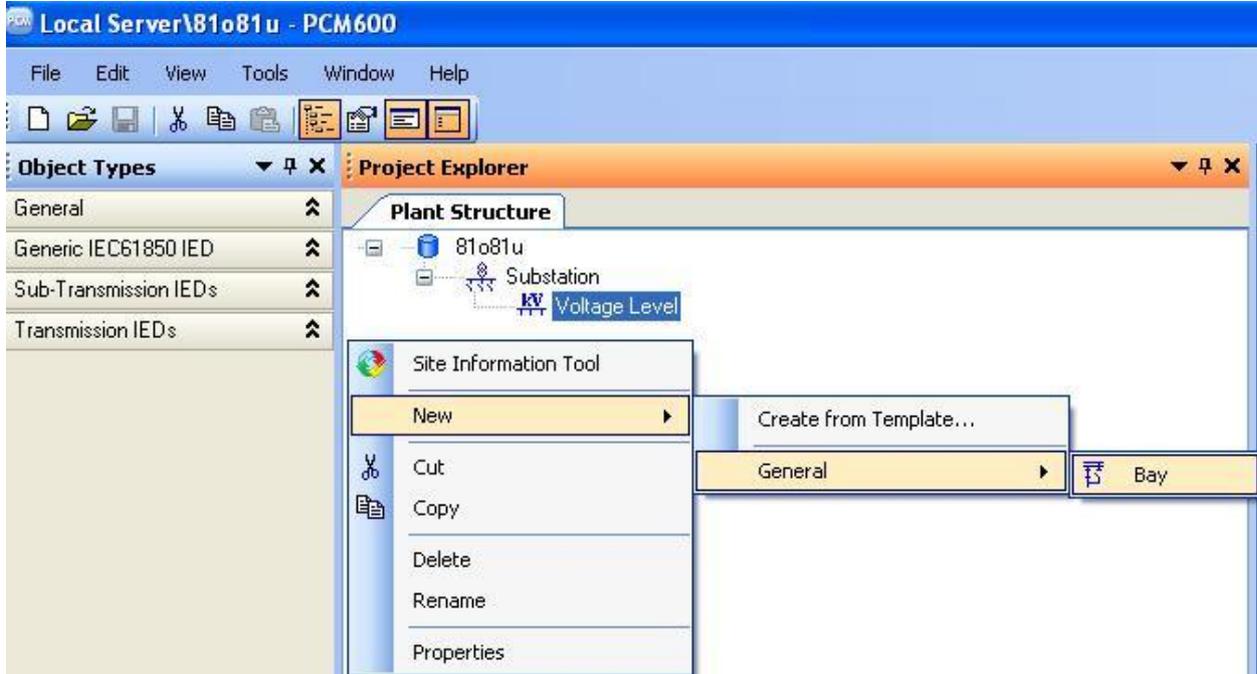


Figure 9

The REL650 relay is inserted inside the bay.

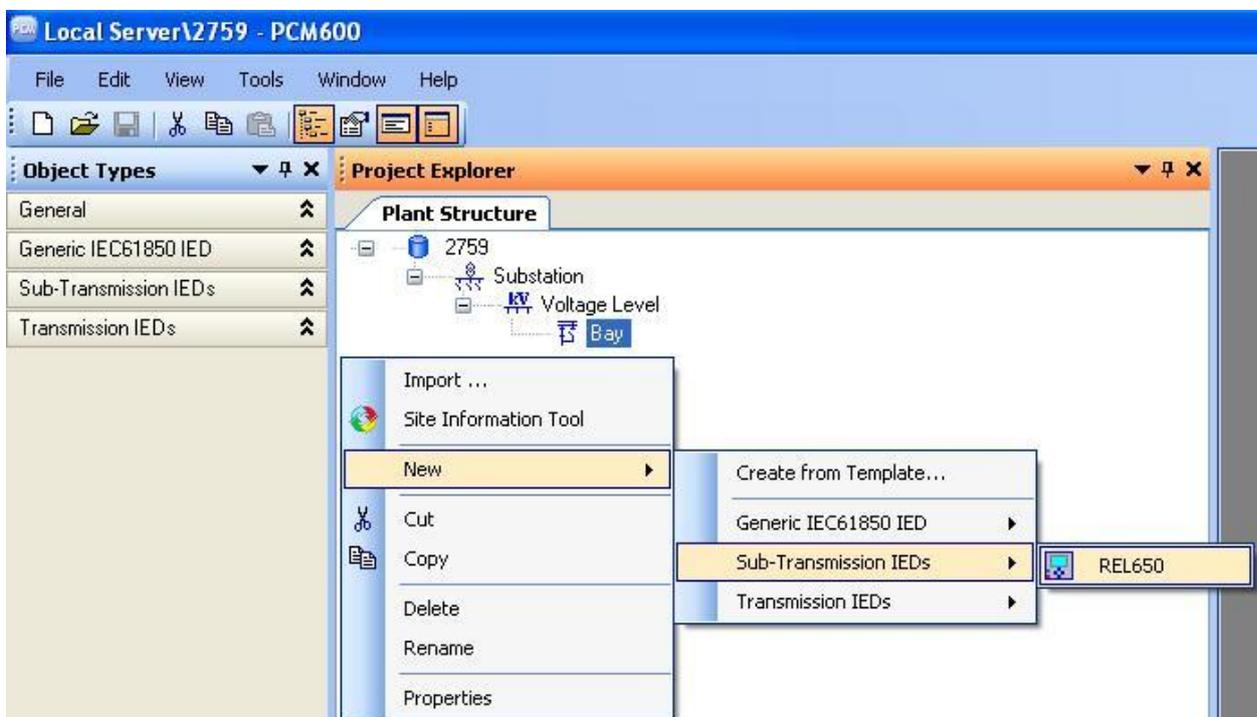


Figure 10

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2.2 Setting up communication

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

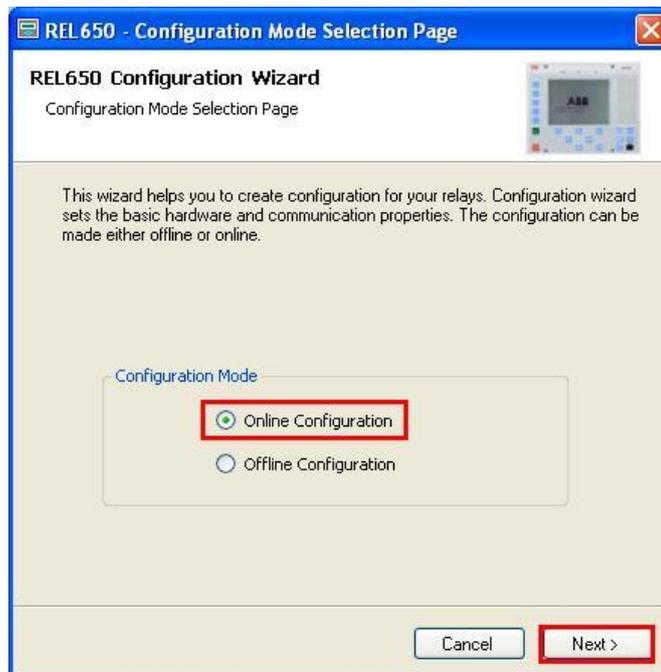


Figure 11

Choose the “*Next >*” option again.

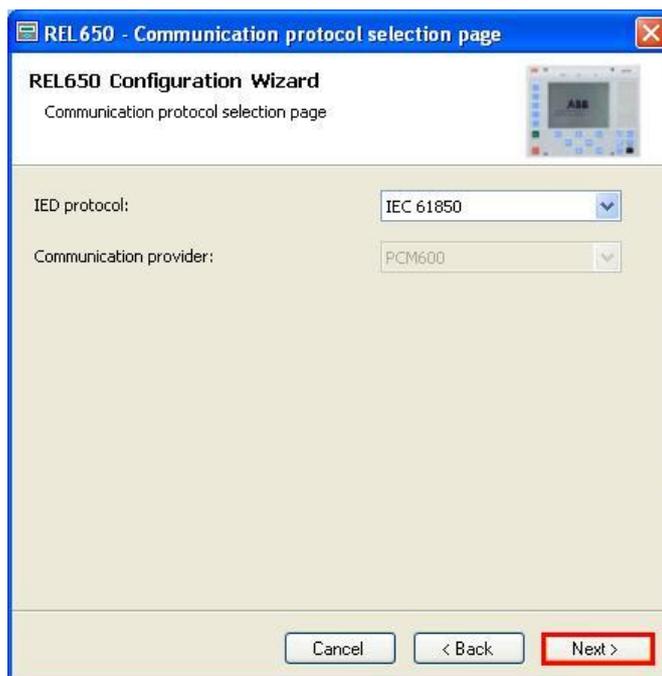


Figure 12

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On the next screen, the user chooses between two options “LANI” or “Front Port”, and 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.

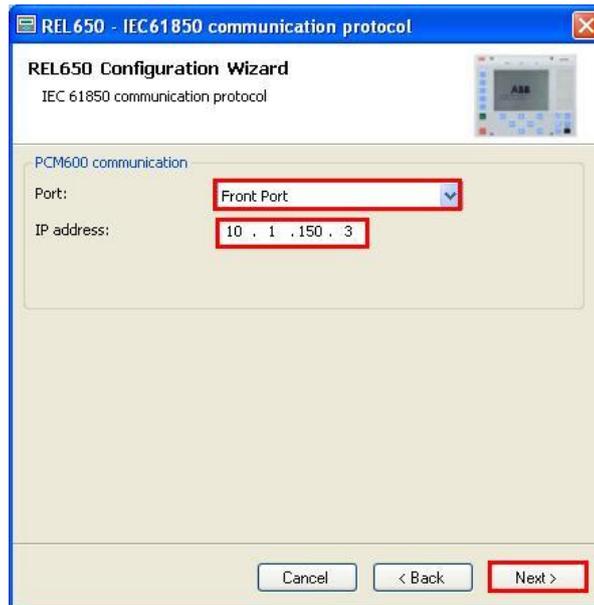


Figure 13

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

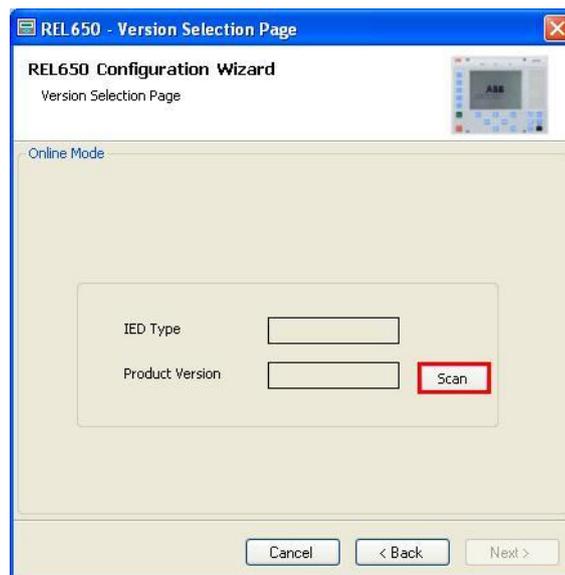


Figure 14

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

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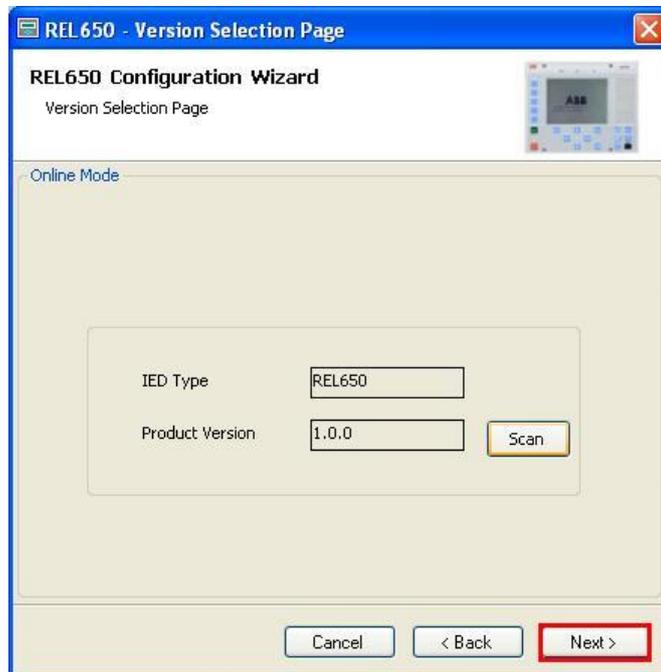


Figure 15

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

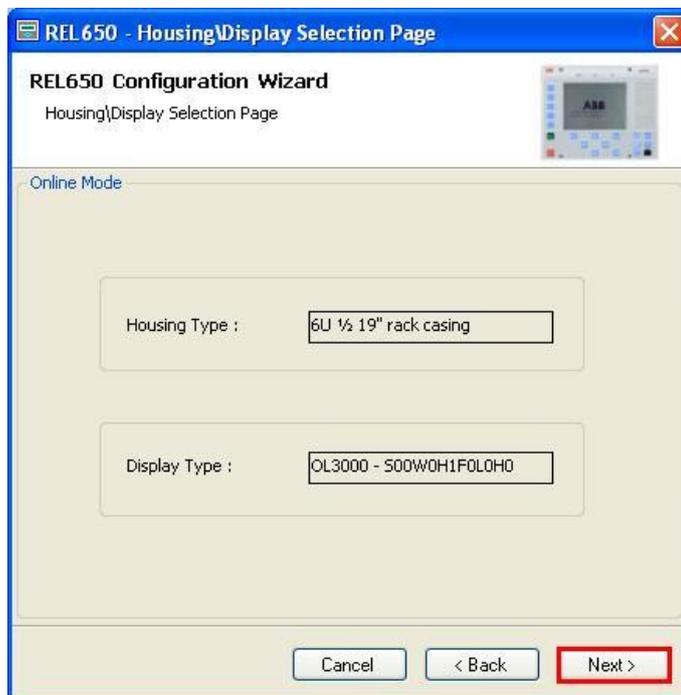


Figure 16

Finally the complete relay information.

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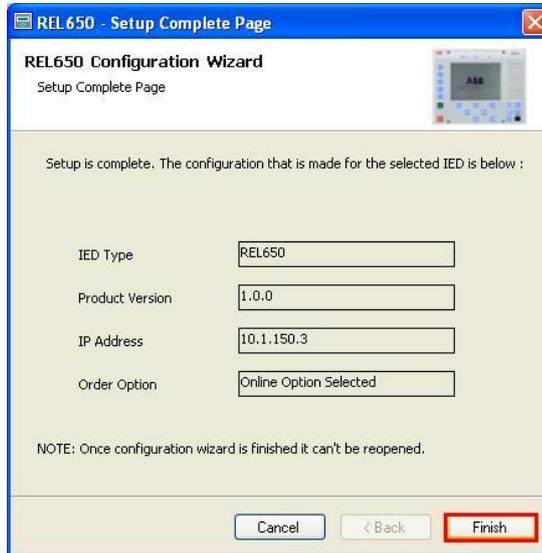


Figure 17

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*”.

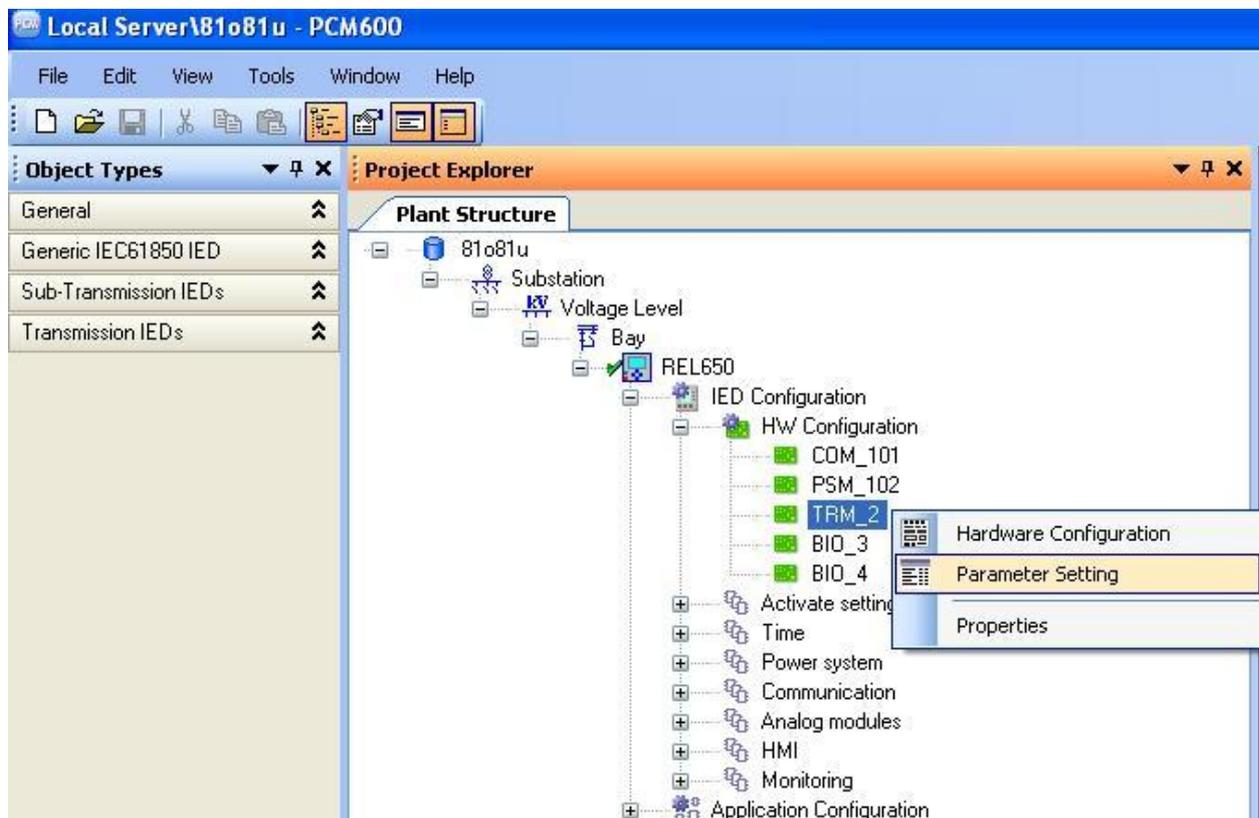


Figure 18

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In this window, the current and voltage transformation relationships must be configured. In this case, only channels 6, 7 and 8 will be configured since the protections to be analyzed are underfrequency and overfrequency.

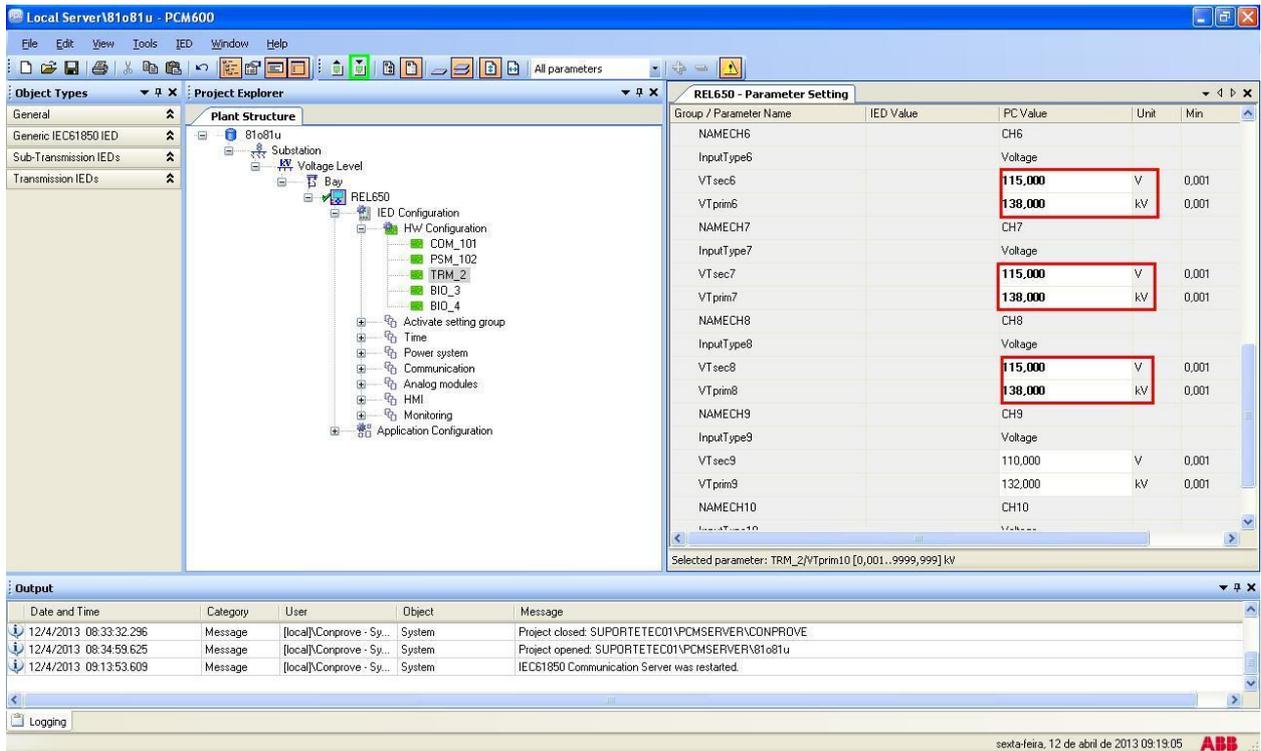


Figure 19

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 20

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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.

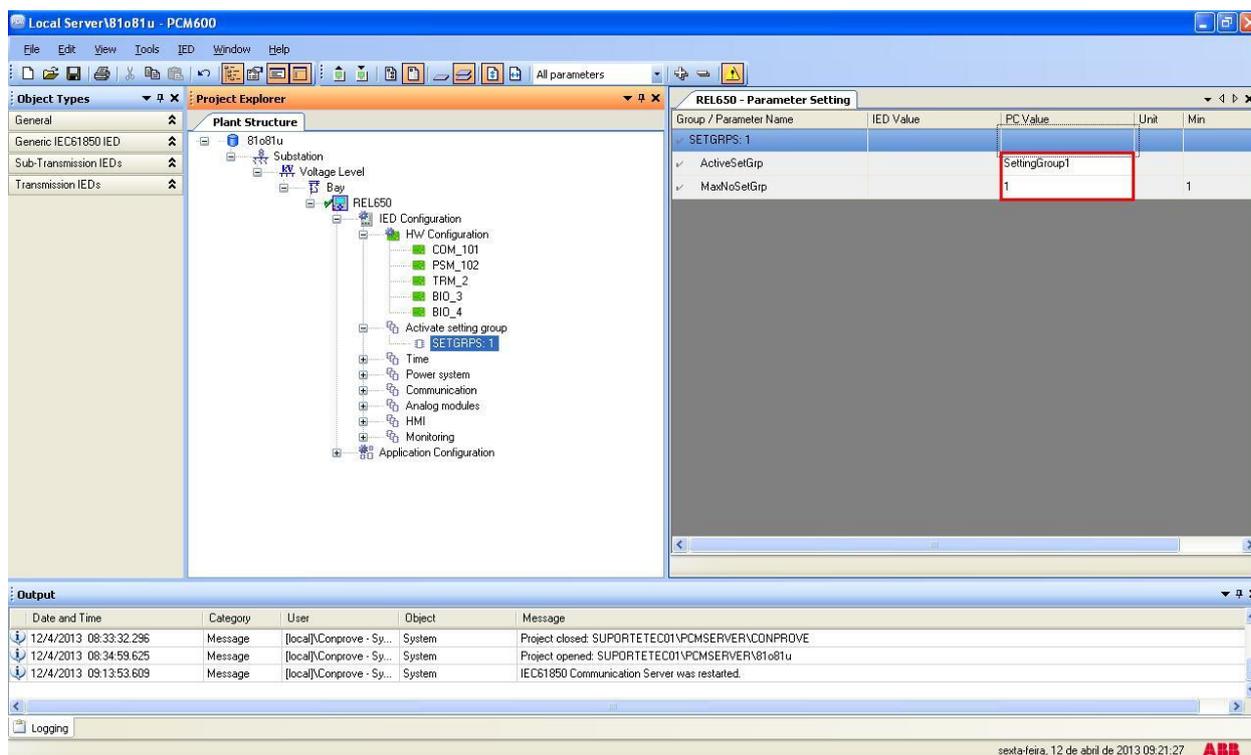


Figure 21

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.

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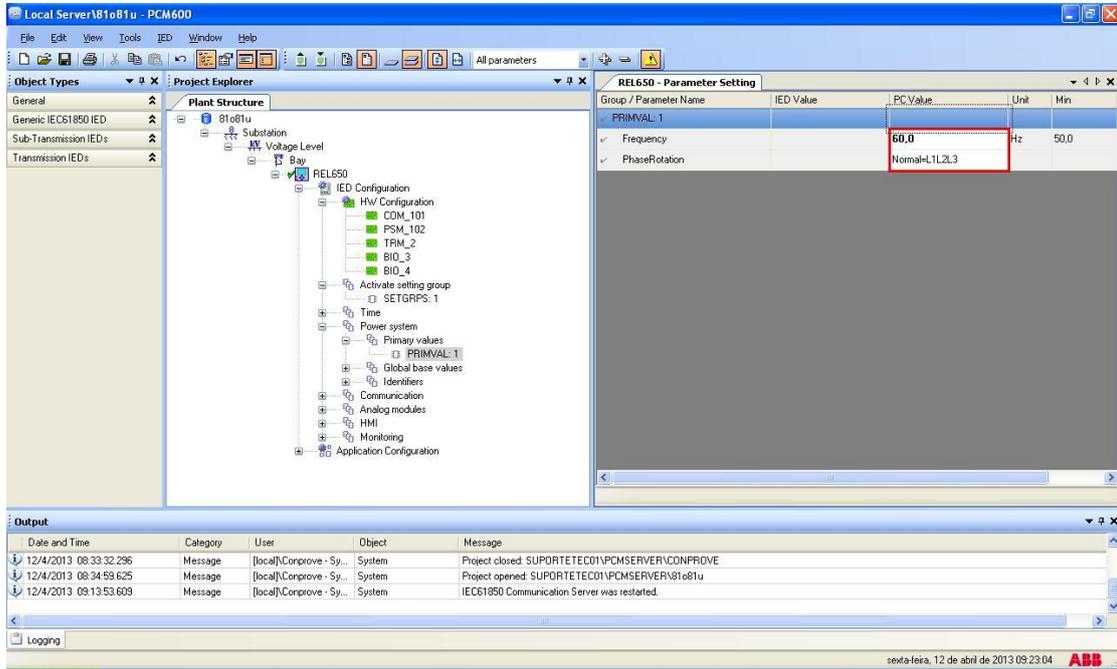


Figure 22

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.

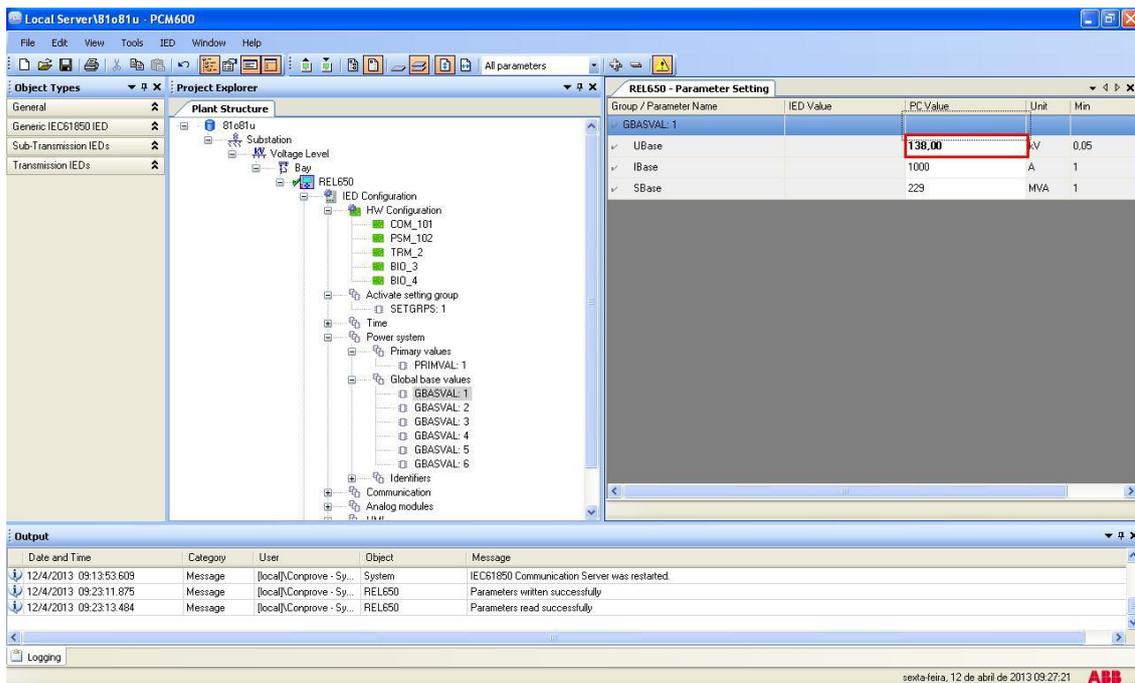


Figure 23

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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.

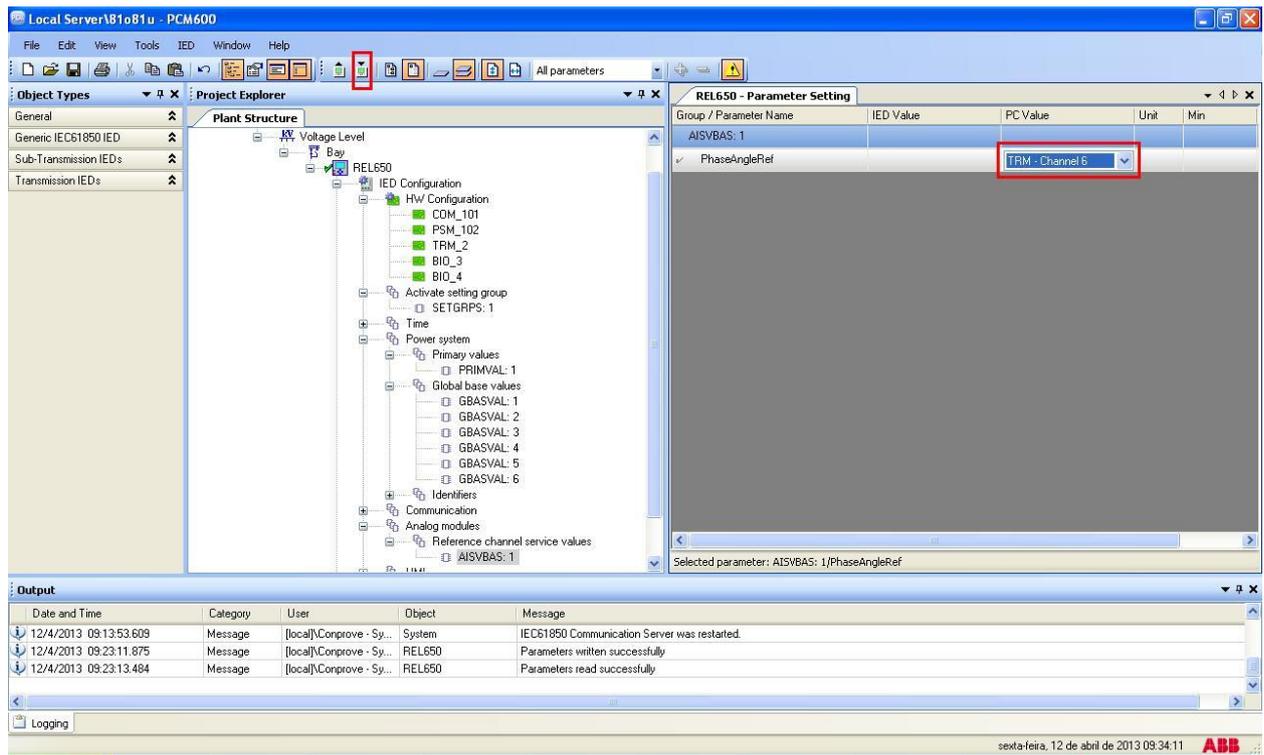


Figure 24

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.

INSTRUMENTOS PARA TESTES ELÉTRICOS

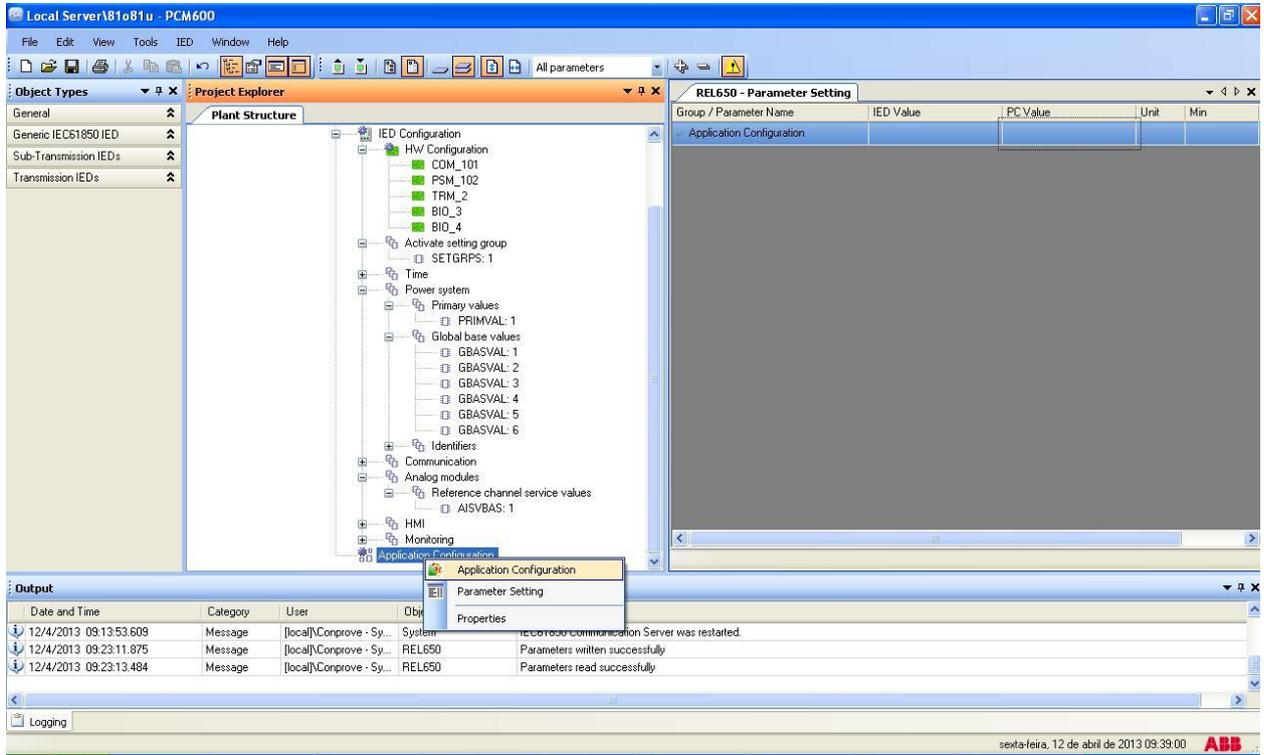


Figure 25

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

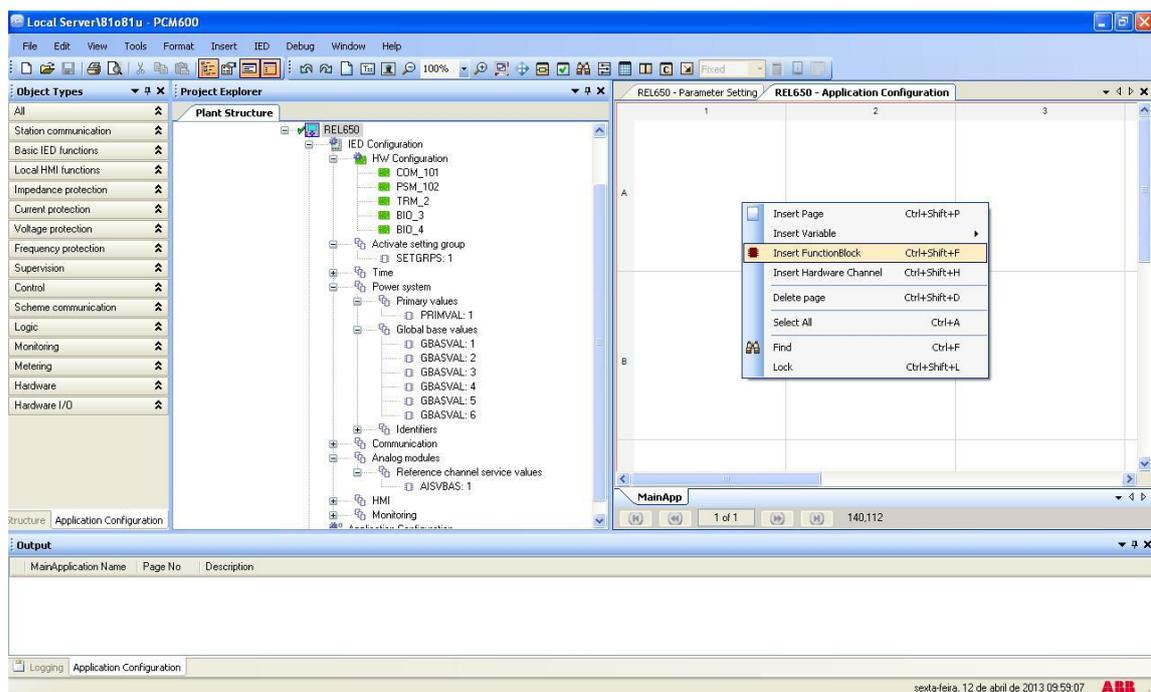


Figure 26

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2.9 SMAI_20_2 (Voltages)

Click on the “+” sign next to “*Basic IED functions*” and insert the “*SMAI_20_2*” block that will be responsible for the voltage channels. To understand the perfect functioning of the different blocks, consult the REL650 manual.

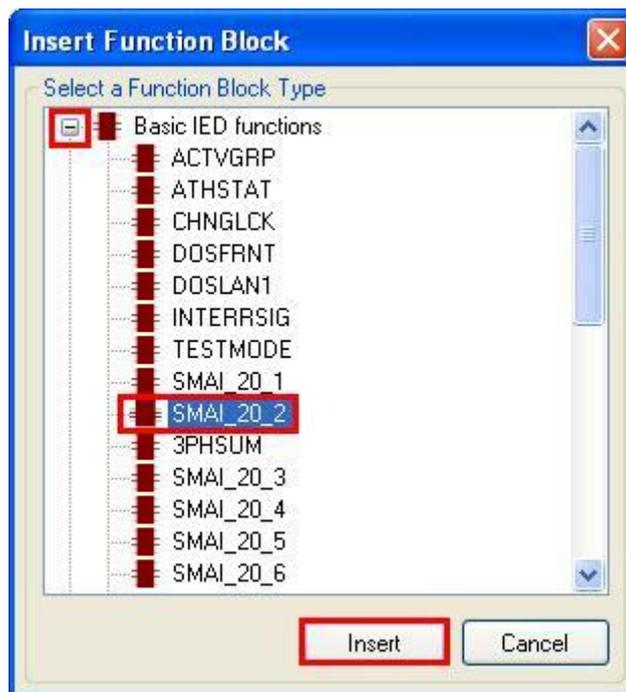


Figure 27

On the next screen, set the “*Cycle Time*” to 20.

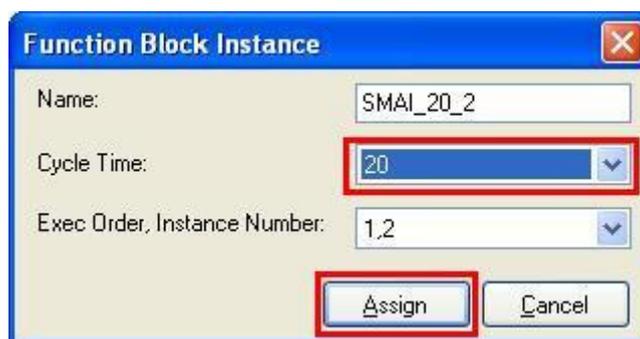


Figure 28

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

INSTRUMENTOS PARA TESTES ELÉTRICOS

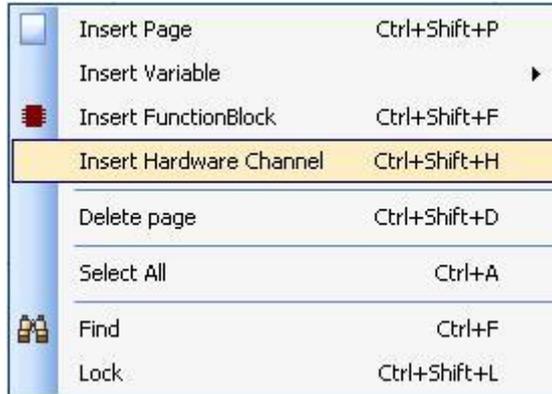


Figure29

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



Figure 30

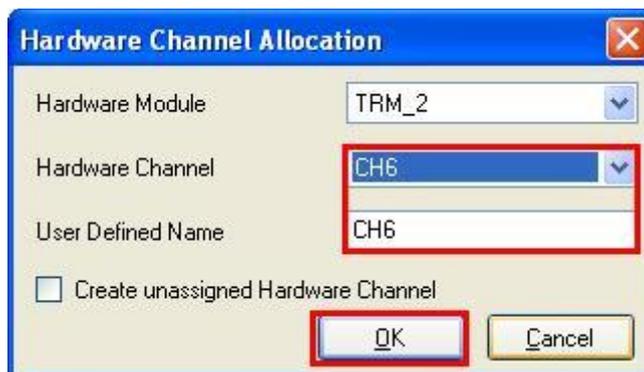


Figure 31

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Repeat the procedure of the previous 3 figures changing the option of “*Hardware Channel*” to CH7 and CH8. Then make the links with the blocks.

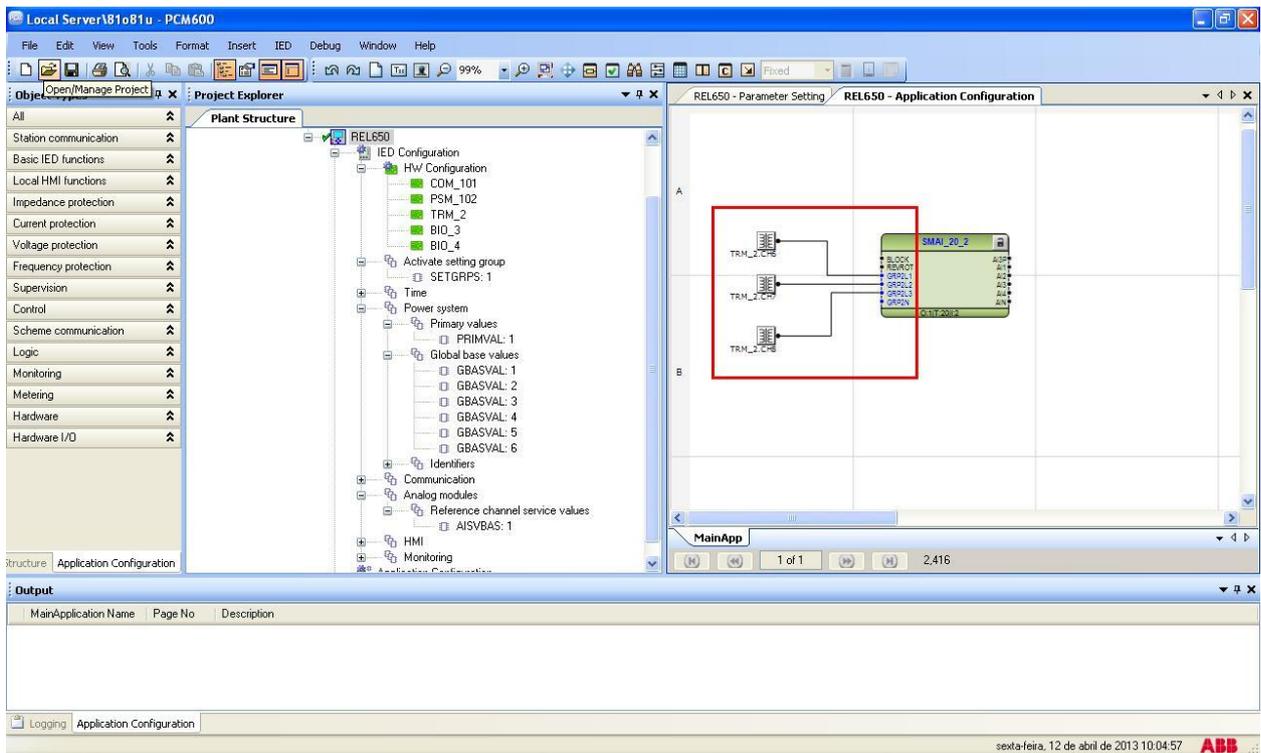


Figure 32

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

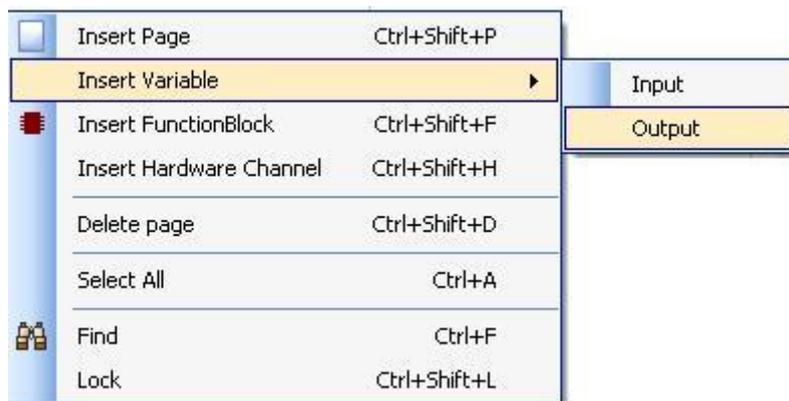


Figure 33

Choose a name for this variable, in this case “*AI3P_TP_20ms*” and connect with the output “*AI3P*”.

INSTRUMENTOS PARA TESTES ELÉTRICOS

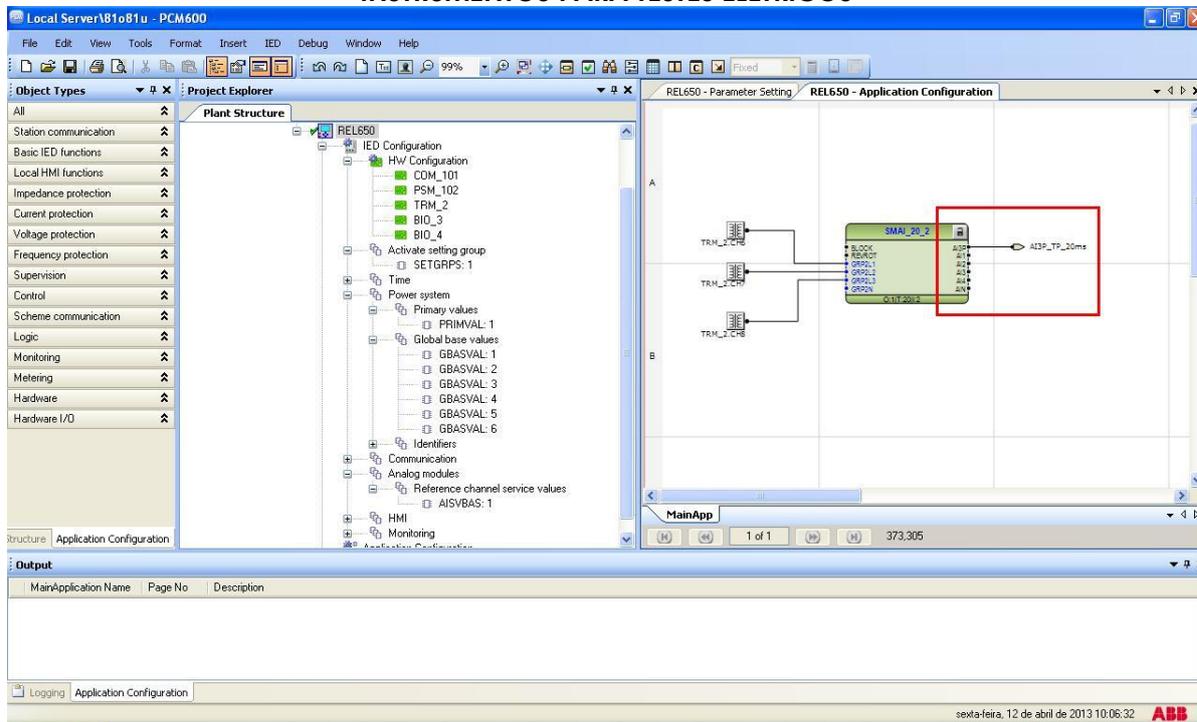


Figure 34

Clicking on the icon highlighted in green and on the “MainApp” tab changes the name of the tab to “CANALIS_TENSÃO”, for example.

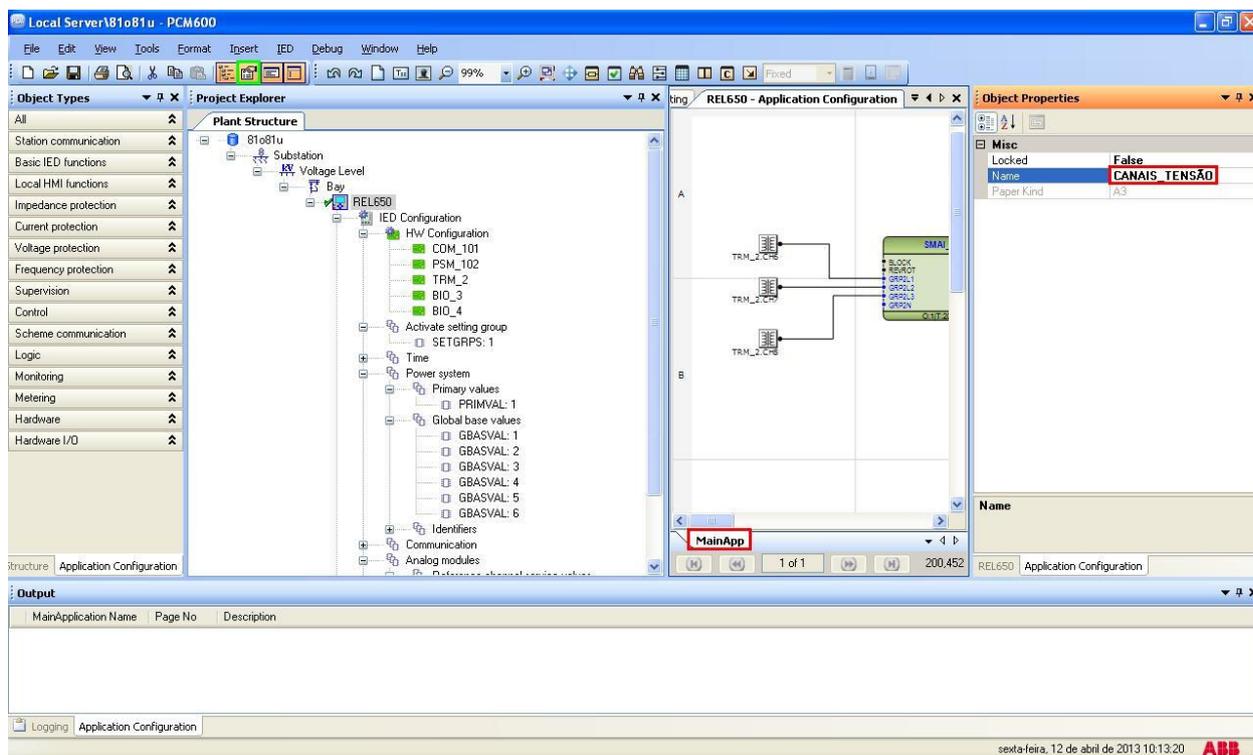


Figure 35

INSTRUMENTOS PARA TESTES ELÉTRICOS

Close the “*Object Properties*” window and insert a new tab to create the overfrequency function block.

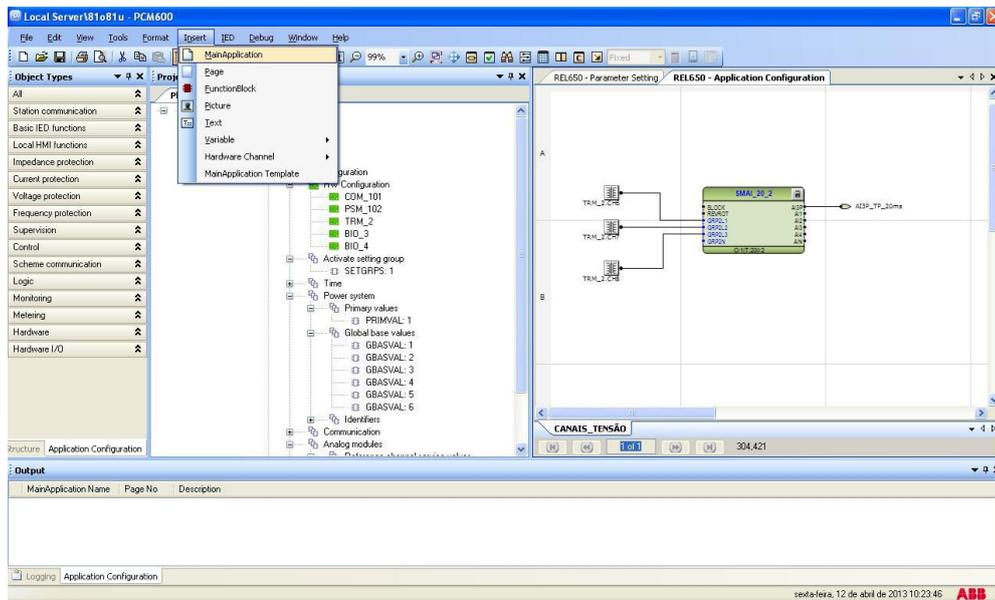


Figure 36

2.10 *SAPTOF (Overfrequency)*

Right-click on the new tab, choose the “*Insert Function Block*” option, click on the “+” sign next to “*Frequency protection*” and finally choose the “*SAPTOF*” block. On the next screen (not shown) click on “*Assign*”.

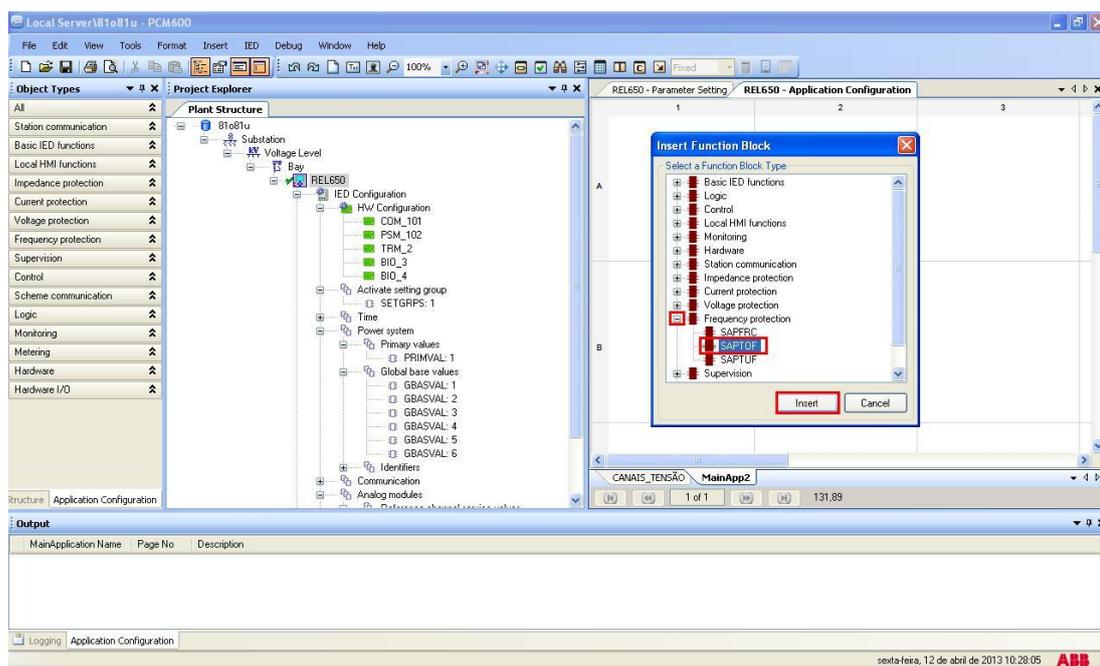


Figure 37

INSTRUMENTOS PARA TESTES ELÉTRICOS

Insert an input variable using the same name given for the output in figure 34 and connect with the voltage input. Create an output variable and use the following nomenclature.

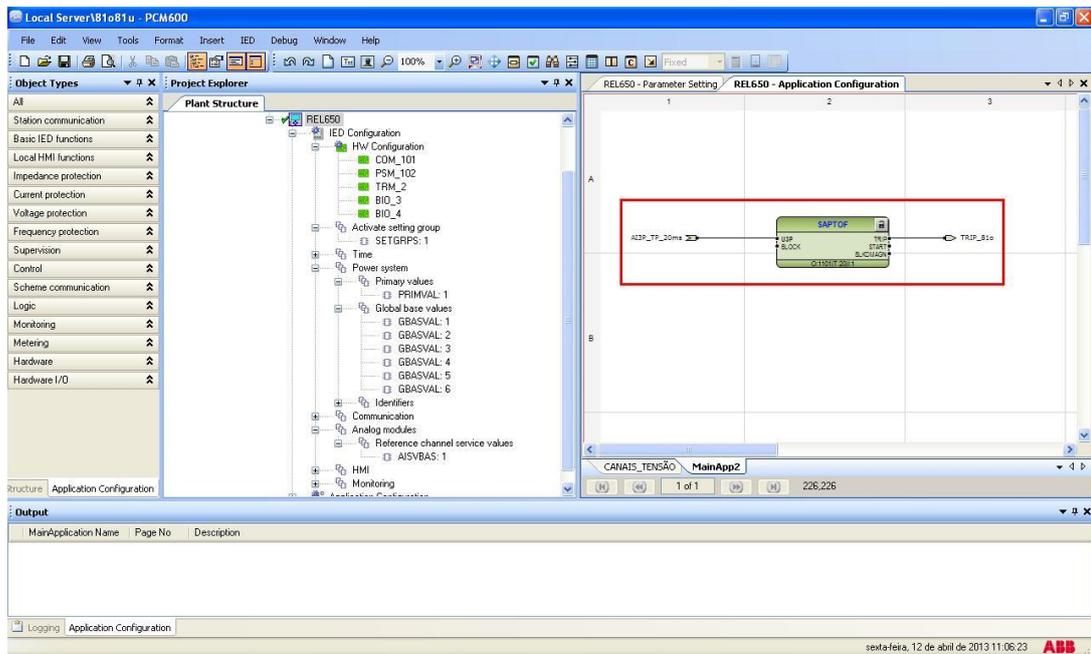


Figure 38

Change the tab name to “SOBREFREQUÊNCIA”.

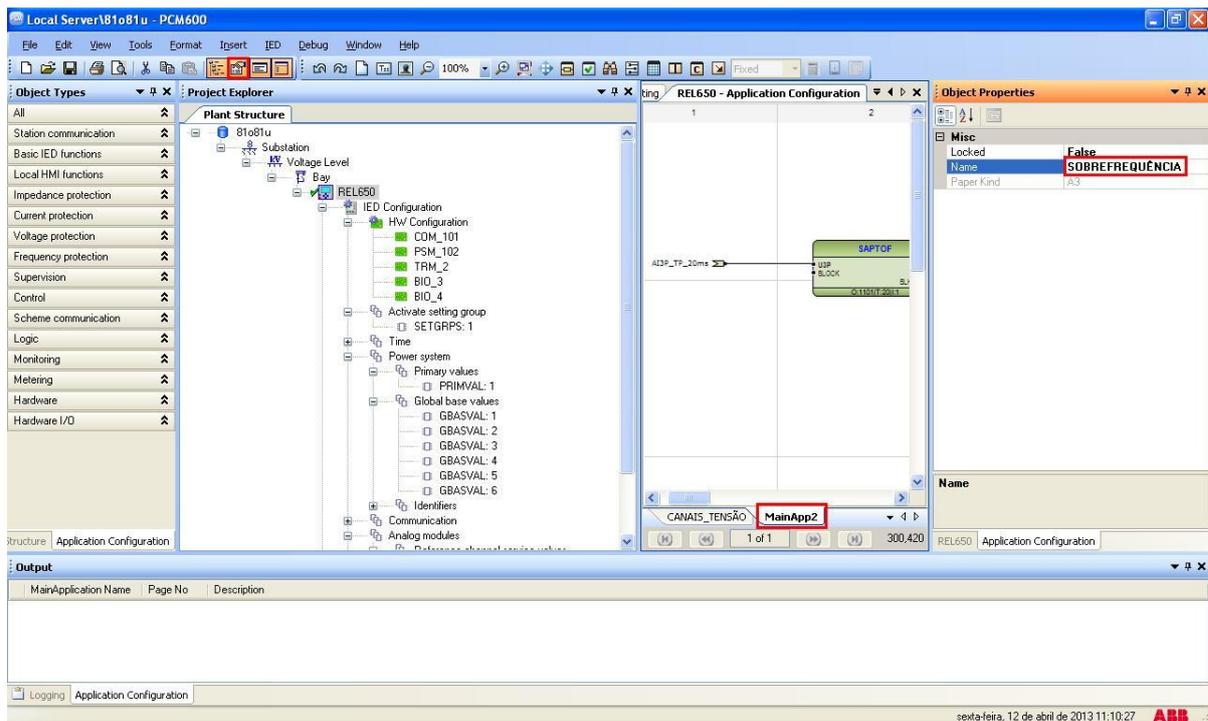


Figure 39

INSTRUMENTOS PARA TESTES ELÉTRICOS

Close the “*Object Properties*” window and insert a new tab to create the underfrequency function block.

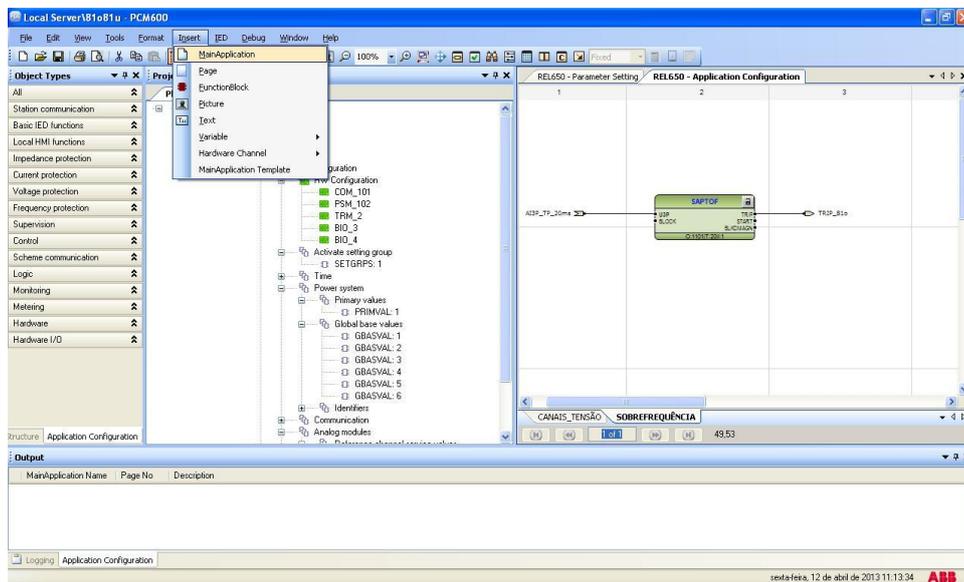


Figure 40

2.11 *SAPTUF (Underfrequency)*

Right-click on the new tab, choose the “*Insert Function Block*” option, click on the “+” sign next to “*Frequency protection*” and finally choose the “*SAPTUF*” block. On the next screen (not shown) click on “*Assign*”.

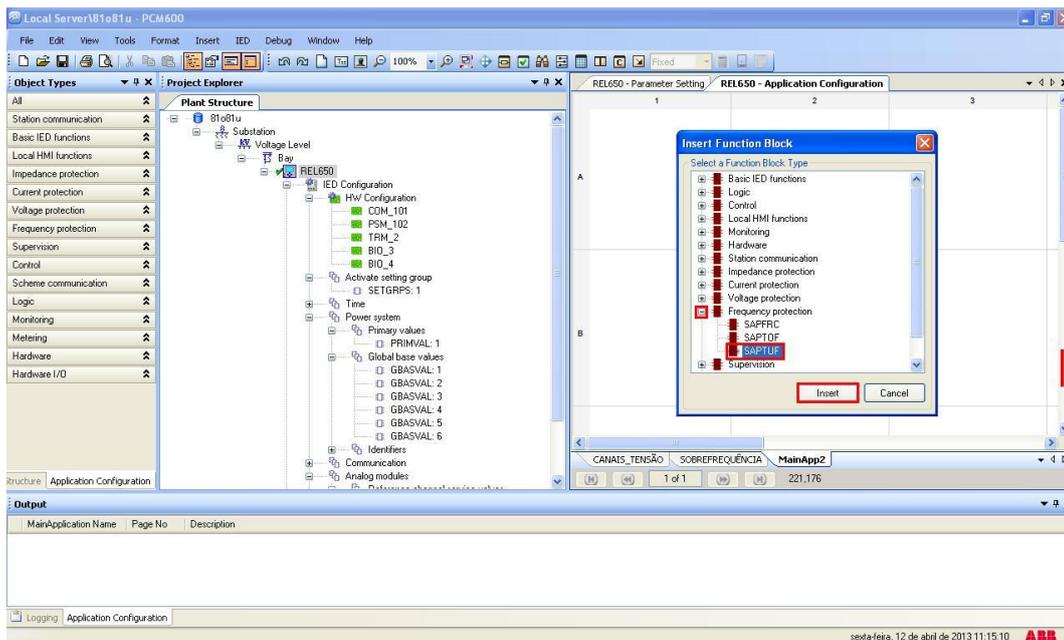


Figure 41

INSTRUMENTOS PARA TESTES ELÉTRICOS

Insert an input variable using the same name given for the output in figure 34 and connect with the voltage input. Create an output variable and use the following nomenclature.

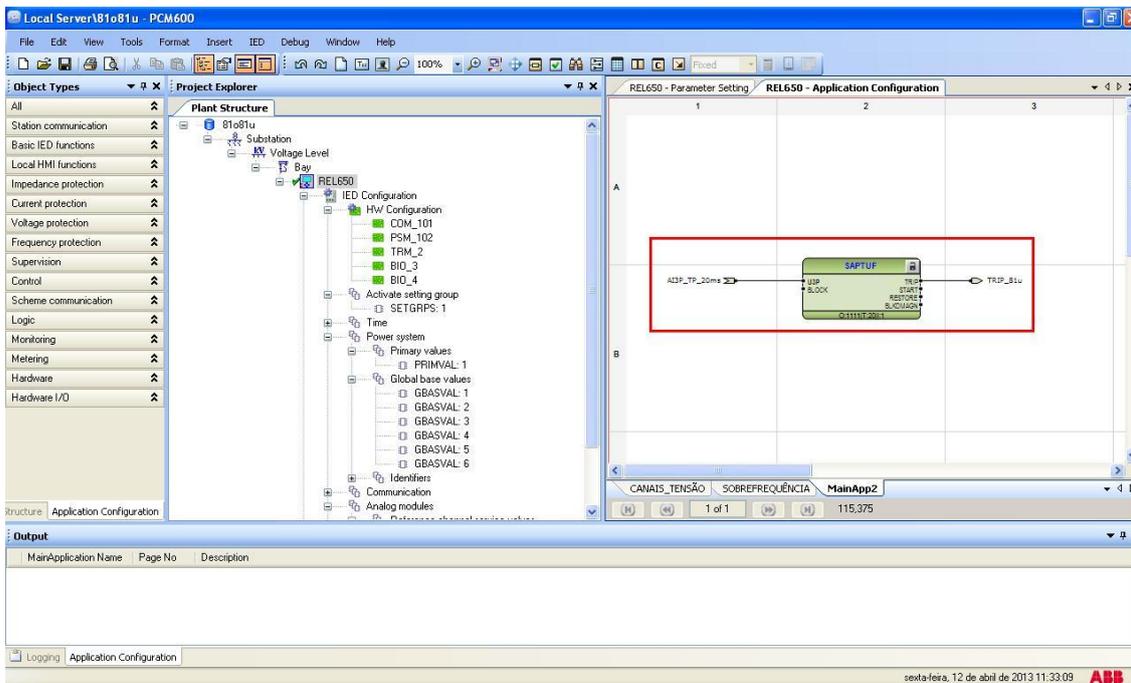


Figure 42

Change the tab name to “SUBFREQUÊNCIA”.

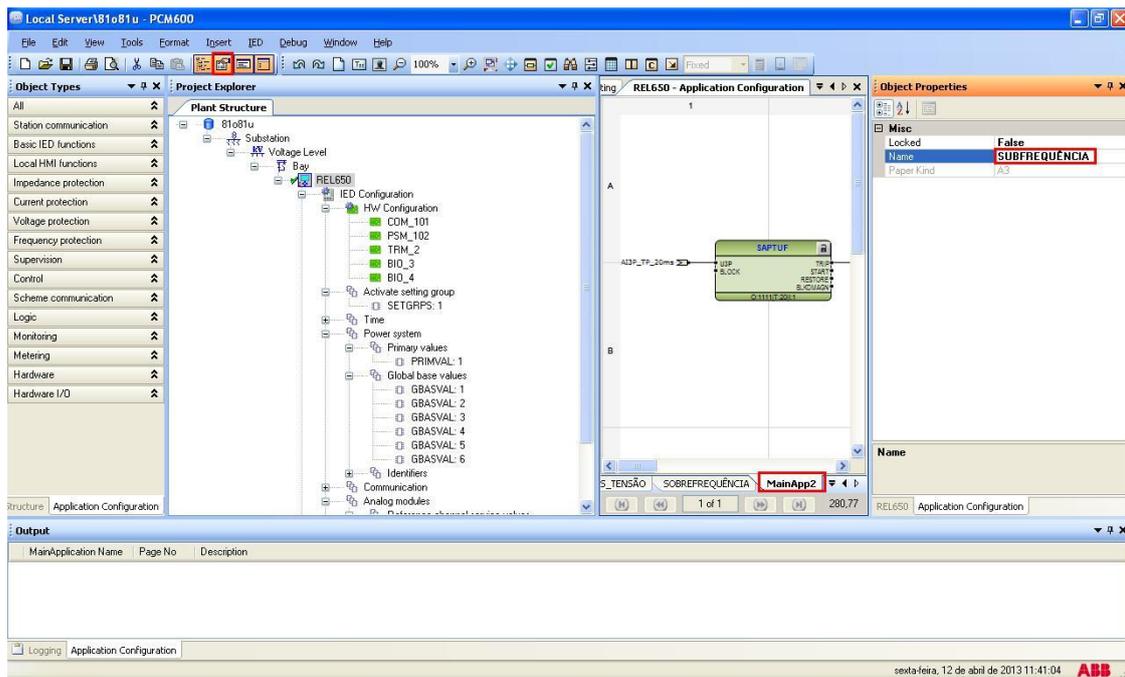


Figure 43

2.12 Binary Outputs

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

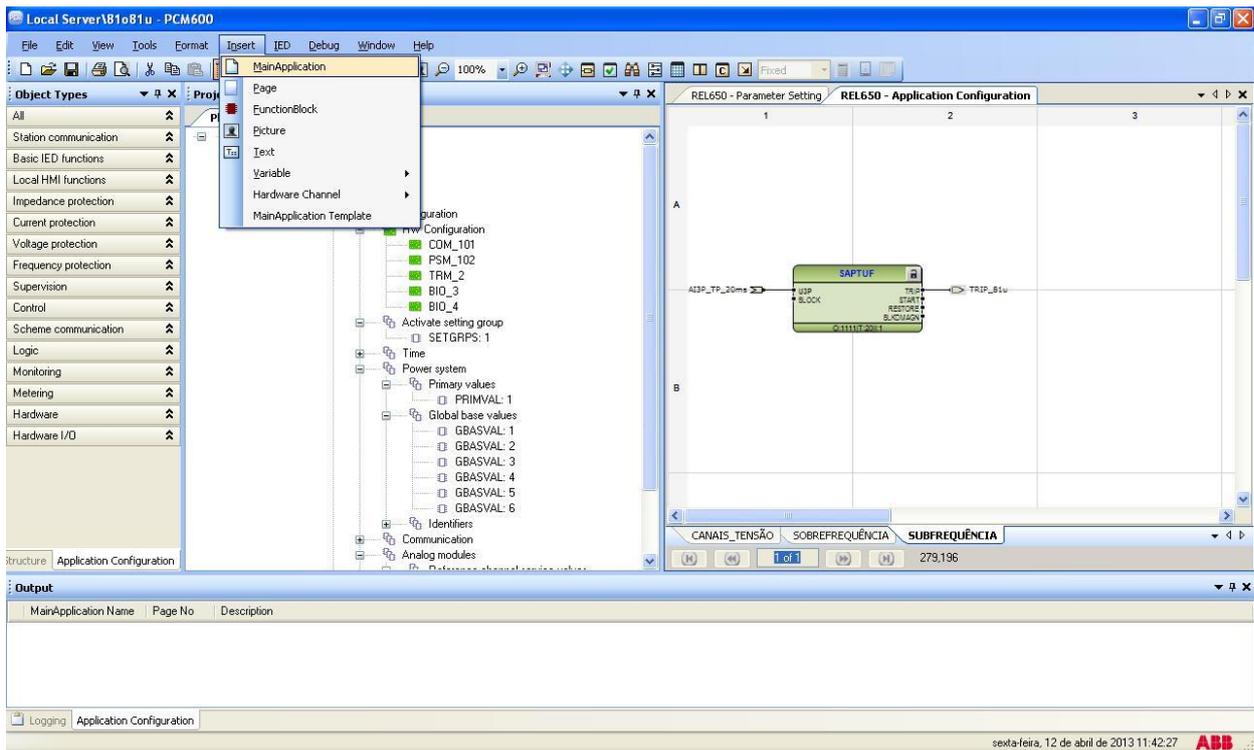


Figure 44

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

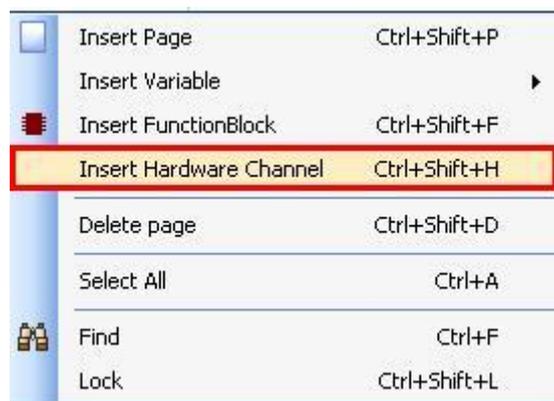


Figure 45

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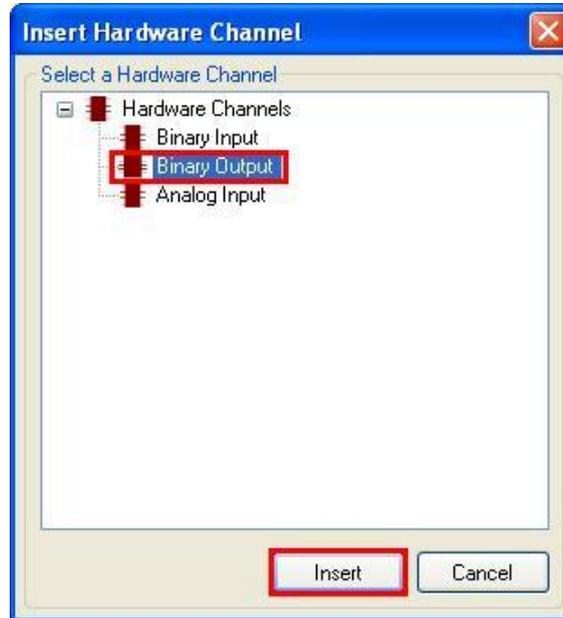


Figure 46

The next step is to choose the channel module “*PSM_102*” and the binary output “*BO4*”.

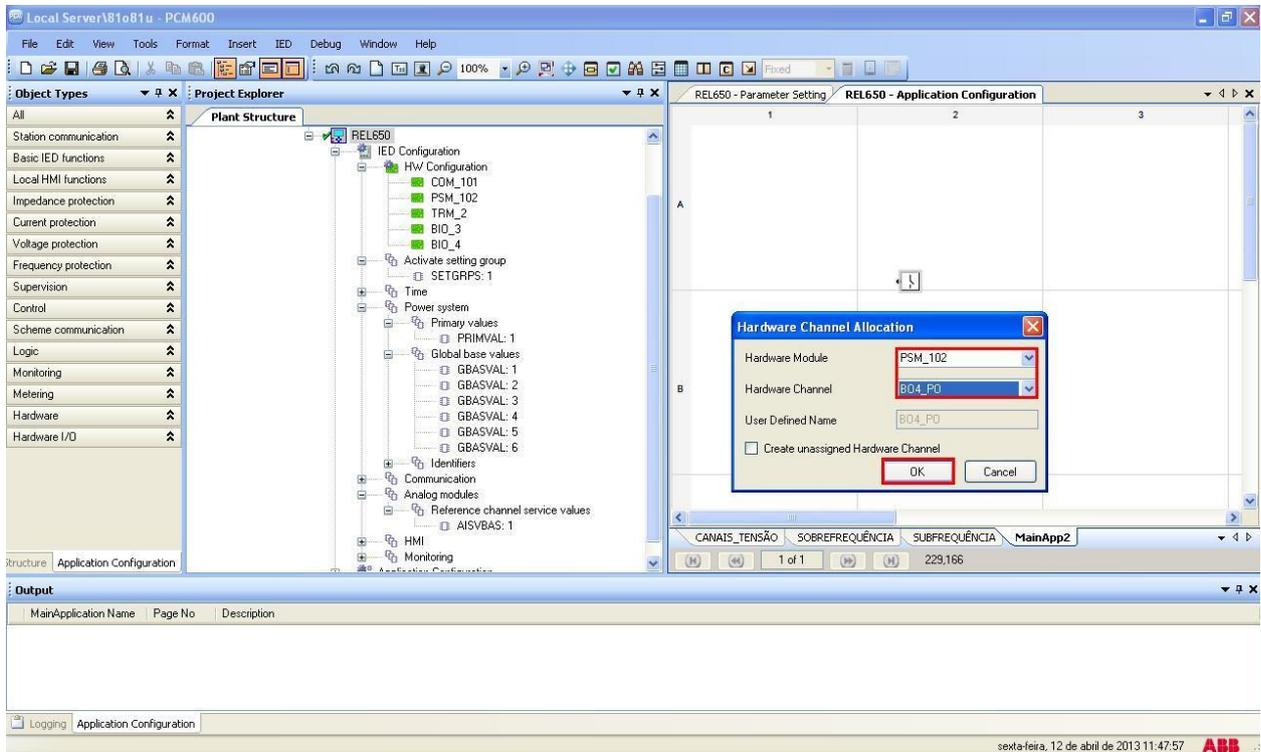


Figure 47

Insert one more output keeping the “*PSM_102*” module and changing the outputs to “*BO5*”.

INSTRUMENTOS PARA TESTES ELÉTRICOS

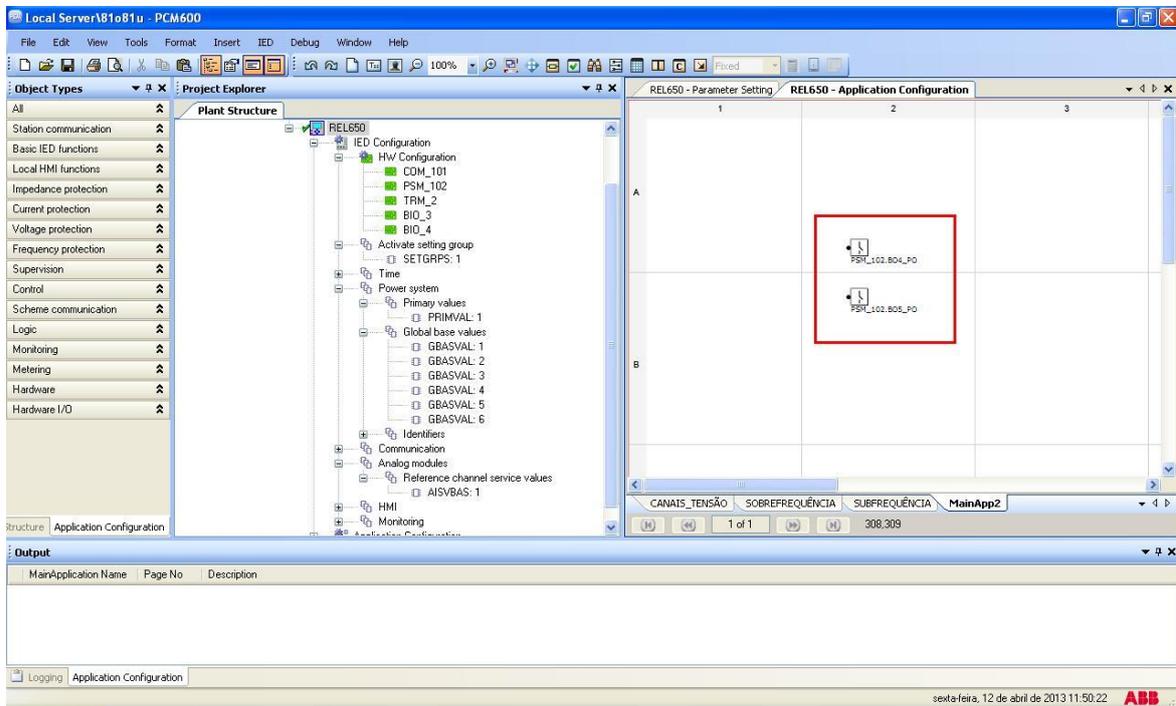


Figure 48

Create two input variables using the same names as the output variables of the overfrequency and underfrequency blocks and assign them to each binary output. Change the name of the tab to “SAÍDAS_BINÁRIAS”.

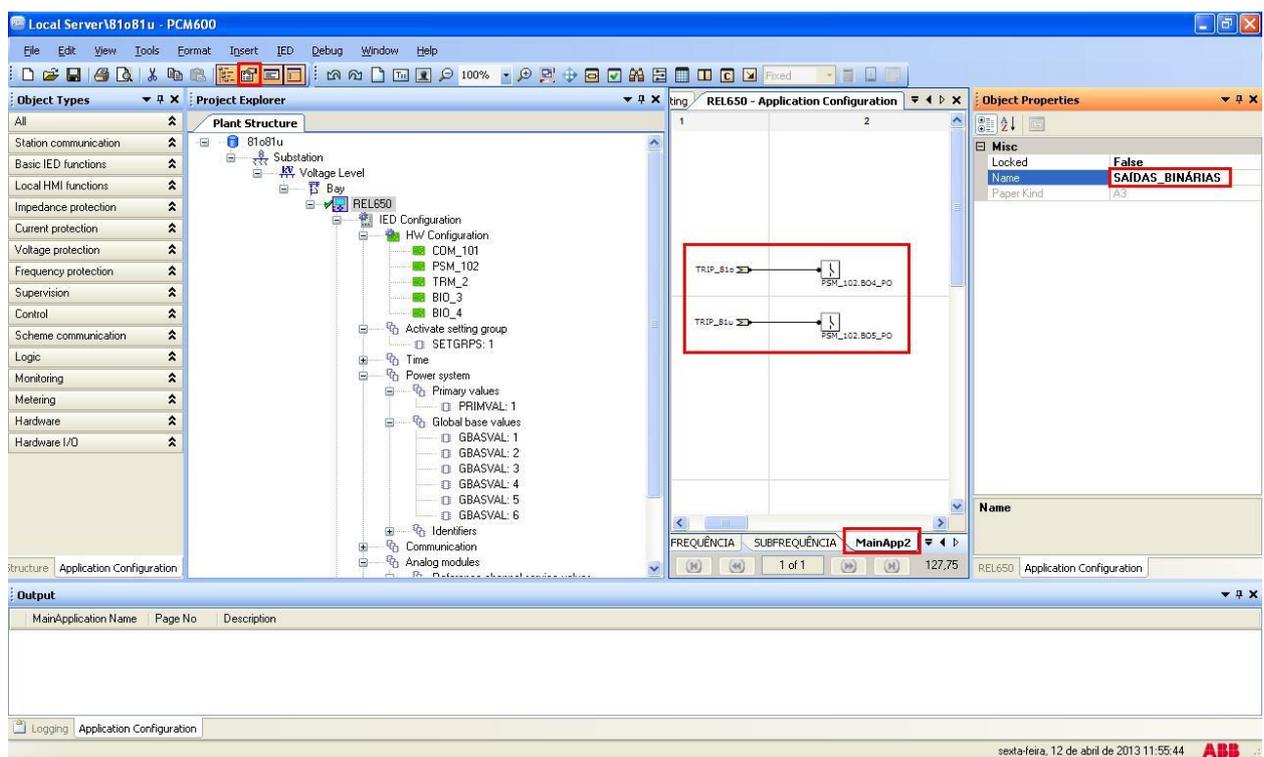


Figure 49

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

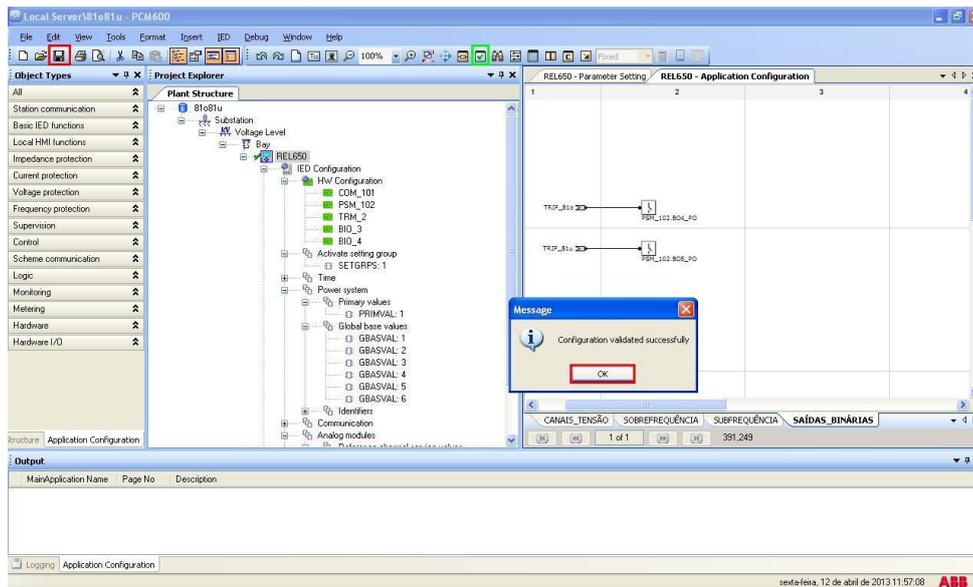


Figure 50

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 next to “Application Configuration > SOBREFREQUÊNCIA > Frequency” and finally “SAPTOF:1”.

INSTRUMENTOS PARA TESTES ELÉTRICOS

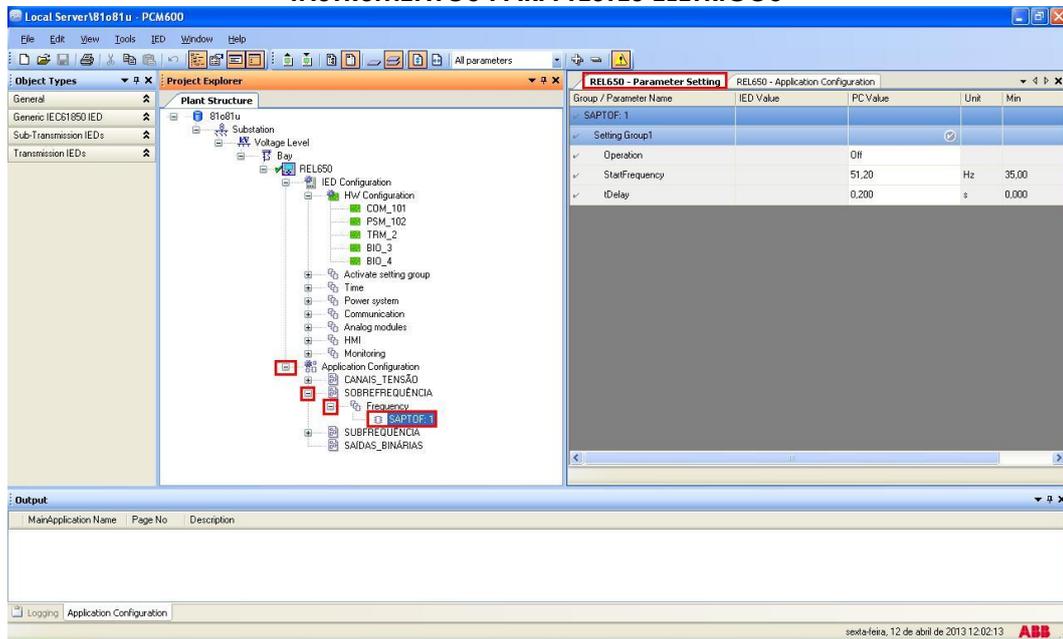


Figure 51

Activate the function and set as pick-up value 62.0Hz with operating time of 1.0 second.

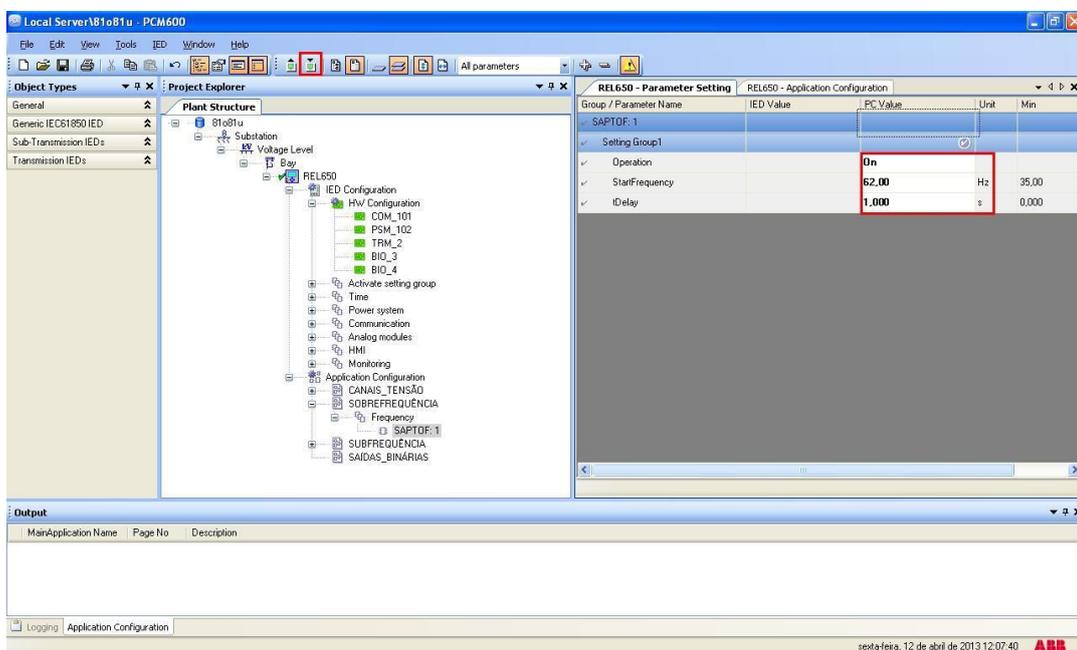


Figure 52

Click on the “+” sign next to “*SUBFREQUÊNCIA > frequency*” and finally “*SAPTUF:1*”.

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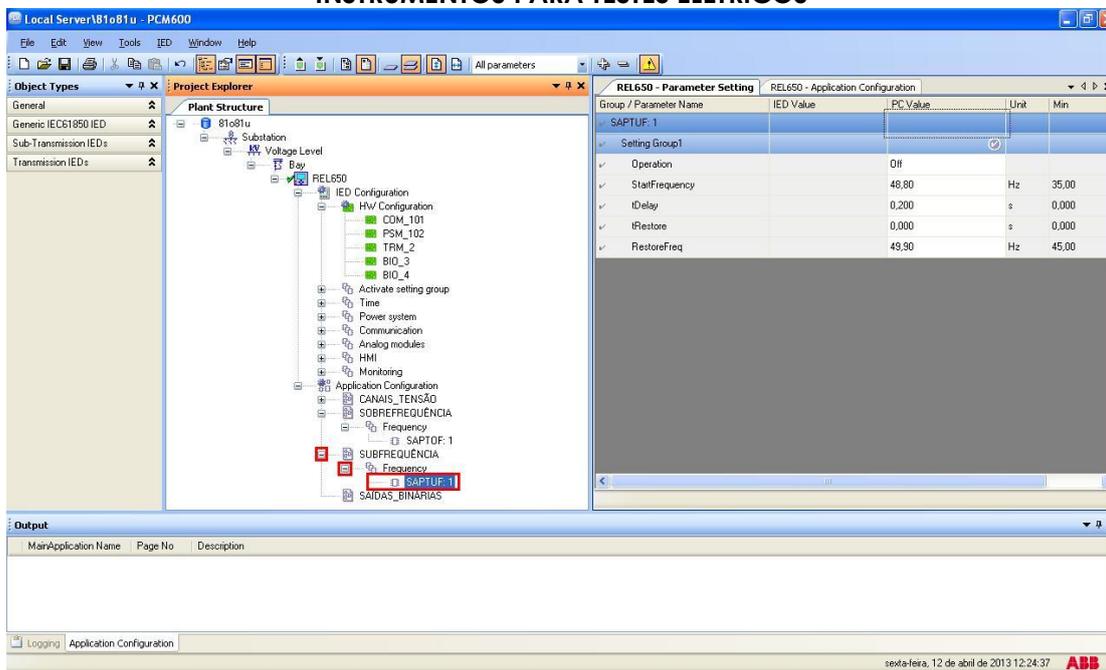


Figure 53

Activate the function and set as pick-up value 58.00Hz with operating time of 1.0 second.

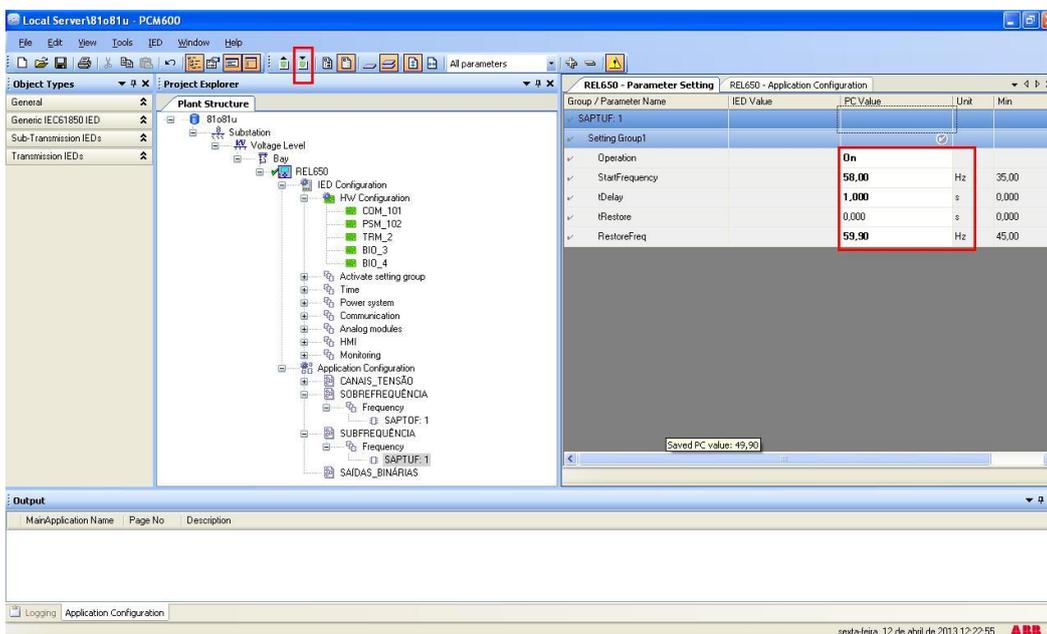


Figure 54

Right-click on the relay icon and submit the changes. In the following message click on “Yes”.

INSTRUMENTOS PARA TESTES ELÉTRICOS

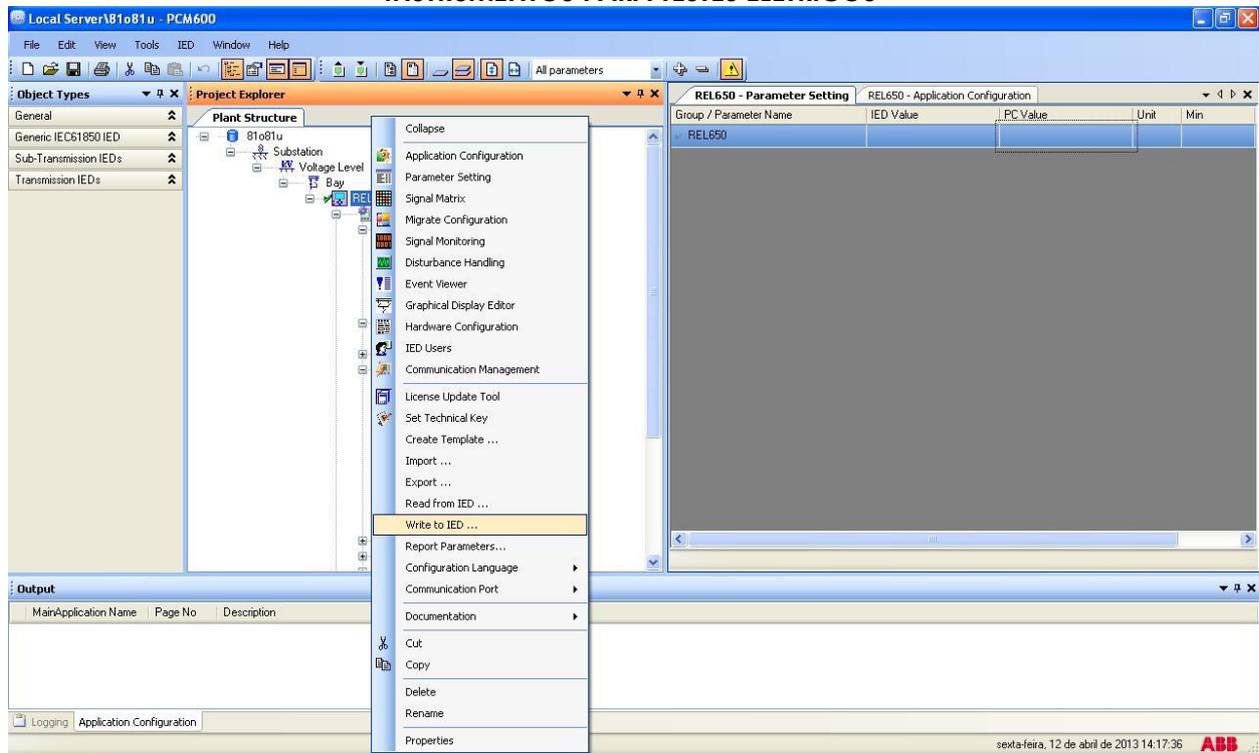


Figure 55

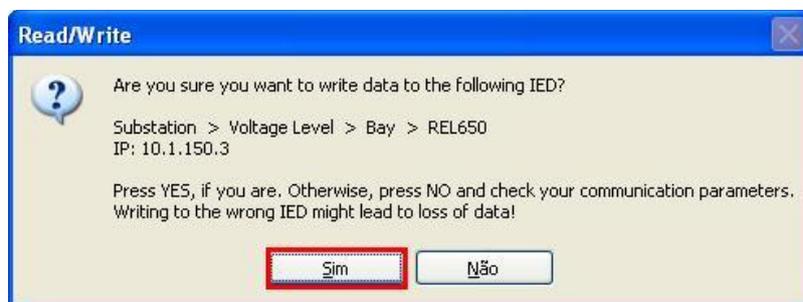


Figure 56

4. Ramp software adjustments

4.1 Opening the ramp

Click on the “CTC” application manager icon.



Figure 57

Click on the “Ramp” software icon.

INSTRUMENTOS PARA TESTES ELÉTRICOS



Figure 58

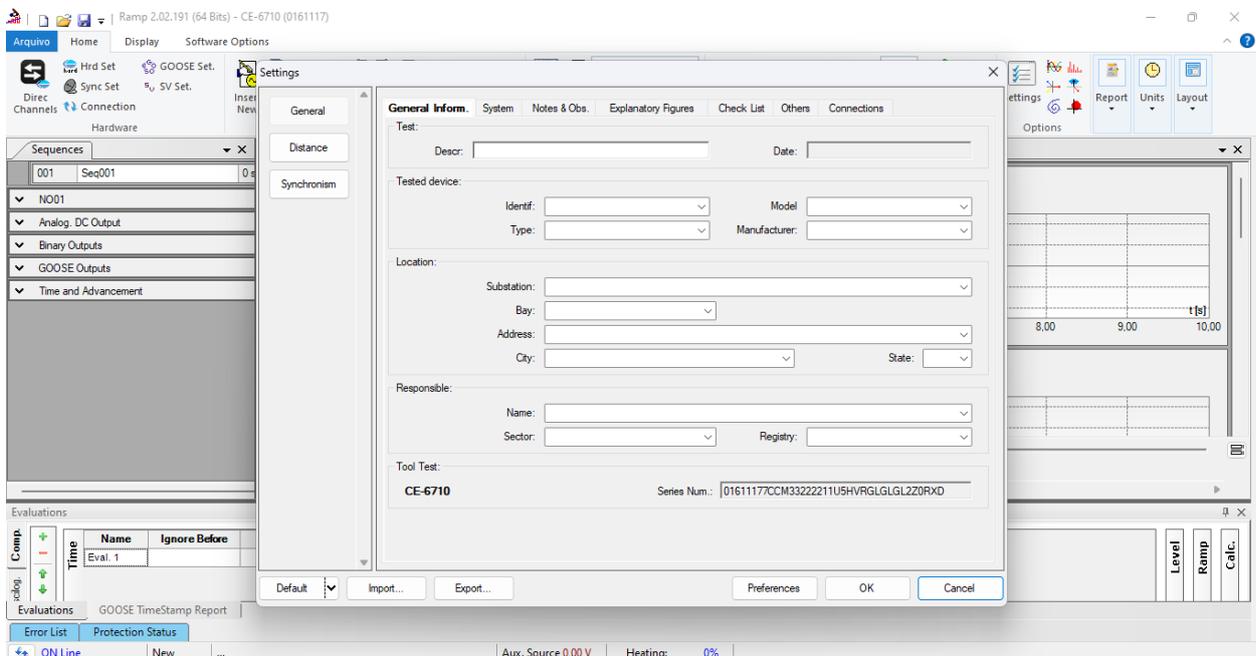


Figure 59

4.2 Configuring the Settings

When opening the software, the “Settings” screen will open automatically (as long as the “Open Settings when Starting” option found in the “Software Options” menu is selected). Otherwise click directly on the “Settings” icon.

INSTRUMENTOS PARA TESTES ELÉTRICOS

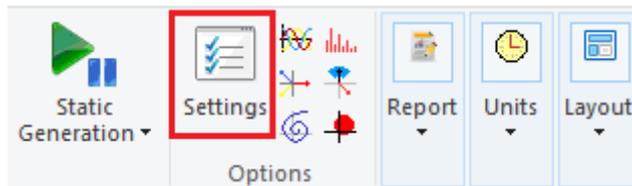


Figure 60

Inside the “Settings” screen, fill in the “General Inform.” with data on the “Tested device”, “Location” and the “Responsible”. This facilitates the elaboration of the report and this tab will be the first page to be shown in the report.

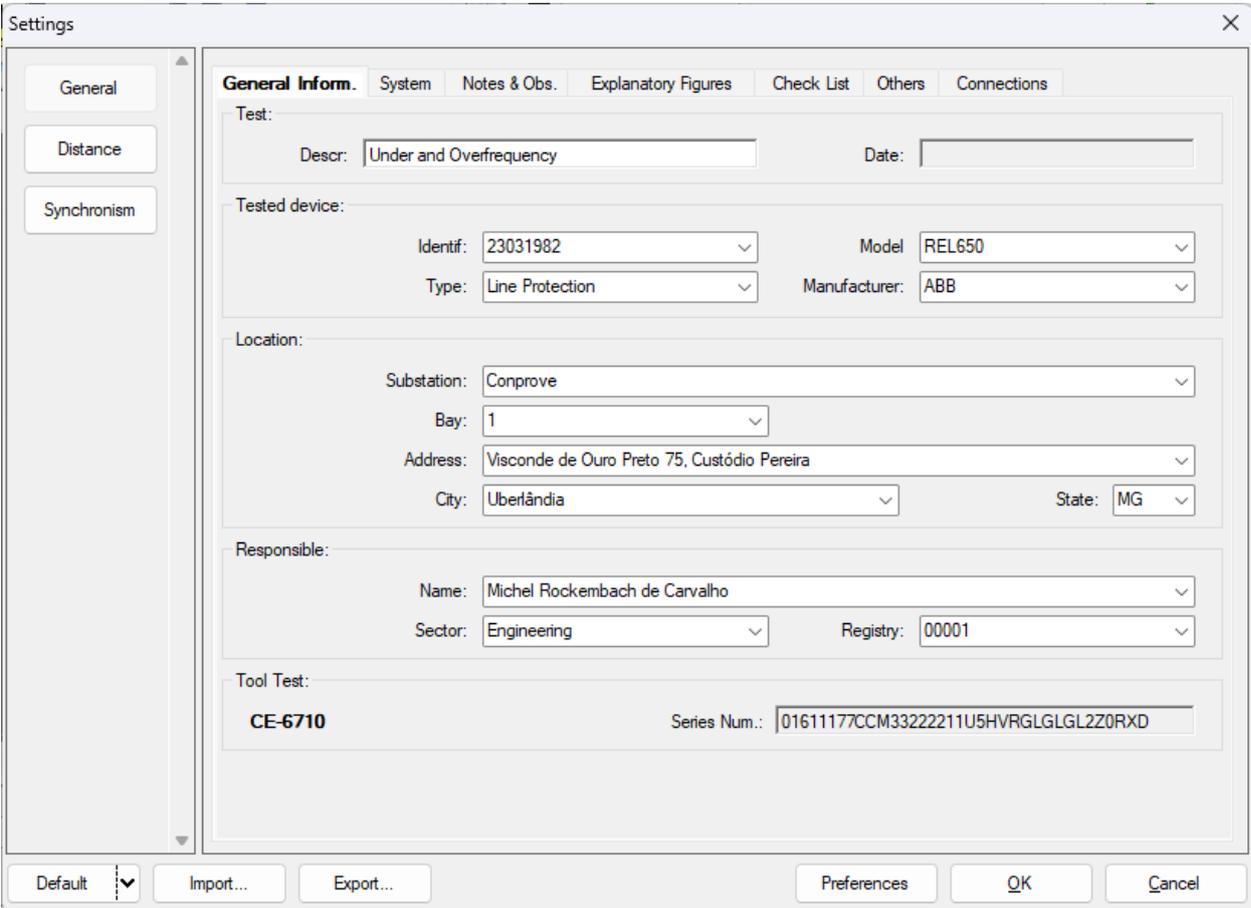


Figure 61

4.3 System

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

INSTRUMENTOS PARA TESTES ELÉTRICOS

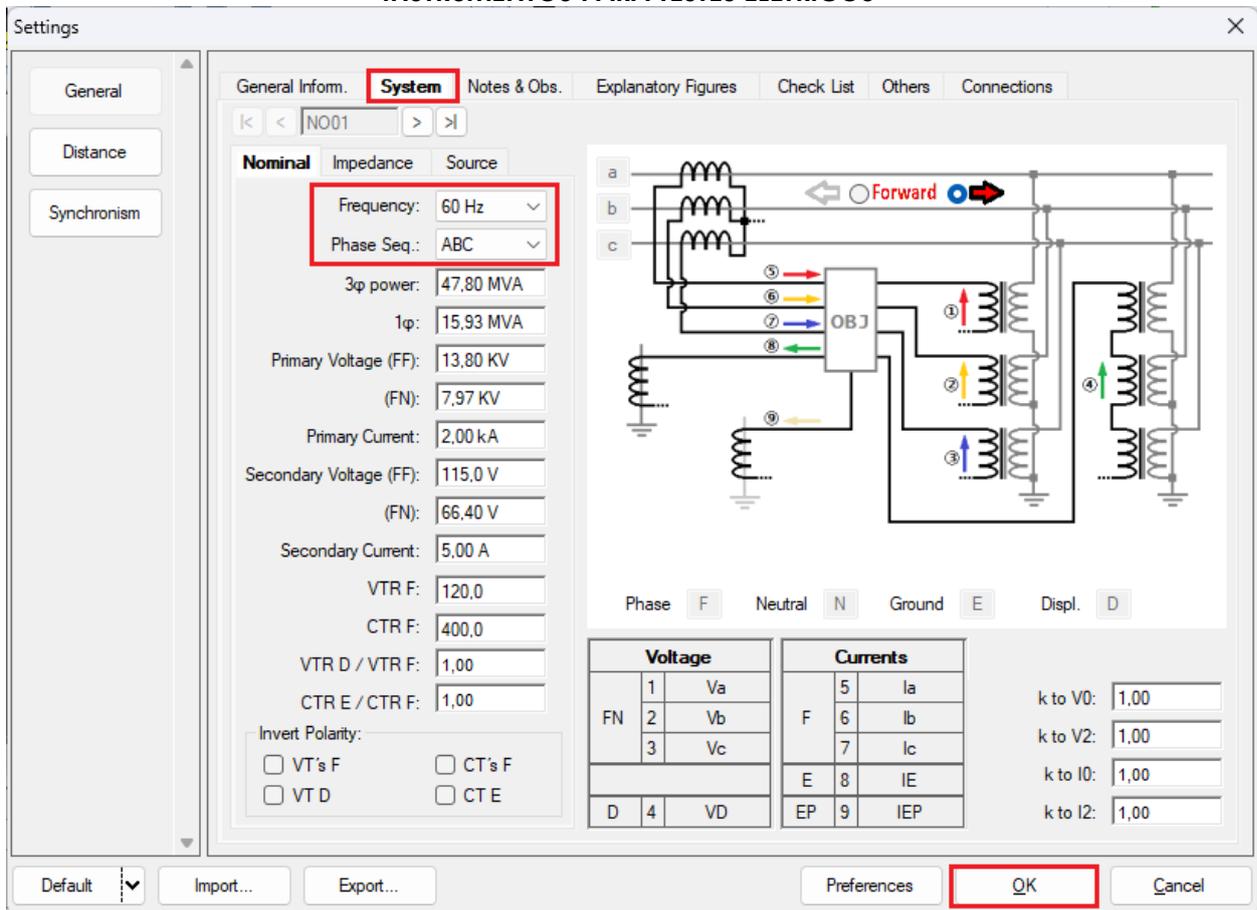


Figure 62

There are other tabs where the user can insert “Notes & Obs., Explanatory Figures”, can create a “Check List” of the procedures for carrying out tests and also create a schematic with all the connections between the test set and the test equipment.

5. Channel Direction and Hardware Configurations

Click on the icon illustrated below.

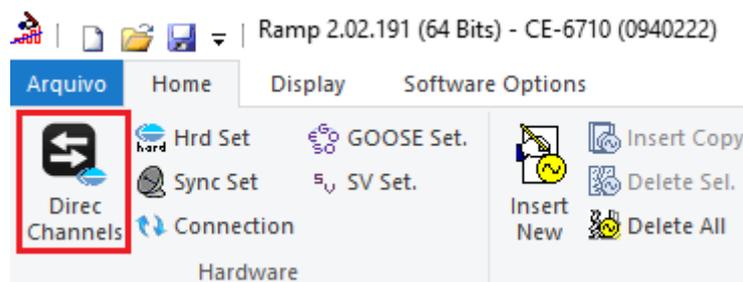


Figure 63

Then click on the highlighted icon to configure the hardware.

INSTRUMENTOS PARA TESTES ELÉTRICOS

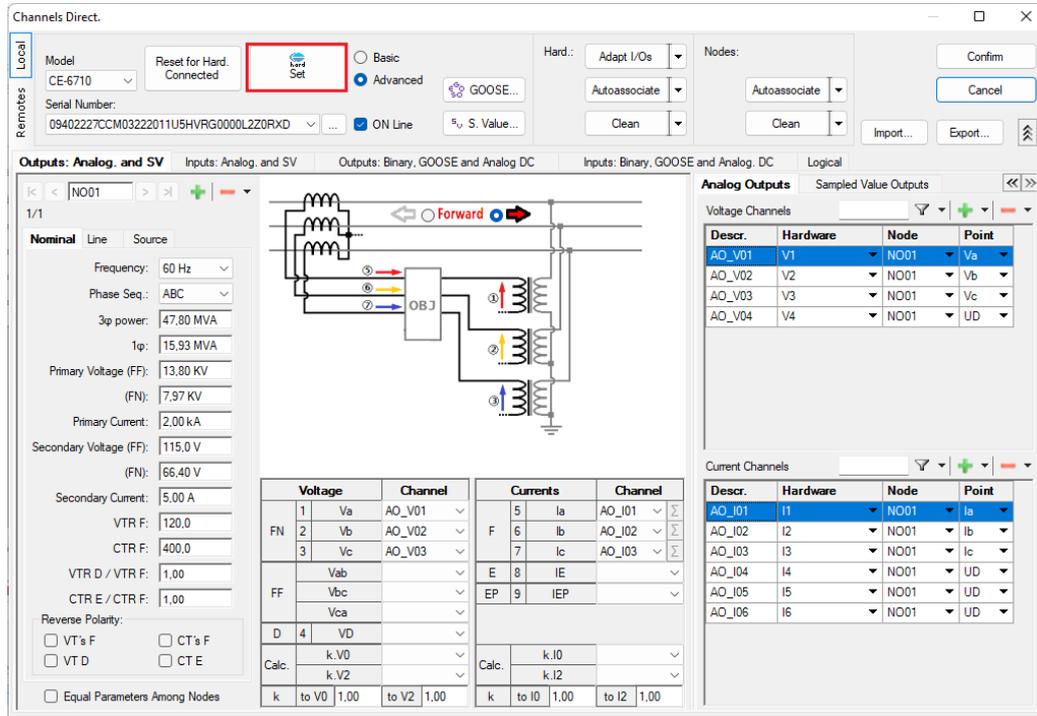


Figure 64

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

INSTRUMENTOS PARA TESTES ELÉTRICOS

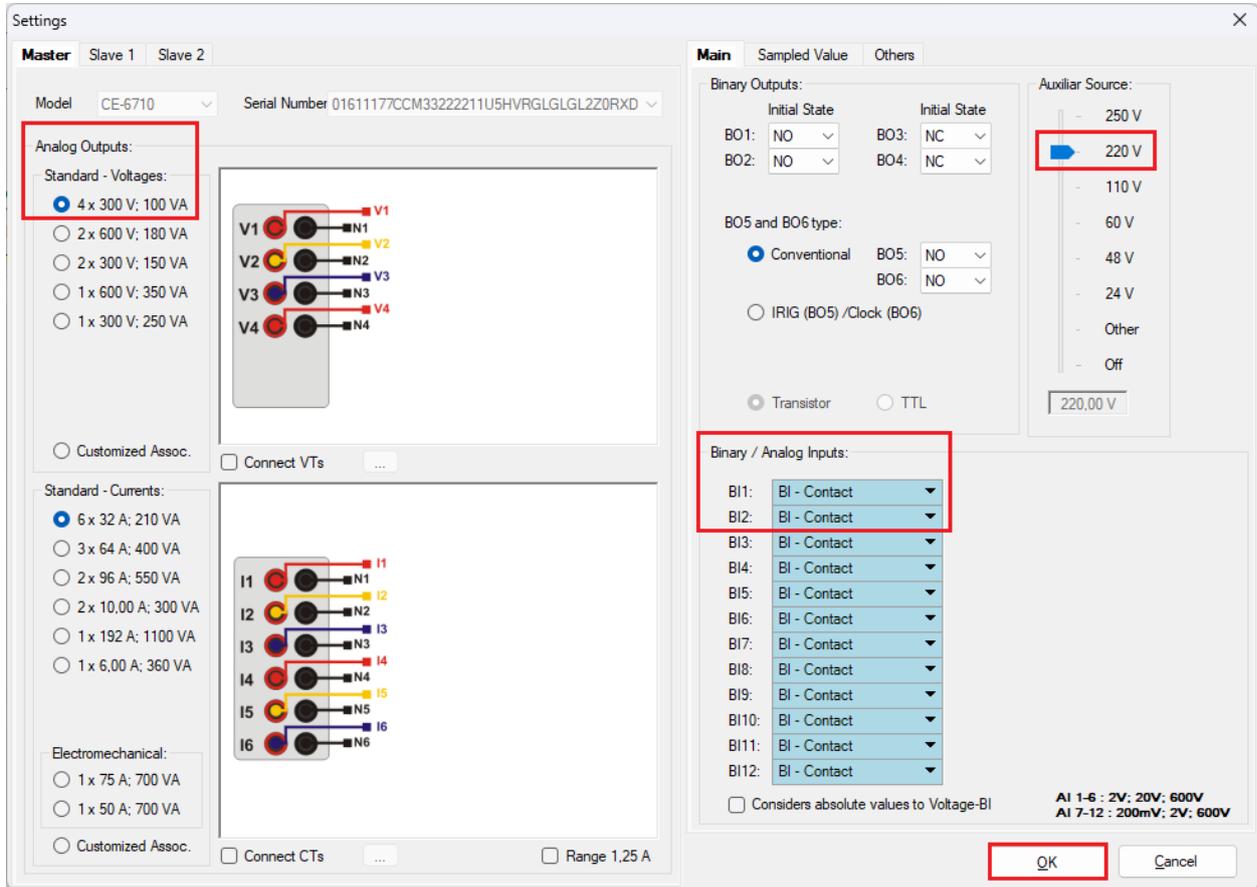


Figure 65

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

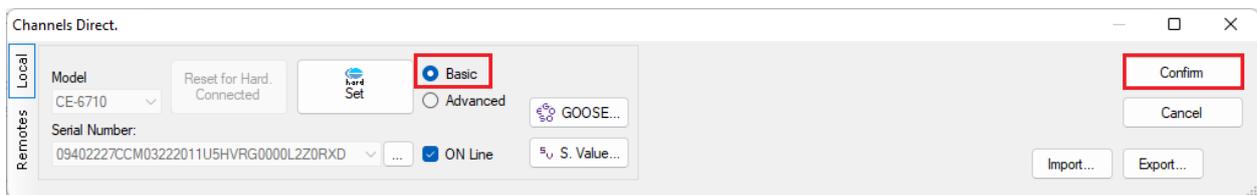


Figure 66

6. Restore Layout

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

INSTRUMENTOS PARA TESTES ELÉTRICOS

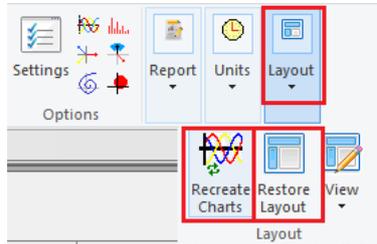


Figure 67

Following is the default structure after the previous commands.

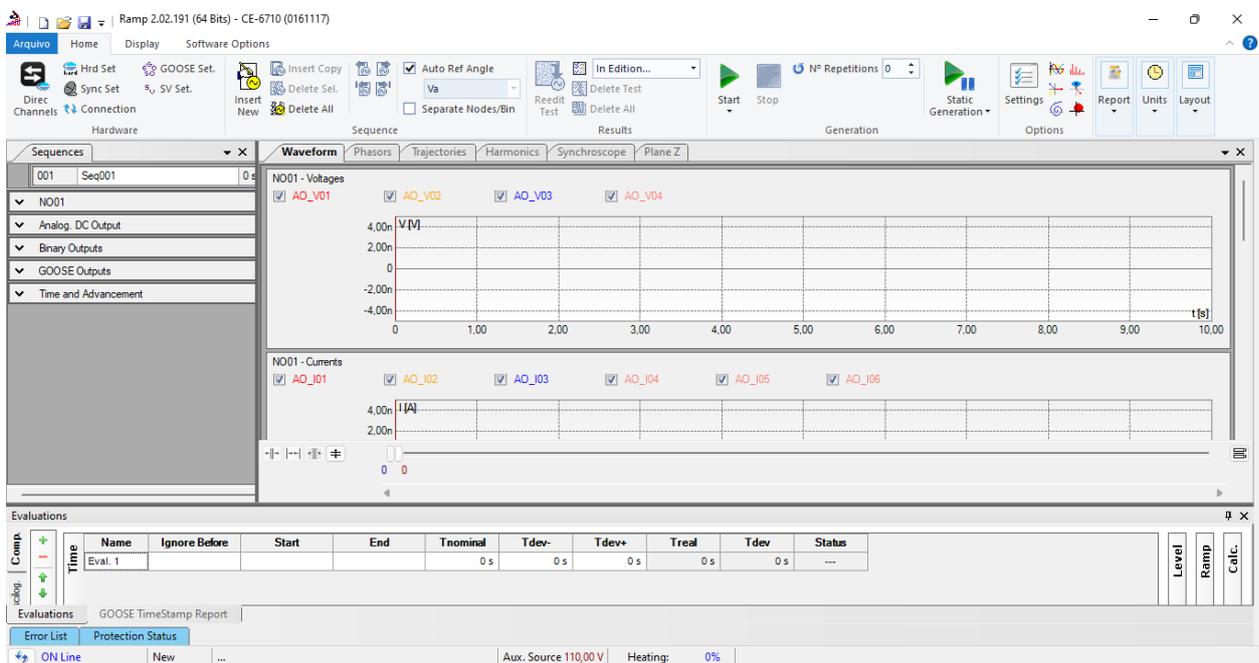


Figure 68

7. Test structure for function 81

Click the button highlighted in red until you create 2 test sequences.

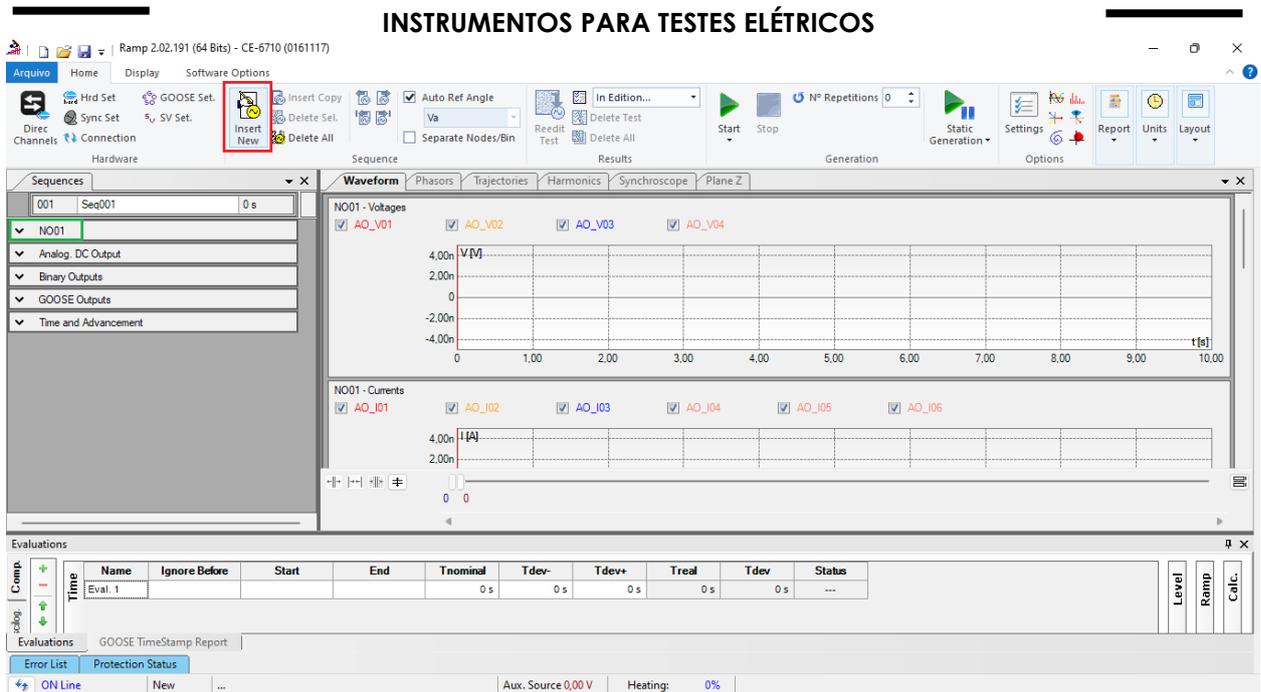


Figure 69

Click on the option “NO01” highlighted in green and decrease the size of the right window for easier viewing.

7.1 Main Screen 81-1

In the first sequence, configure a situation to check the overfrequency of the 81-1 element whose adjustment is at 62.0Hz and 1.0s. In place of “Seq 001” write “81-1”. Then click on the highlighted button in the figure below.

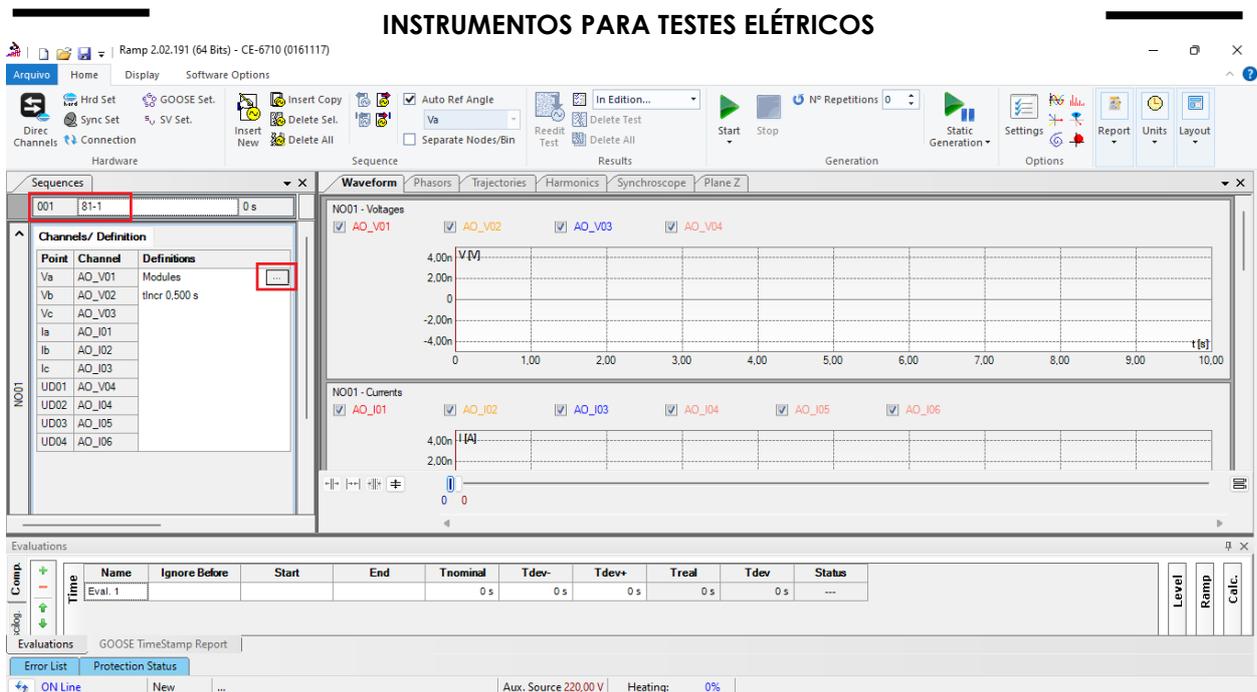


Figure 70

7.2 Screen for incrementing 81-1

On this screen, in the “Ramp Type” field, choose the “Frequency” option and then select the “Pulsed” option. For the voltage value, either initial or reset use the nominal voltage of 66.4V balanced three-phase ABC. For the initial frequency use 61.98Hz and for the final frequency 62.02Hz with a step of 5.0mHz. In the field “Generation Time in Each Incr.” the user must configure a time that is always longer than the actuation time. In this case, a time of 1.25 seconds was chosen. “Reset Time” has been set to 0.25 seconds.

INSTRUMENTOS PARA TESTES ELÉTRICOS

Ramp

Ramp Type: Direct Pulsed

Frequency:

Generation Time in Each Incr.: Reset Time:

Initial Values

Channels/ Definition				
Point	Channel	Mod.	Ang.	Freq.
Va	AO_V01	66,40 V	0 °	61,98 Hz
Vb	AO_V02	66,40 V	-120,0 °	61,98 Hz
Vc	AO_V03	66,40 V	120,0 °	61,98 Hz
Ia	AO_I01	0 A	0 °	60,00 Hz
Ib	AO_I02	0 A	0 °	60,00 Hz
Ic	AO_I03	0 A	0 °	60,00 Hz
UD01	AO_V04	0 V	0 °	60,00 Hz
UD02	AO_I04	0 A	0 °	60,00 Hz
UD03	AO_I05	0 A	0 °	60,00 Hz
UD04	AO_I06	0 A	0 °	60,00 Hz

Limits and Increases

	Limit	Incr.	d/dt	N Steps	Time
<input checked="" type="checkbox"/> Va	62,02 Hz	5,00 mHz	4,00 mHz/s	19,00	13,75 s
<input checked="" type="checkbox"/> Vb	62,02 Hz	5,00 mHz	4,00 mHz/s	19,00	13,75 s
<input checked="" type="checkbox"/> Vc	62,02 Hz	5,00 mHz	4,00 mHz/s	19,00	13,75 s
<input type="checkbox"/> Ia					
<input type="checkbox"/> Ib					
<input type="checkbox"/> Ic					
<input type="checkbox"/> UD01					
<input type="checkbox"/> UD02					
<input type="checkbox"/> UD03					
<input type="checkbox"/> UD04					

Reset

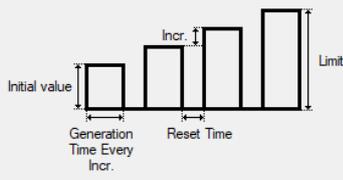
Channels/ Definition				
Point	Channel	Mod.	Ang.	Freq.
Va	AO_V01	66,40 V	0 °	60,00 Hz
Vb	AO_V02	66,40 V	-120,0 °	60,00 Hz
Vc	AO_V03	66,40 V	120,0 °	60,00 Hz
Ia	AO_I01	0 A	0 °	60,00 Hz
Ib	AO_I02	0 A	0 °	60,00 Hz
Ic	AO_I03	0 A	0 °	60,00 Hz
UD01	AO_V04	0 V	0 °	60,00 Hz
UD02	AO_I04	0 A	0 °	60,00 Hz
UD03	AO_I05	0 A	0 °	60,00 Hz
UD04	AO_I06	0 A	0 °	60,00 Hz

Binary Outputs

Channel	Incr.	Reset
<input type="checkbox"/> BO01		
<input type="checkbox"/> BO02		
<input type="checkbox"/> BO03		
<input type="checkbox"/> BO04		
<input type="checkbox"/> BO05		
<input type="checkbox"/> BO06		
<input type="checkbox"/> BO07		
<input type="checkbox"/> BO08		

GOOSE Outputs

Channel	Incr.	Reset



OK Cancel

Figure 71

7.3 Main screen 81-2

In the second sequence, a situation is configured to check the underfrequency of element 81-2 whose adjustment is at 58.0 Hz and 1.0 second. In place of “Seq 002” write “81-2”. Then click on the highlighted button in the figure below.

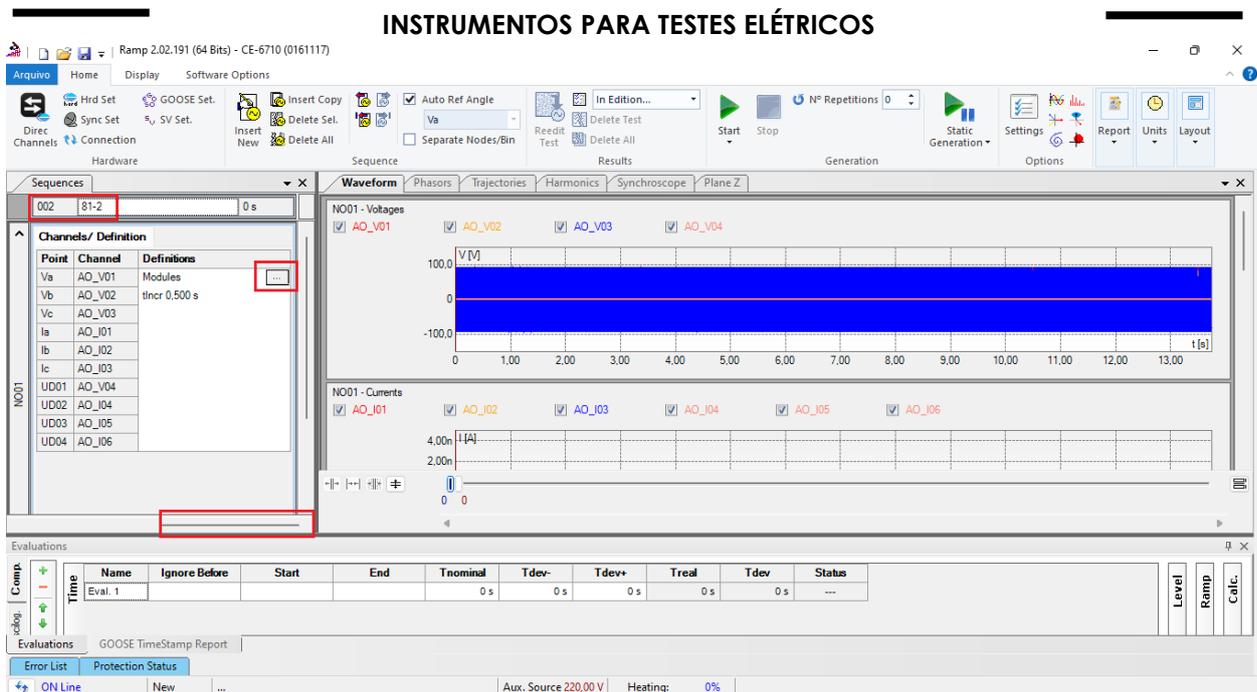


Figure 72

7.4 Screen for incrementing 81-2

On this screen, in the “*Ramp Type*” field, choose the “*Frequency*” option and then select the “*Pulsed*” option. For the voltage value either initial or reset, use the rated voltage of 66.4V balanced three-phase ABC. For the initial frequency use 58.02 Hz and for the final frequency 57.98Hz with a step of -5.0mHz. In the field “*Generation Time in Each Incr.*” the user must configure a time that is always longer than the actuation time. In this case, a time of 1.25 seconds was chosen. “*Reset Time*” has been set to 0.25 seconds.

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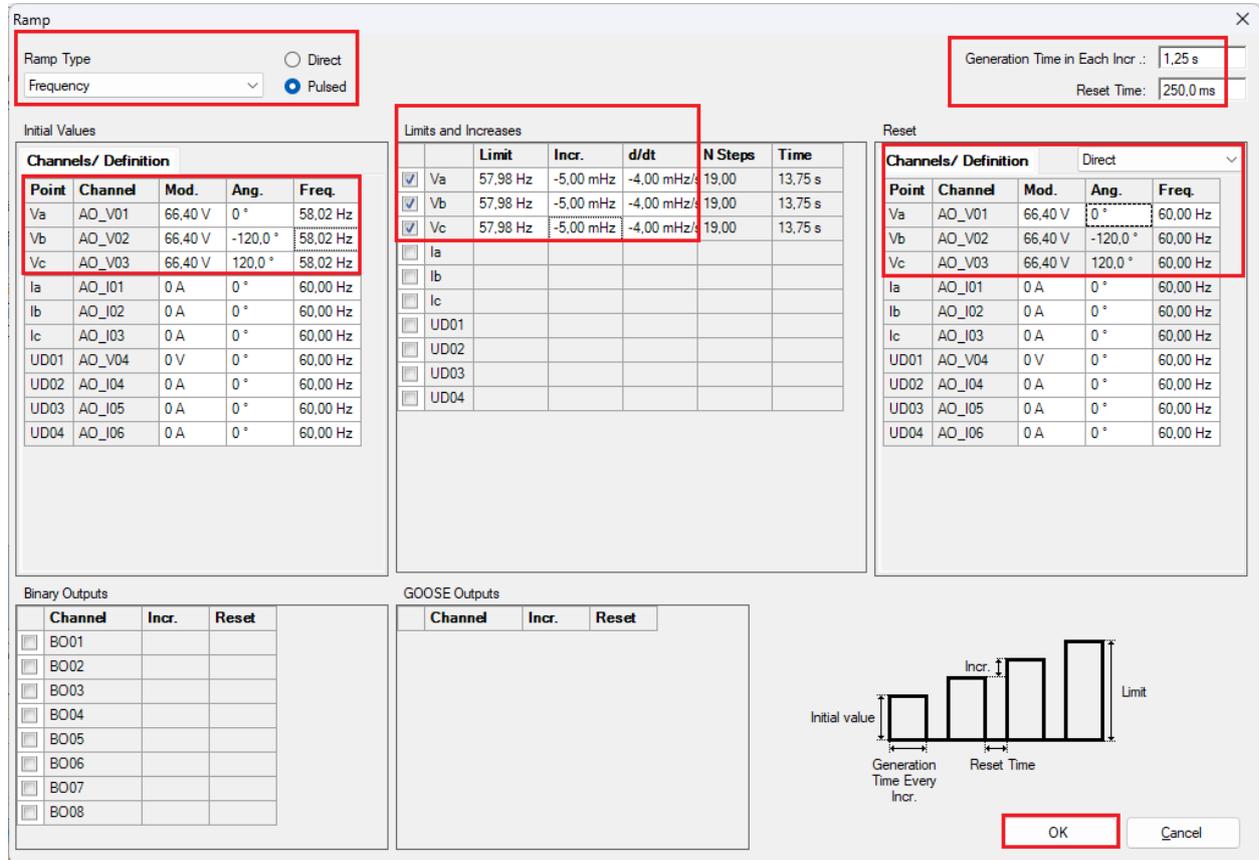


Figure 73

7.5 Evaluation of pick-ups

Clicking on the “Ramp” field, as shown in the next figure, you can configure 2 pick-up evaluations as follows.

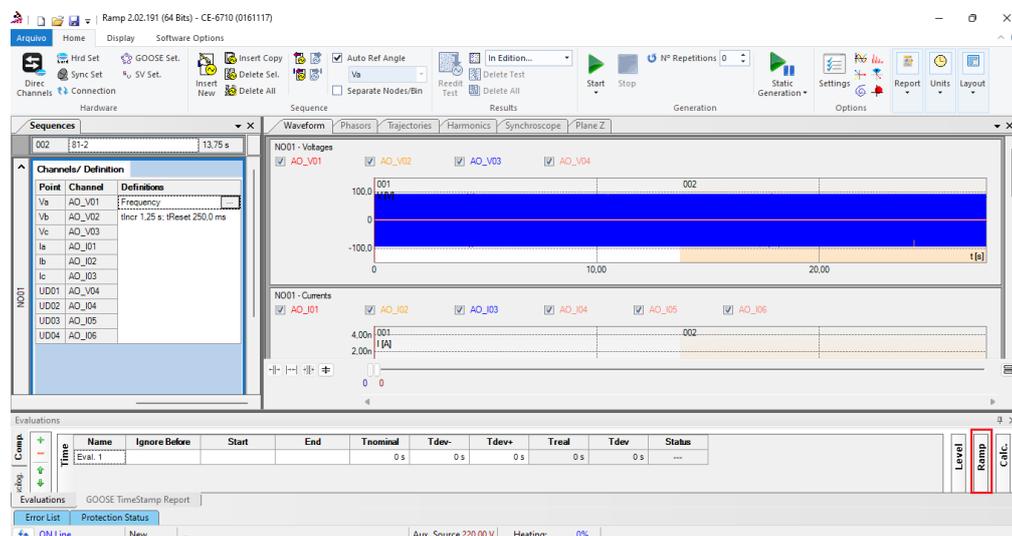
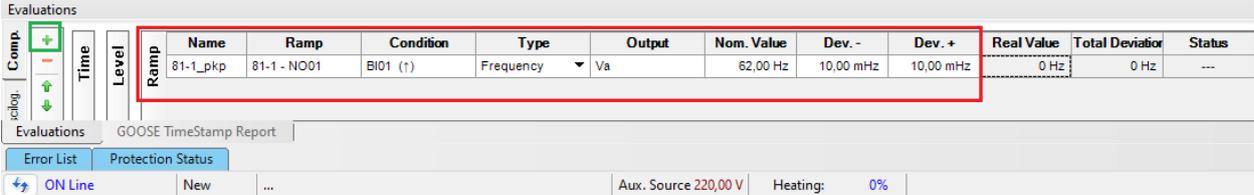


Figure 74

INSTRUMENTOS PARA TESTES ELÉTRICOS

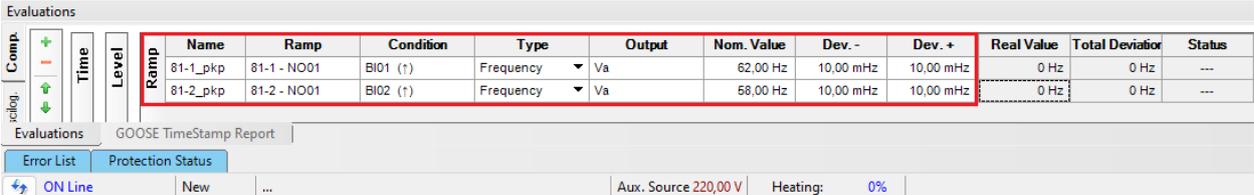
Instead of “*Eval.1*” write “*81-1_pkp*”, in Ramp select “*81-1 > NO01*” for “*Condition*” set “*BI01 (↑)*”, for “*Type*” choose “*Frequency*”, for “*Output*” set “*Va*”, in the field “*Nom Value*” set 62.00Hz and in the fields related to deviations set 10mHz.



Name	Ramp	Condition	Type	Output	Nom. Value	Dev. -	Dev. +	Real Value	Total Deviator	Status
81-1_pkp	81-1 - NO01	BI01 (↑)	Frequency	Va	62,00 Hz	10,00 mHz	10,00 mHz	0 Hz	0 Hz	---

Figure 75

Clicking on the “+” icon of the previous figure insert one more evaluation. The configuration must be done in a similar way to the first evaluation with changes in the binary input and value of the pick-up.



Name	Ramp	Condition	Type	Output	Nom. Value	Dev. -	Dev. +	Real Value	Total Deviator	Status
81-1_pkp	81-1 - NO01	BI01 (↑)	Frequency	Va	62,00 Hz	10,00 mHz	10,00 mHz	0 Hz	0 Hz	---
81-2_pkp	81-2 - NO01	BI02 (↑)	Frequency	Va	58,00 Hz	10,00 mHz	10,00 mHz	0 Hz	0 Hz	---

Figure76

7.6 Adjusting graphics

Double click on the “*Waveform*” option of the right window and maximize the screen to choose the relevant signals and insert time analysis markings.

INSTRUMENTOS PARA TESTES ELÉTRICOS

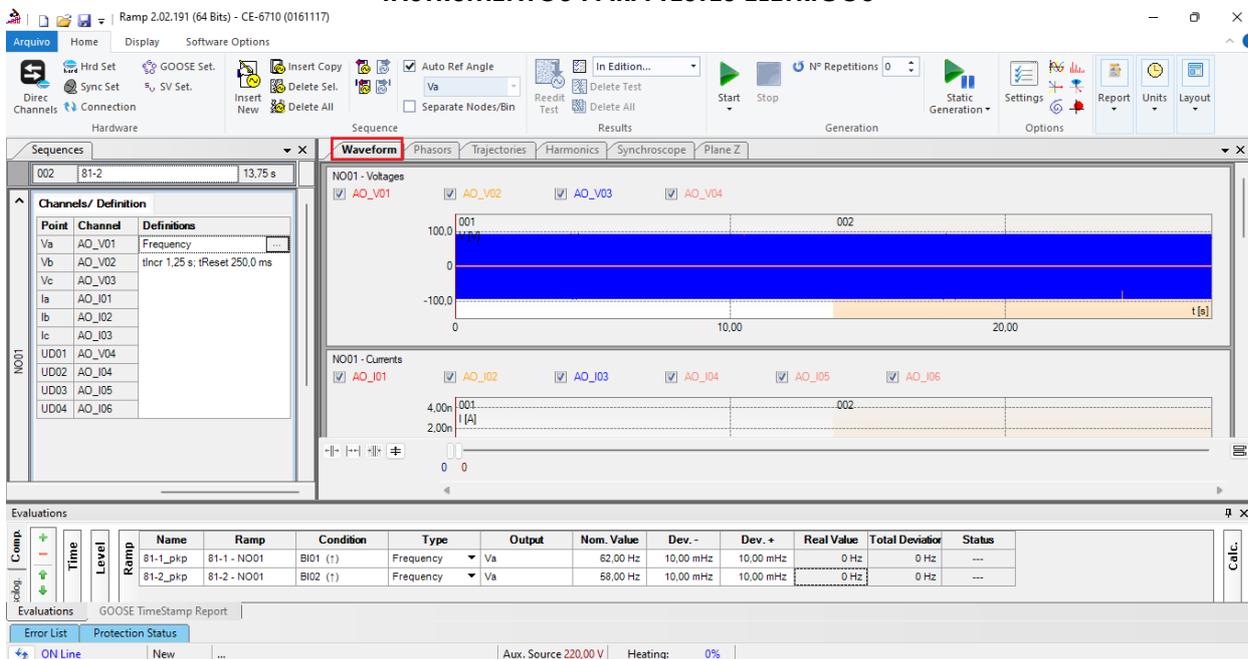


Figure 77

Right click on the voltage graph and choose the highlighted option.

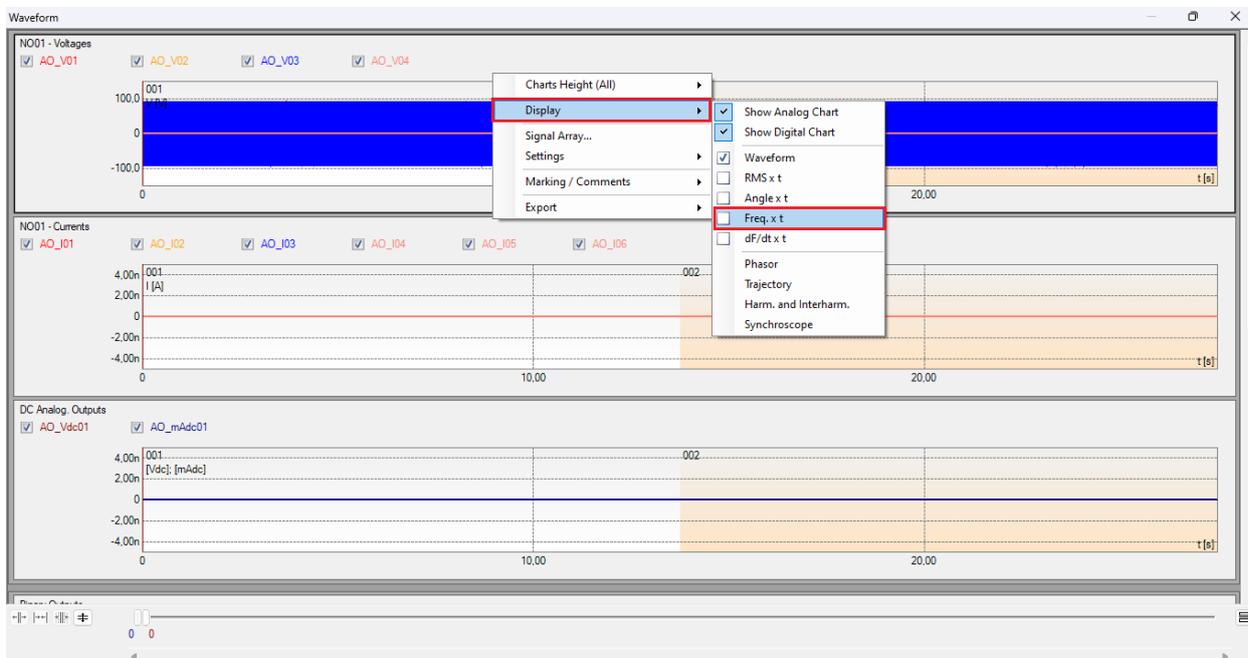


Figure 78

Select the current graph and click on the “Delete” key. Repeat the procedure for the DC analog outputs and binary output graph. Uncheck the option “V04”.

INSTRUMENTOS PARA TESTES ELÉTRICOS

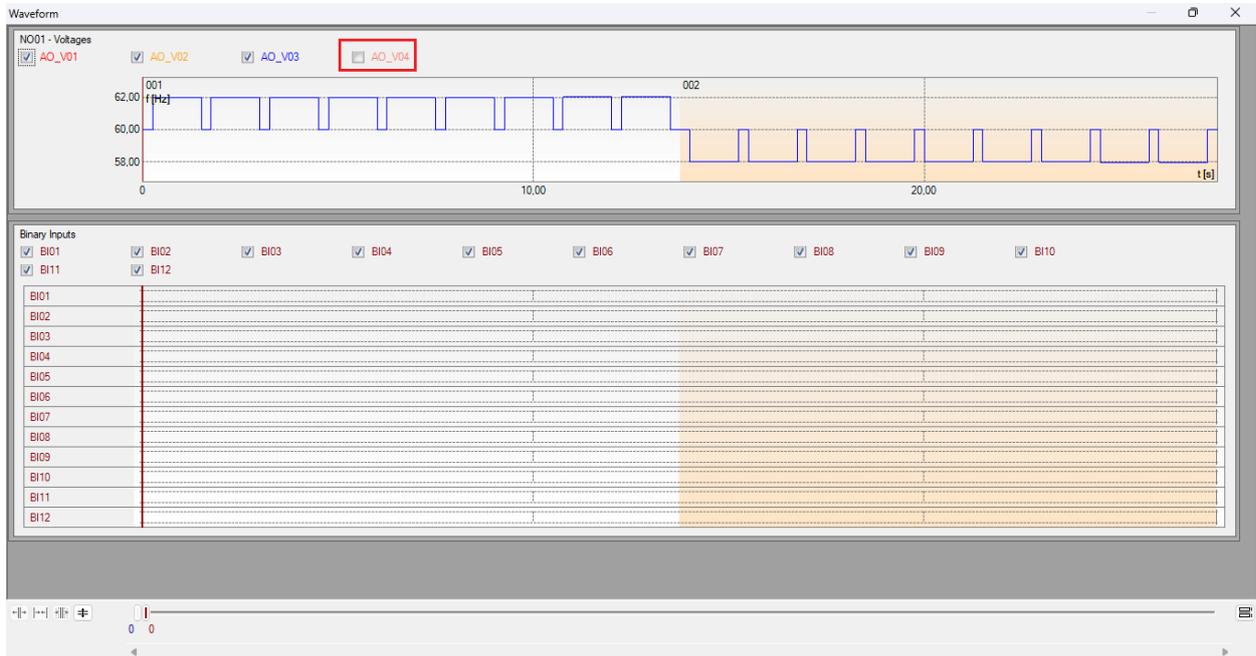


Figure 79

Right click and increase the height of the graphics. The next step is to select only the binaries “BI01” and “BI02”.

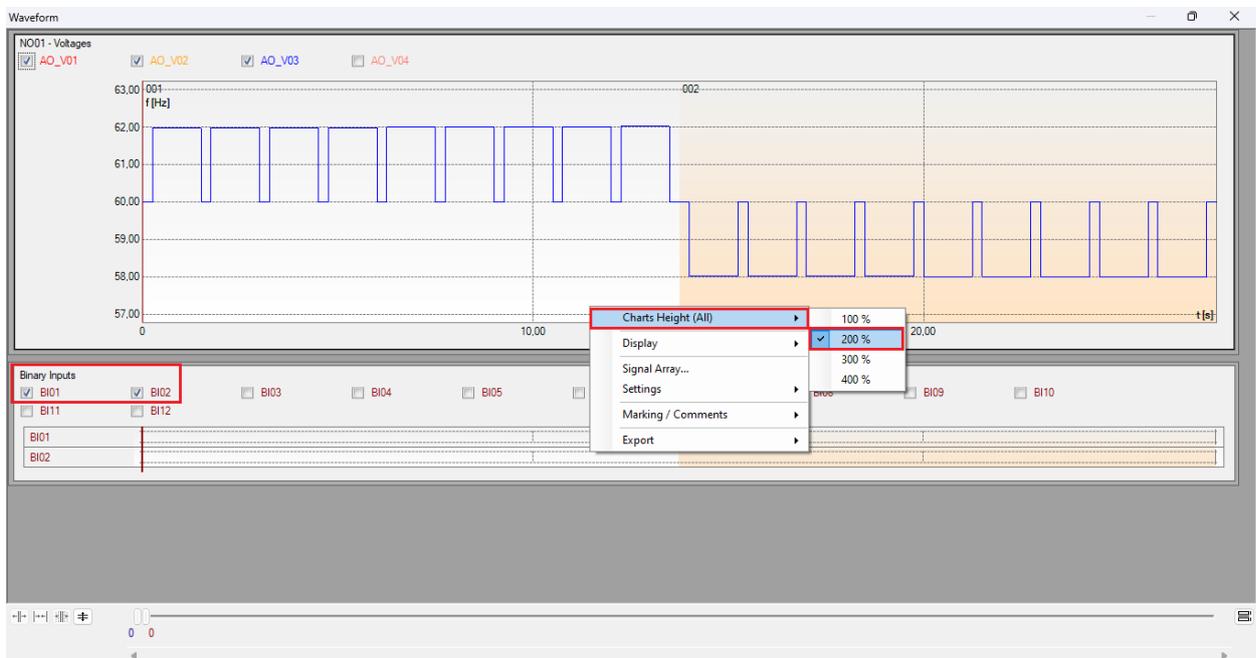


Figure 80

7.7 Time analysis

To evaluate the time, the value of the frequency where the last increment or decrement of each sequence occurs must be marked. To find these values, cursors are used. If necessary, a zoom can be performed to verify the moment of time where the marking must be carried out. To do this, left-click and drag the desired region. To remove the zoom, just double-click on the graph. The following figure shows the time for the two elements.

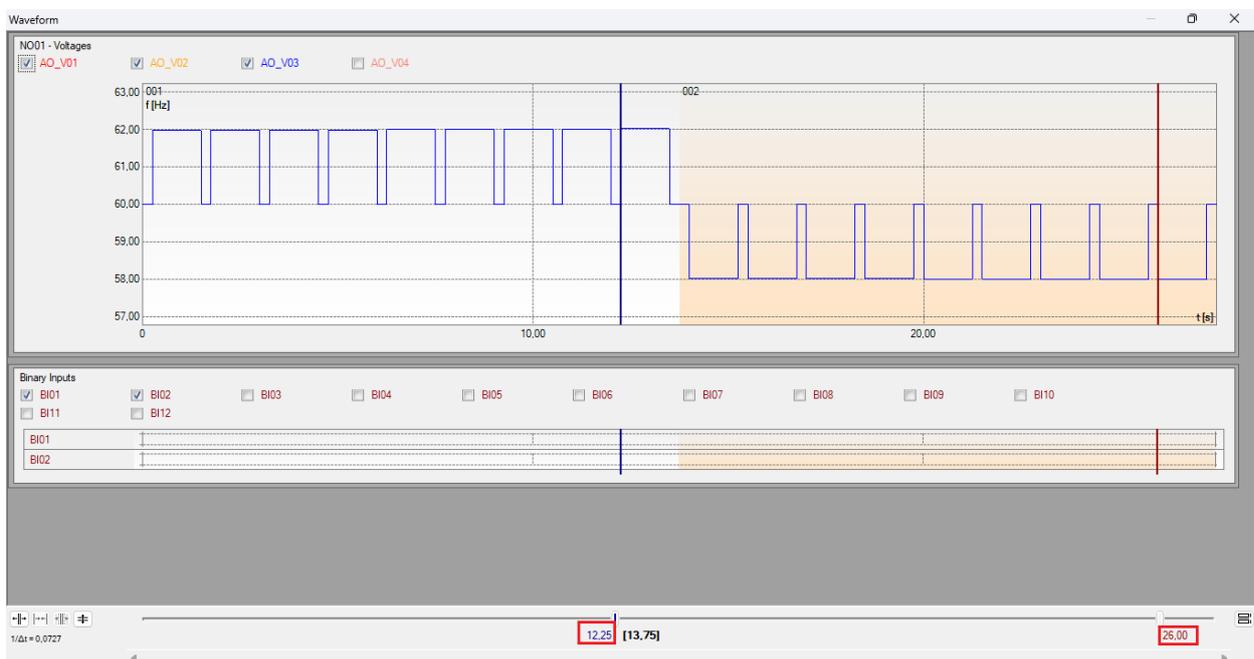


Figure 81

According to the previous figure, it can be concluded that the time for marking 1 is 12.25 seconds and for the second, 26.00 seconds.

7.8 Inserting markup

To insert the mark, right-click on the graphic and choose the following option.

INSTRUMENTOS PARA TESTES ELÉTRICOS

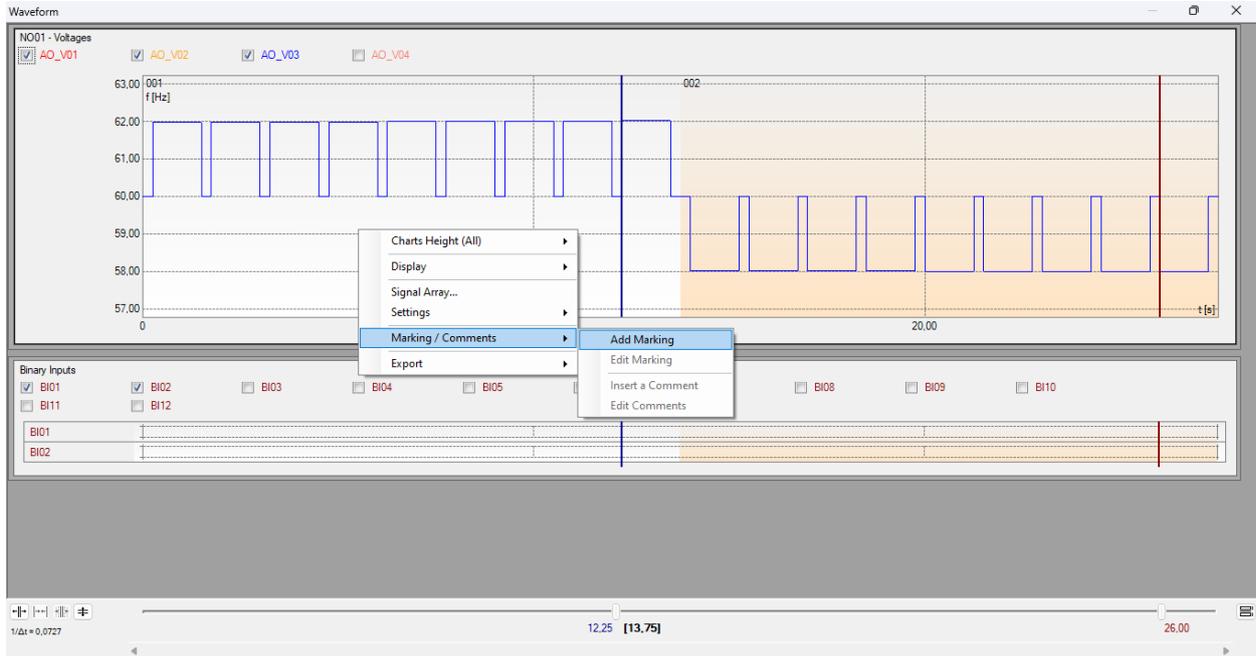
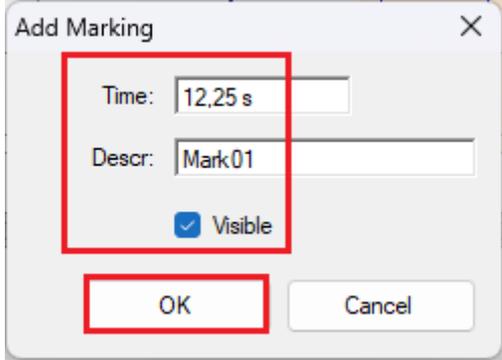


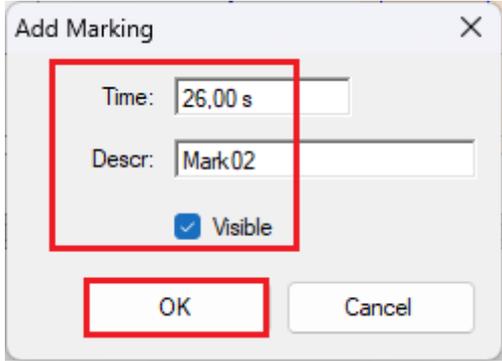
Figure 82

Adjust the first time and repeat the procedure for the other marking.



The 'Add Marking' dialog box is shown. It has a title bar with a close button. The 'Time' field contains '12,25 s', the 'Descr' field contains 'Mark01', and the 'Visible' checkbox is checked. The 'OK' button is highlighted with a red box.

Figure 83



The 'Add Marking' dialog box is shown. It has a title bar with a close button. The 'Time' field contains '26,00 s', the 'Descr' field contains 'Mark02', and the 'Visible' checkbox is checked. The 'OK' button is highlighted with a red box.

Figure 84

INSTRUMENTOS PARA TESTES ELÉTRICOS

The markings are shown in the following figure. To return this window to its initial position, double-click on the top bar (highlighted in green).

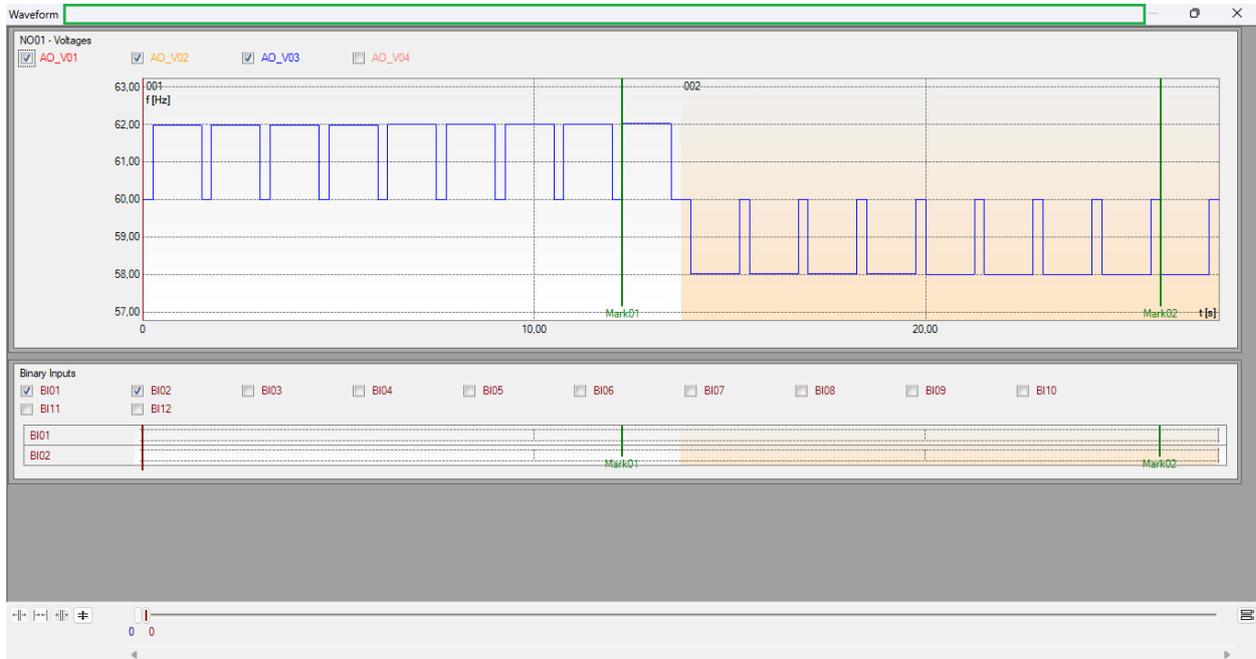


Figure 85

7.9 Time evaluation

By clicking on the “Time” field, as shown in the next figure, you can configure 2 time evaluations of operations as follows.

INSTRUMENTOS PARA TESTES ELÉTRICOS

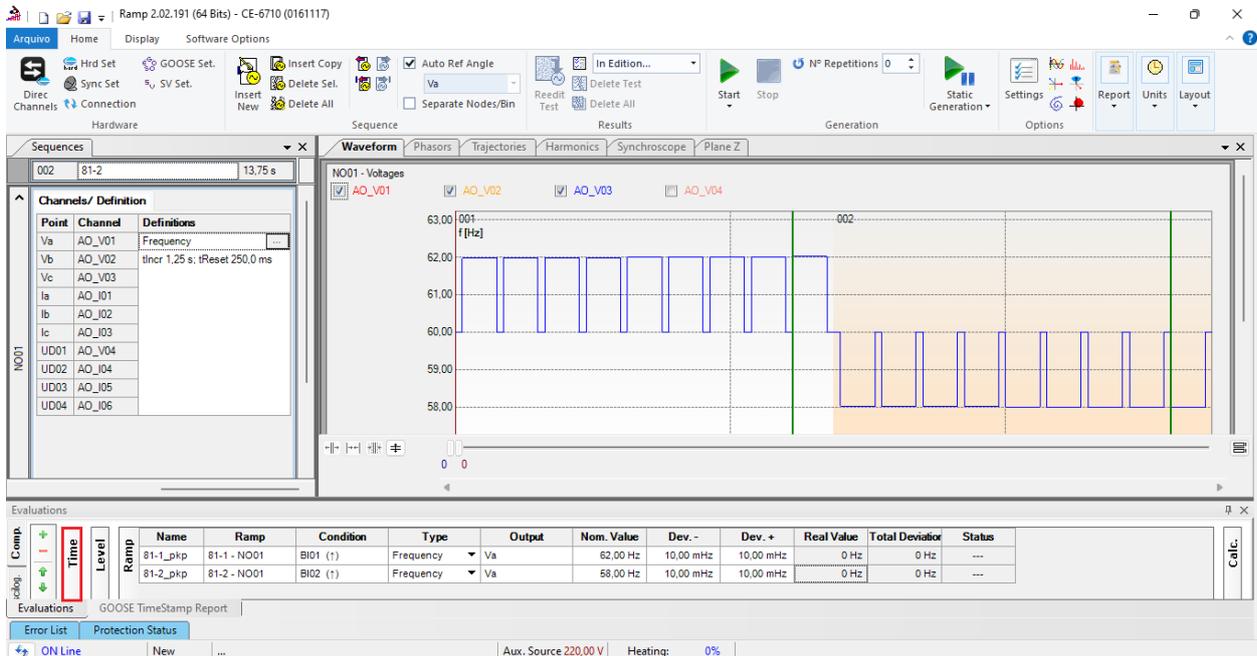


Figure 86

Change the name “*Eval. 1*” to “*81-1_t*” in the “*Ignore before*” option choose “*Tagging > Mark01*” in the “*Start*” option choose “*Tagging > Mark01*” in the “*End*” option choose “*Binary Input > BI01 (↑)*”. In nominal time, set 1.0s with deviations of 200ms. The figure below shows these settings.

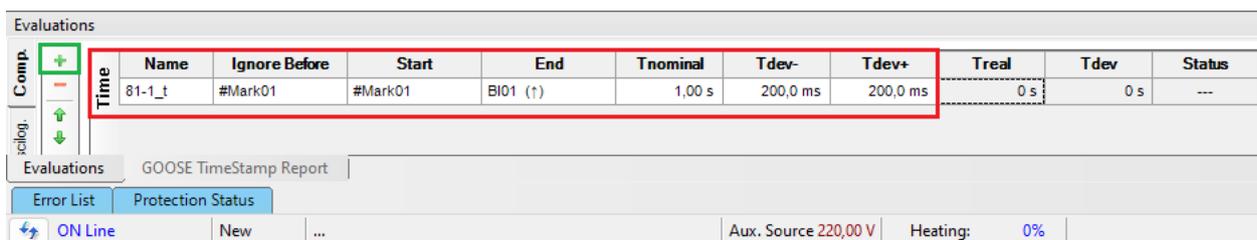


Figure 87

By clicking on the “+” icon, one more evaluation is added and its adjustments are made in a similar way to the first evaluation.

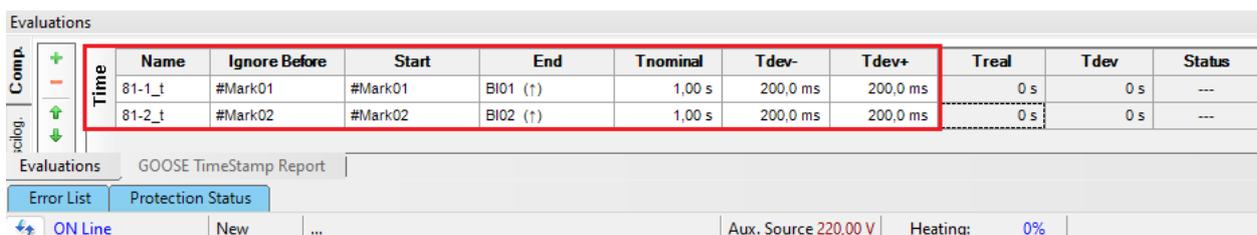


Figure 88

INSTRUMENTOS PARA TESTES ELÉTRICOS

Use the command “*Alt + G*” to start the generation. The next figure shows the result with the pickup values found.

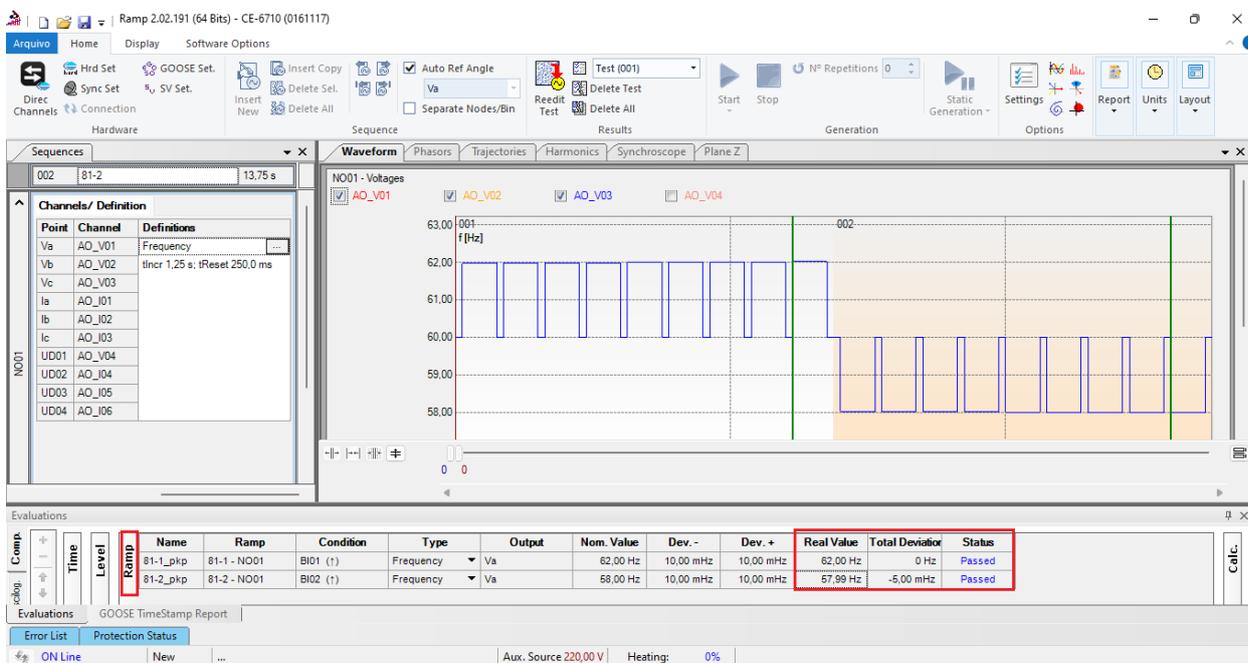


Figure 89

The following figure shows the operating times within the range of values given by the manufacturer.

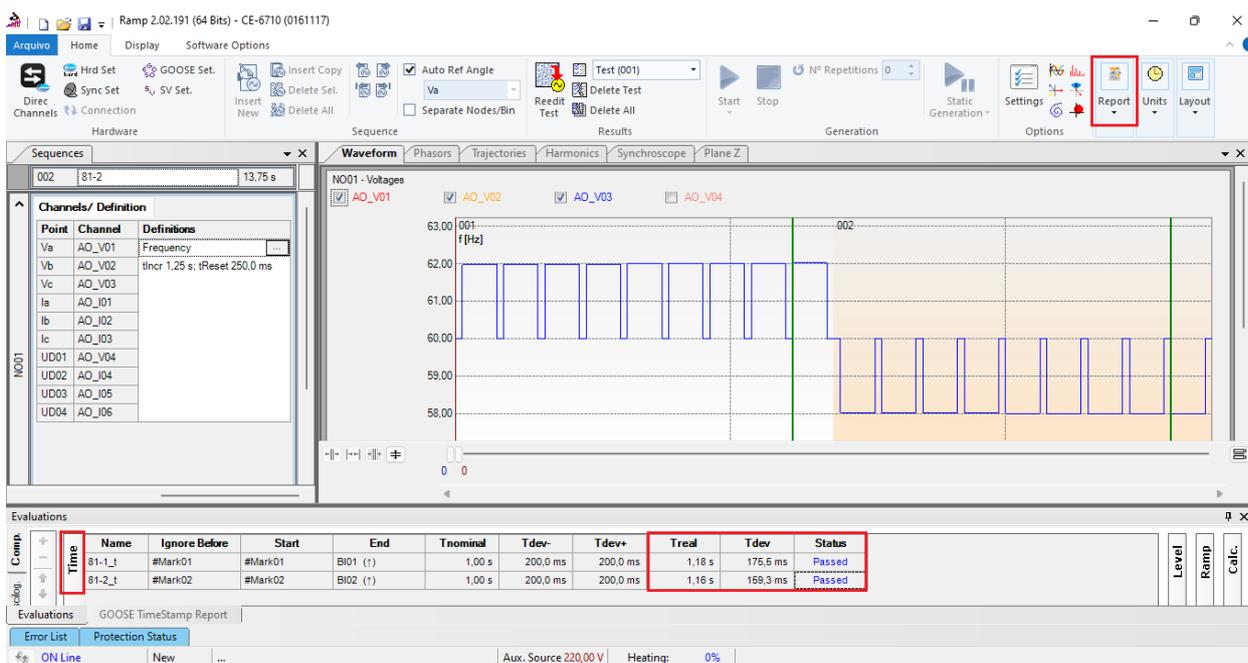


Figure 90

8. Report

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

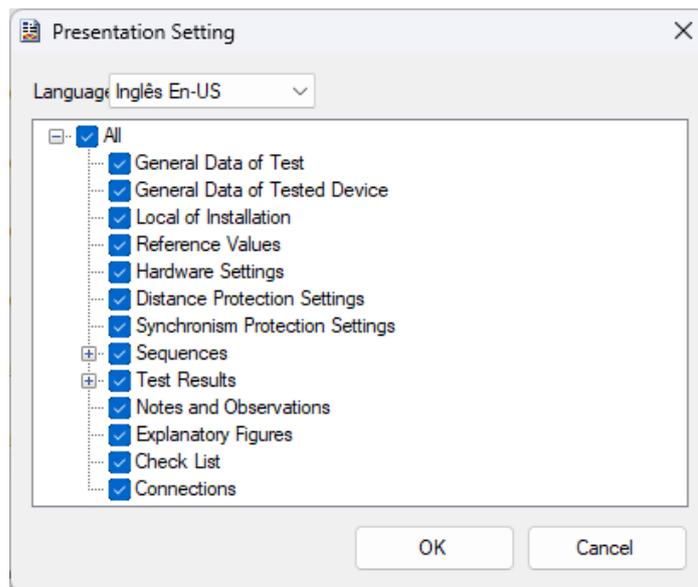


Figure 91

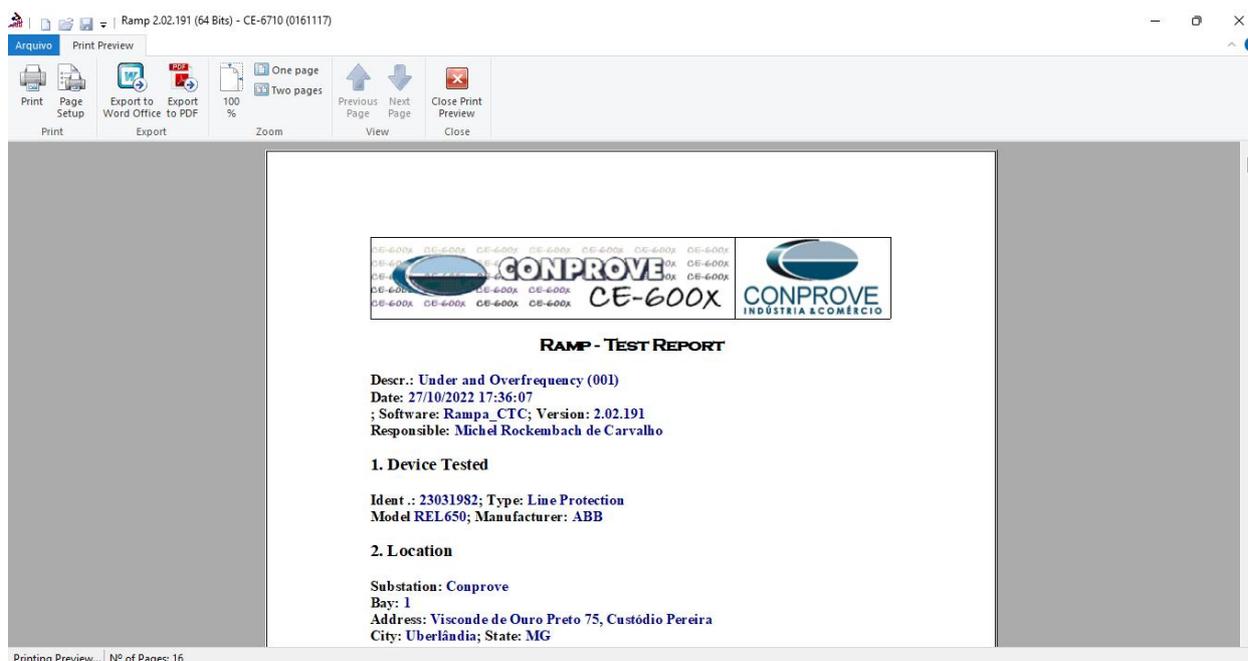


Figure 92

APPENDIX A

A.1 Terminal Designation

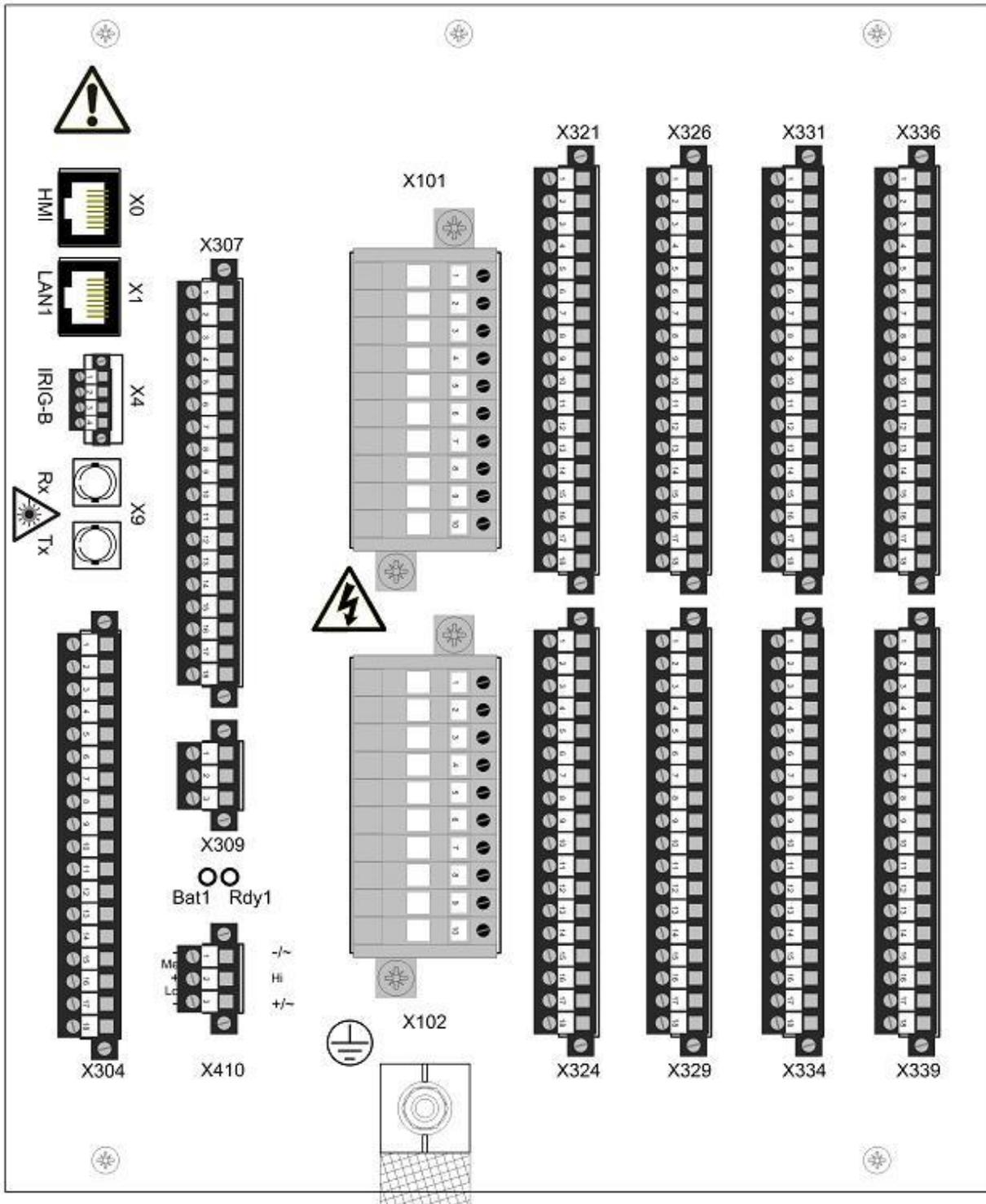


Figure 93

INSTRUMENTOS PARA TESTES ELÉTRICOS

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

INSTRUMENTOS PARA TESTES ELÉTRICOS

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 197: SAPTOF technical data

Function	Range or value	Accuracy
Operate value, start function	(35.00-75.00) Hz	± 2.0 mHz at symmetrical three-phase voltage
Operate time, start function	At 50 Hz: 200 ms typically at $f_{set} - 0.5$ Hz to $f_{set} + 0.5$ Hz At 60 Hz: 170 ms at $f_{set} - 0.5$ Hz to $f_{set} + 0.5$ Hz	-
Reset time, start function	At 50 and 60 Hz: 55 ms typically at $f_{set} + 0.5$ Hz to $f_{set} - 0.5$ Hz	-
Timer	(0.000-60.000)s	<250 ms

Technical data

Table 192: SAPTUF Technical data

Function	Range or value	Accuracy
Operate value, start function	(35.00-75.00) Hz	± 2.0 mHz
Operate value, restore frequency	(45 - 65) Hz	± 2.0 mHz
Operate time, start function	At 50 Hz: 200 ms typically at $f_{set} + 0.5$ Hz to $f_{set} - 0.5$ Hz At 60 Hz: 170 ms typically at $f_{set} + 0.5$ Hz to $f_{set} - 0.5$ Hz	-
Reset time, start function	At 50 Hz: 60 ms typically at $f_{set} - 0.5$ Hz to $f_{set} + 0.5$ Hz At 60 Hz: 50 ms typically at $f_{set} - 0.5$ Hz to $f_{set} + 0.5$ Hz	-
Operate time delay	(0.000-60.000)s	<250 ms
Restore time delay	(0.000-60.000)s	<150 ms

APPENDIX B

Equivalence of software parameters and the relay under test.

Table 1

Ramp Software		REL650 Relay	
Parameter	Figure	Parameter	Figure
81-1_pkp	76	StartFrequency	52
81-2_pkp	76	StartFrequency	54
81-1_t	88	tDelay	52
81-2_t	88	tDelay	54