INSTRUMENTOS PARA TESTES ELÉTRICOS

Test Tutorial

Equipment Type: Protection Relay

Brand: GE

Model: T60

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	14/09/2021	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.

The tutorial contains knowledge gained from the resources and technical data at the time was writing. Therefore, CONPROVE reserves the right to make changes to this document without prior notice.

This document is intended as a guide only; the manual of the equipment under tested should always be consulted.

ATTENTION!

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

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

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Summary

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Sequence for T60 relay tests in Differential software

1. Relay connection to CE-6006

Appendix A shows the relay terminal designations.

1.1 *Auxiliary Source*

Connect the positive (red terminal) of the Vdc Aux. Source to pin B5b of the relay and the negative (black terminal) of the Vdc Aux. Source to pin B6a of the relay.

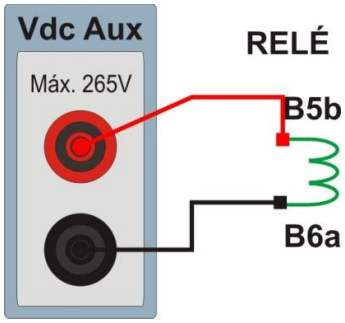

Figure 1

1.2 *Current Coils*

Connect the I1, I2 and I3 current channels of the CE-6006 to pins F1a, F2a and F3a of the relay respectively, if the commons of the relay are short circuited, just connect the commons of the channels to that point, otherwise connect the three common CE-6006 to pins F1b, F2b and F3b relay then forming the winding dial 1. Likewise, to establish the winding 2 connection, connect I4, I5 and I6 current channels to relay pins F5a, F6a and F7a respectively, connecting the common three to pin F5b, F6b and F7b.

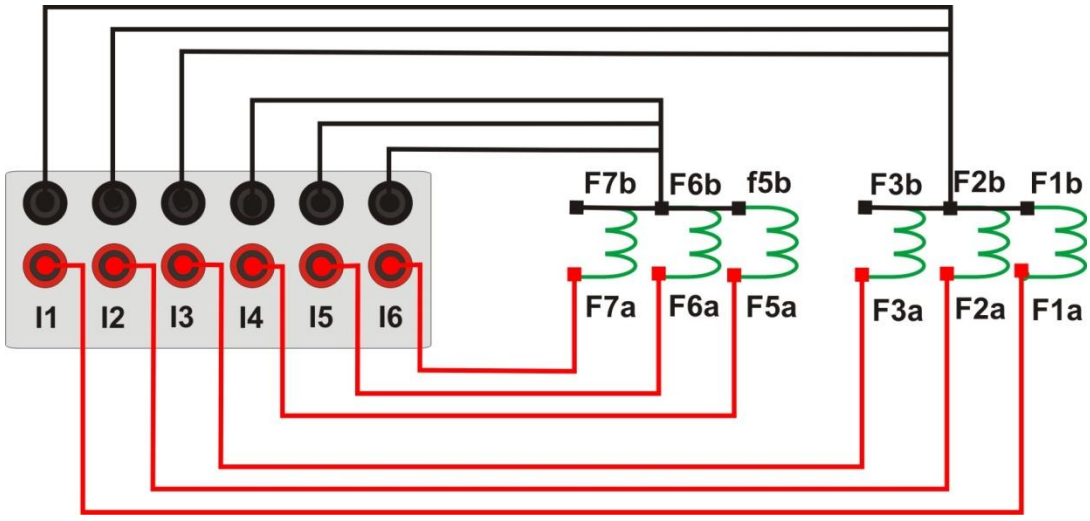

Figure 2

1.3 *Binary Inputs*

Connect the binary input of the CE-6006 to the binary output relay.

- BI1 to pin H1b and its common to pin H1c;
- BI2 to pin H2b and its common to pin H2c;

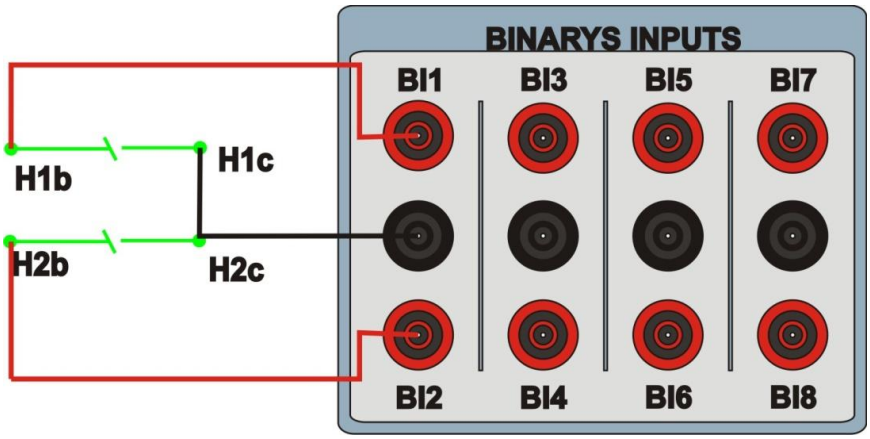

Figure 3

2. Communication with T60 relay

Before starting the T60 relay test, open the *"EnerVista"* software and download the *"UR"* series software, if you already have it, click directly on:

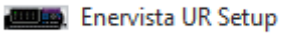

Figure 4

In the *"EnerVista UR"* software click on *"Quick Connect"*.

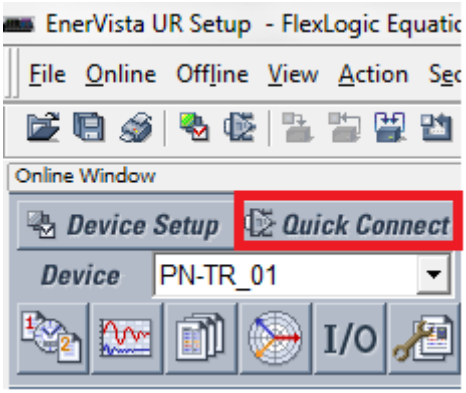

Figure 5

Then click on *"Connect"* and choose the port being used. In this case COM5.

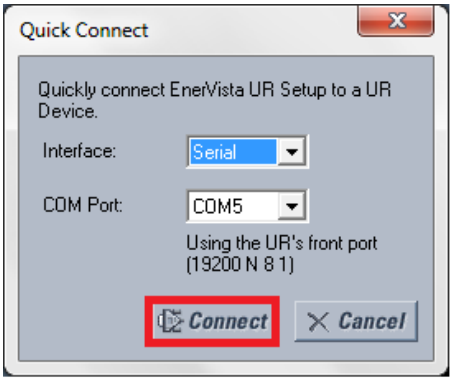

Figure 6

The following figure shows the message after connecting.

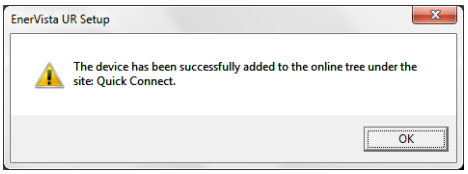

Figure 7

3. Parameterization of the relay 7UT61

3.1 *AC Inputs*

After the connection has been established, click on the *"+"* signs near to *"Quick Connect Device > Settings > System Setup"* and double-click on *"AC Input",* in it adjust the values of primary current and secondary of the current transformer on both sides.

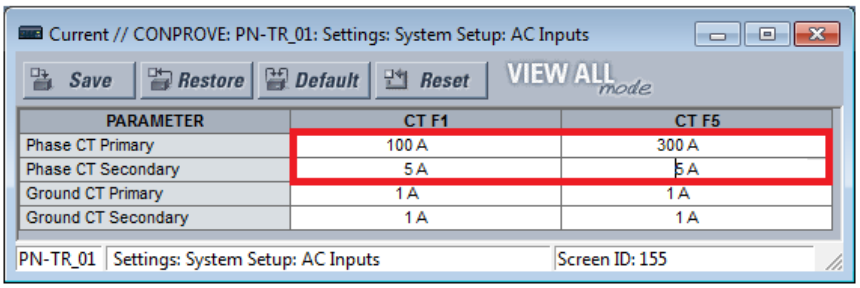

Figure 8

3.2 *Power system*

In this field the nominal frequency, the phase sequence and the side used as reference are set.

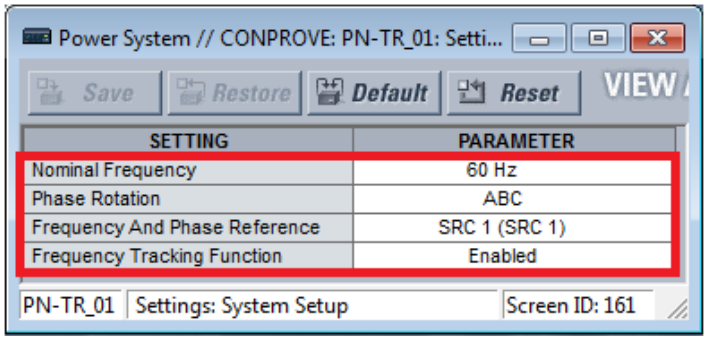

Figure 9

3.3 *General*

Click on the *"+"* sign near to *"Transformer"* and double-click on *"General"*. This option adjusts the number of windings and whether the angular compensation is internal or external.

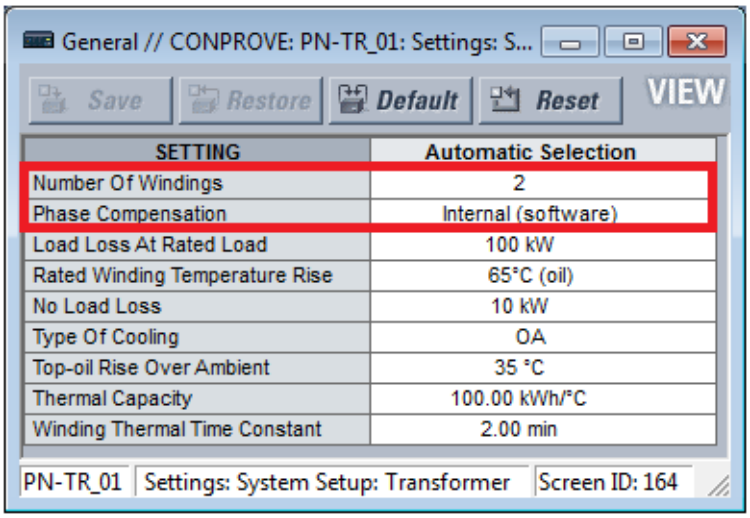

Figure 10

3.4 *Windings*

In this tab the transformer power, voltage on the high and low side, whether the windings are grounded and the angular phase shift are adjusted. Remembering that the angle must always be negative taking as reference the low side in relation to the high side. In this example, the Yd30° connection is used, which means that the high side (STAR) is 30° ahead of the low side (DELTA), or that the low side is 30° behind the high side (philosophy adopted by IED).

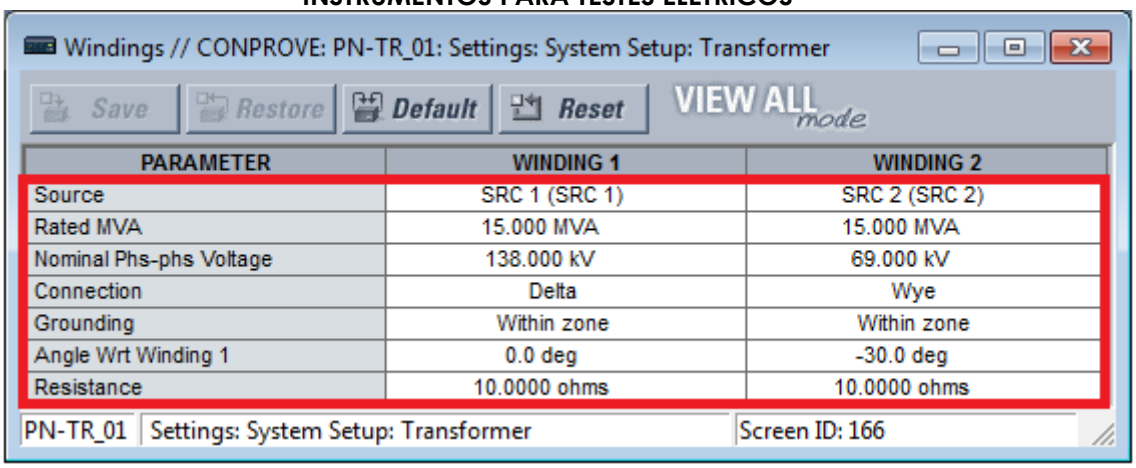

Figure 11

3.5 *Percent Differential*

Click on the *"+"* sign near to *"Grouped Elements > Group1 > Transformer"* and double-click on *"Percent Differential"*. This option adjusts the break points, slopes and harmonic constraints.

Note: If the user disables harmonic restrictions, certain tested points may show inconsistency.

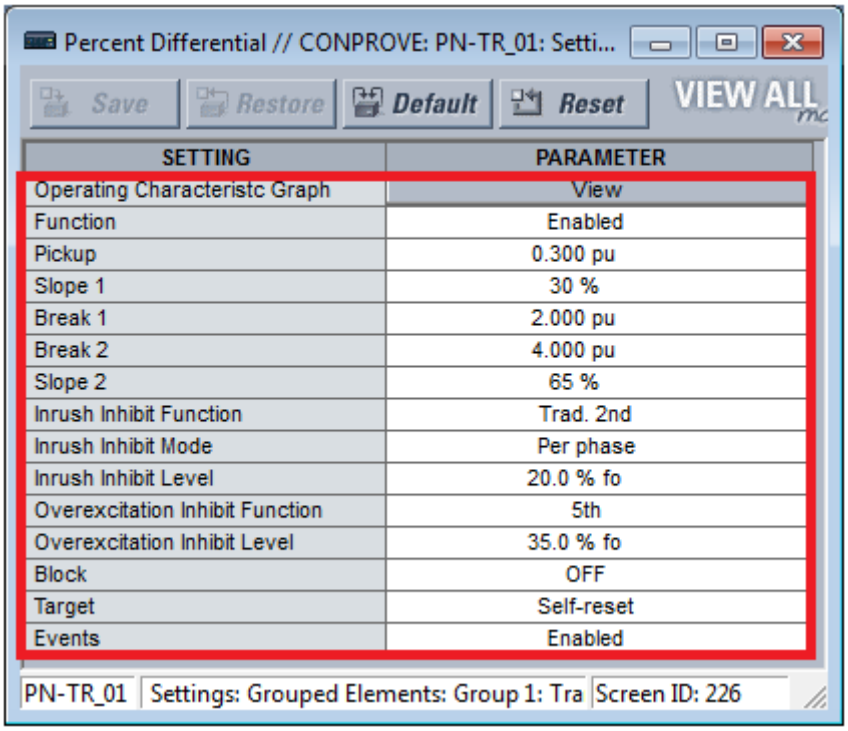

Figure 12

3.6 *Instantaneous Differential*

On this tab you can adjust the instantaneous value of the differential element.

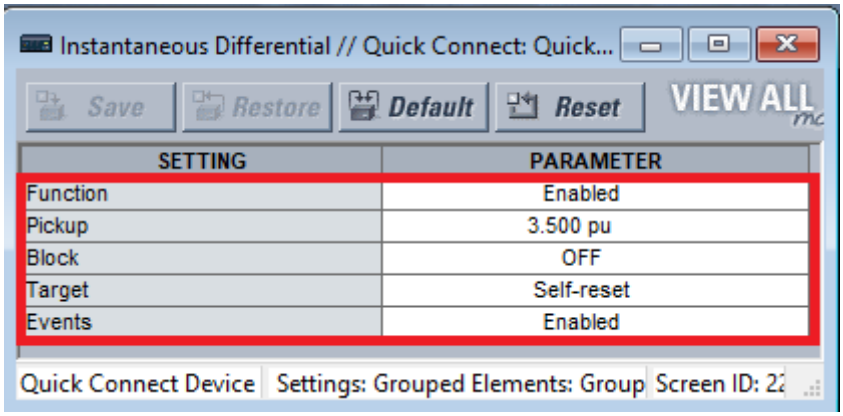

Figure 13

4. Binary Output Adjustments

4.1 *FlexLogic Equation Editor*

Click on the *"+"* sign near to *"FlexLogic"* and double-click on *"FlexLogic Equation Editor"*. On this screen, only one logic is programmed. An *"OR"* logic is created between the trip signals of the percentage and instantaneous function associating to a virtual output 1.

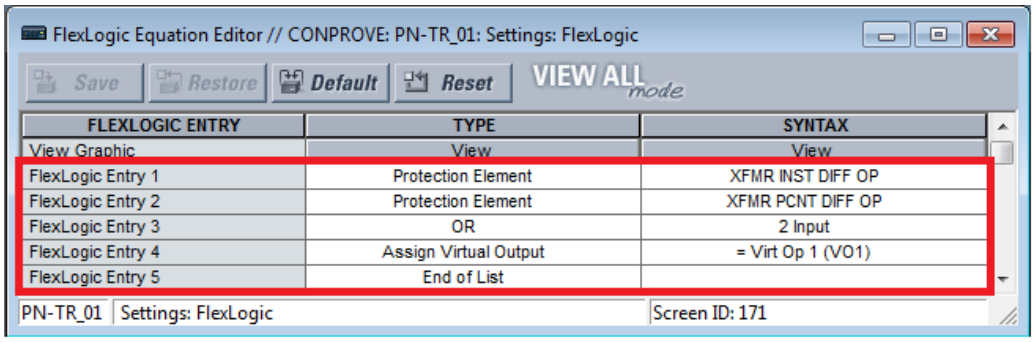

Figure 14

4.2 *Contact Outputs*

Click on the *"+"* sign near to *"Inputs/Outputs"* and double-click on *"Contact Outputs"*. On this screen, the trips of the virtual outputs are designated the binary outputs of the relay.

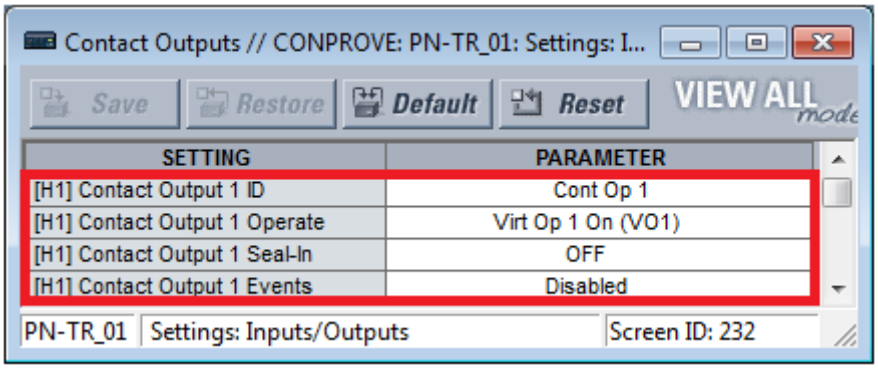

Figure 15

5. Differential software settings

5.1 *Opening the Differential*

Click on the *"Conprove Test Center"* application manager icon.

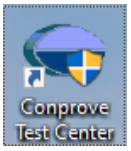

Figure 16

Make a click on the software icon *"Differential"*.

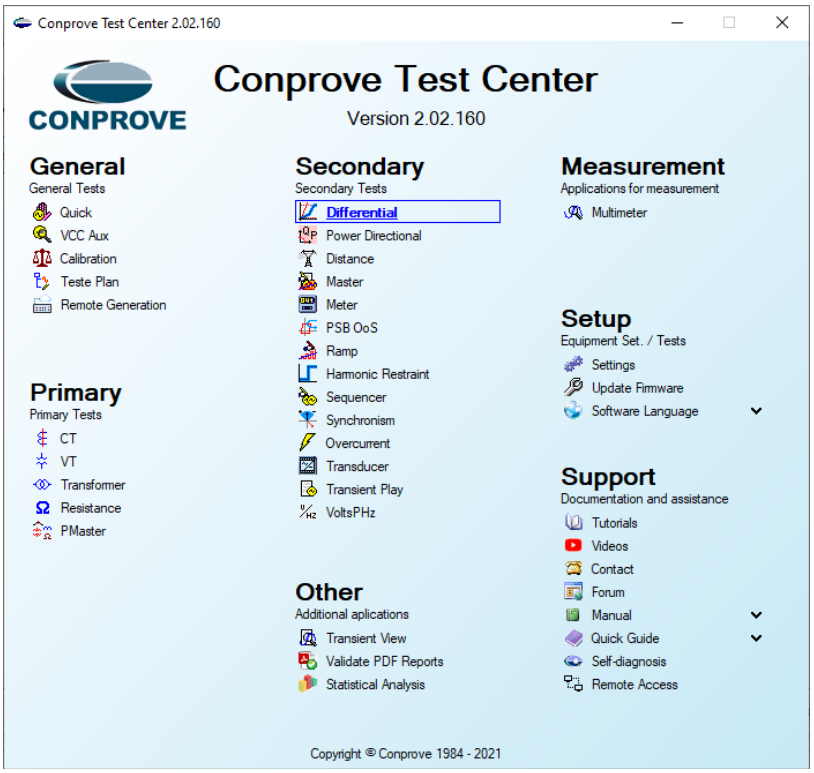

Figure 17

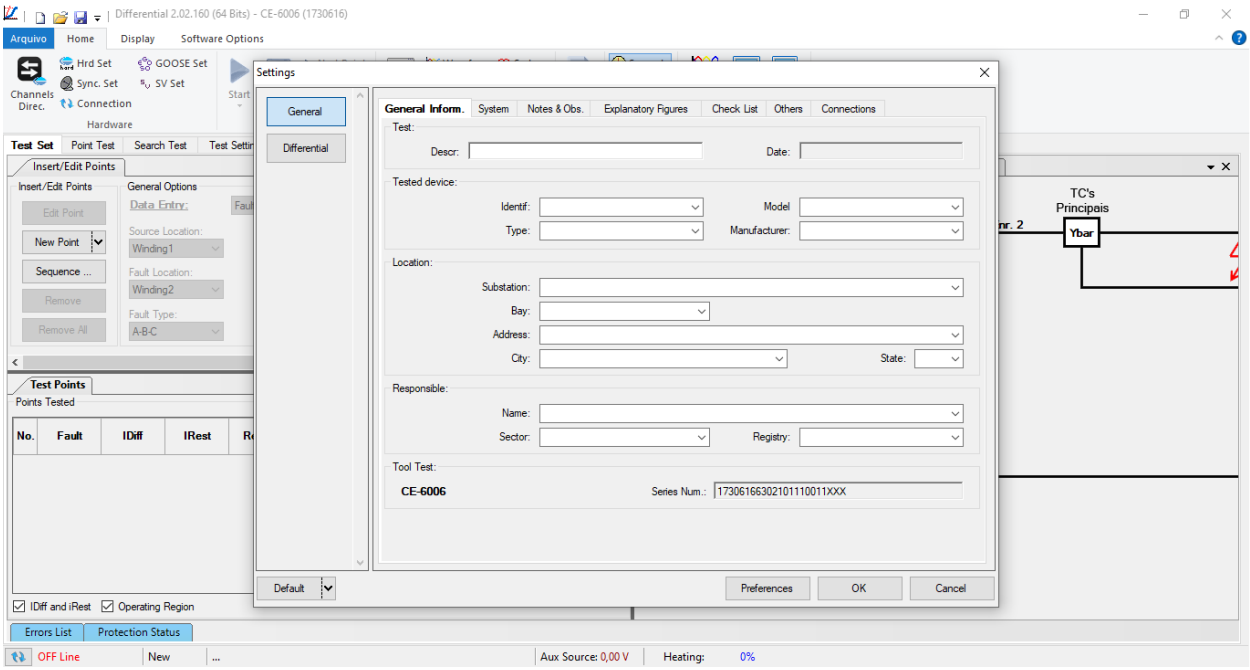

Figure 18

5.2 *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.

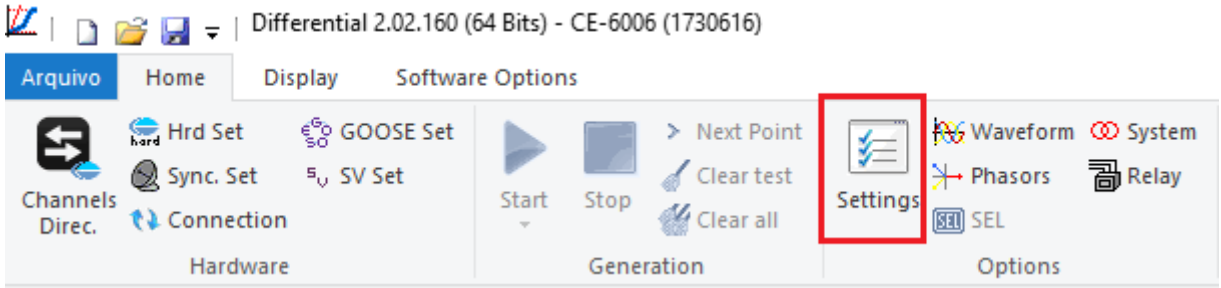

Figure 19

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.

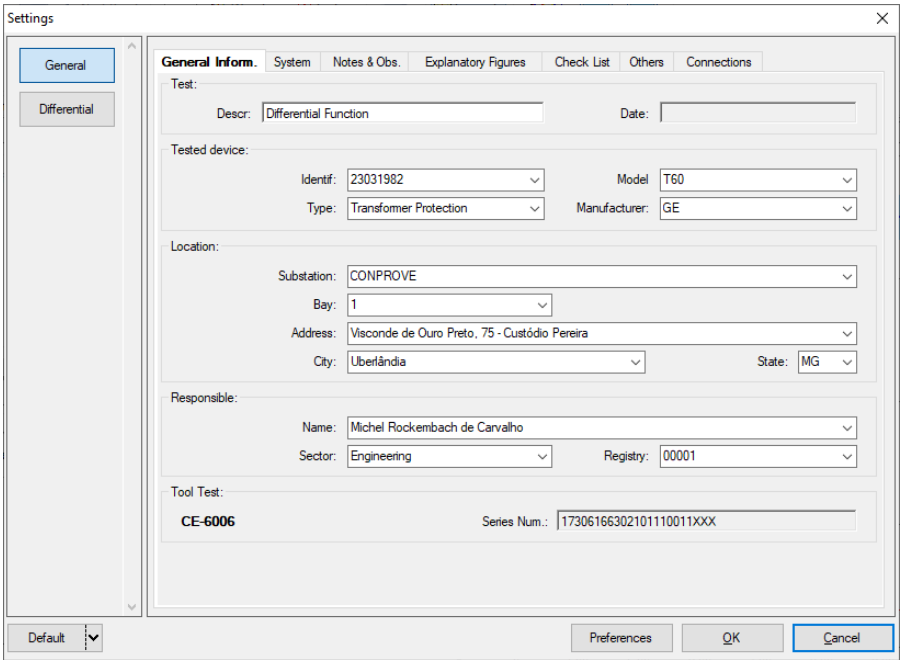

Figure 20

5.3 *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.

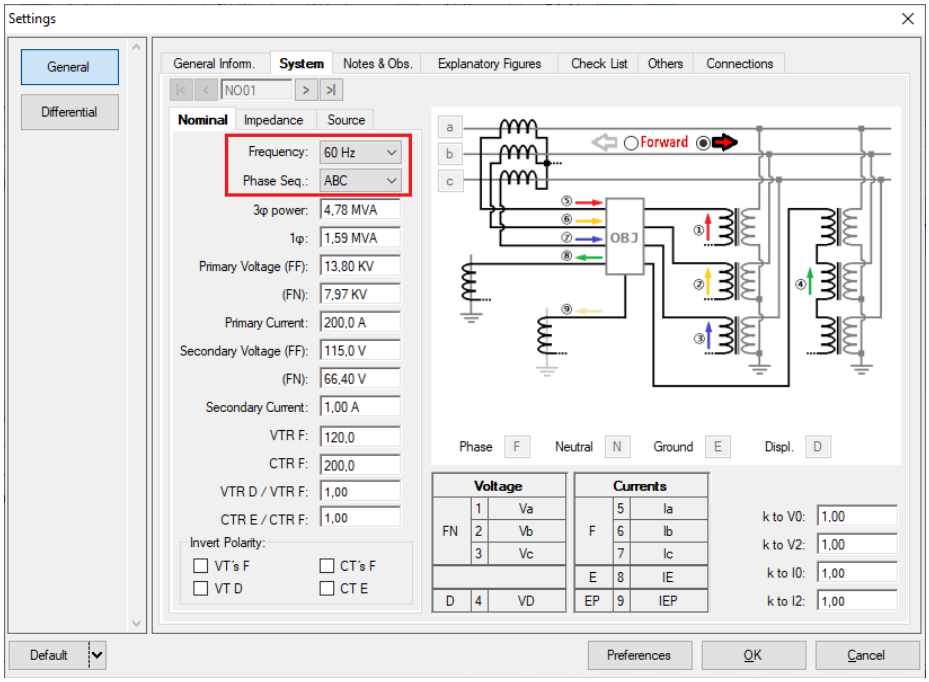

Figure 21

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 schematic with all the schematic of the connections between the test set and the test equipment.

6. Differential Adjustment

6.1 *Differential Screen > Protected Equipment/CTs*

In this tab you must inform the protected equipment, the number of windings, rated voltages, rated powers, connections, primary and secondary currents of the main CTs and the currents of the auxiliary CTs if necessary. This test uses the settings for a relay that is protecting a transformer. However, it is possible to test, in addition to the differential protection of transformers, the protections of generators, busbar, motor and line. For transformer protection there is the possibility of testing up to four windings automatically.

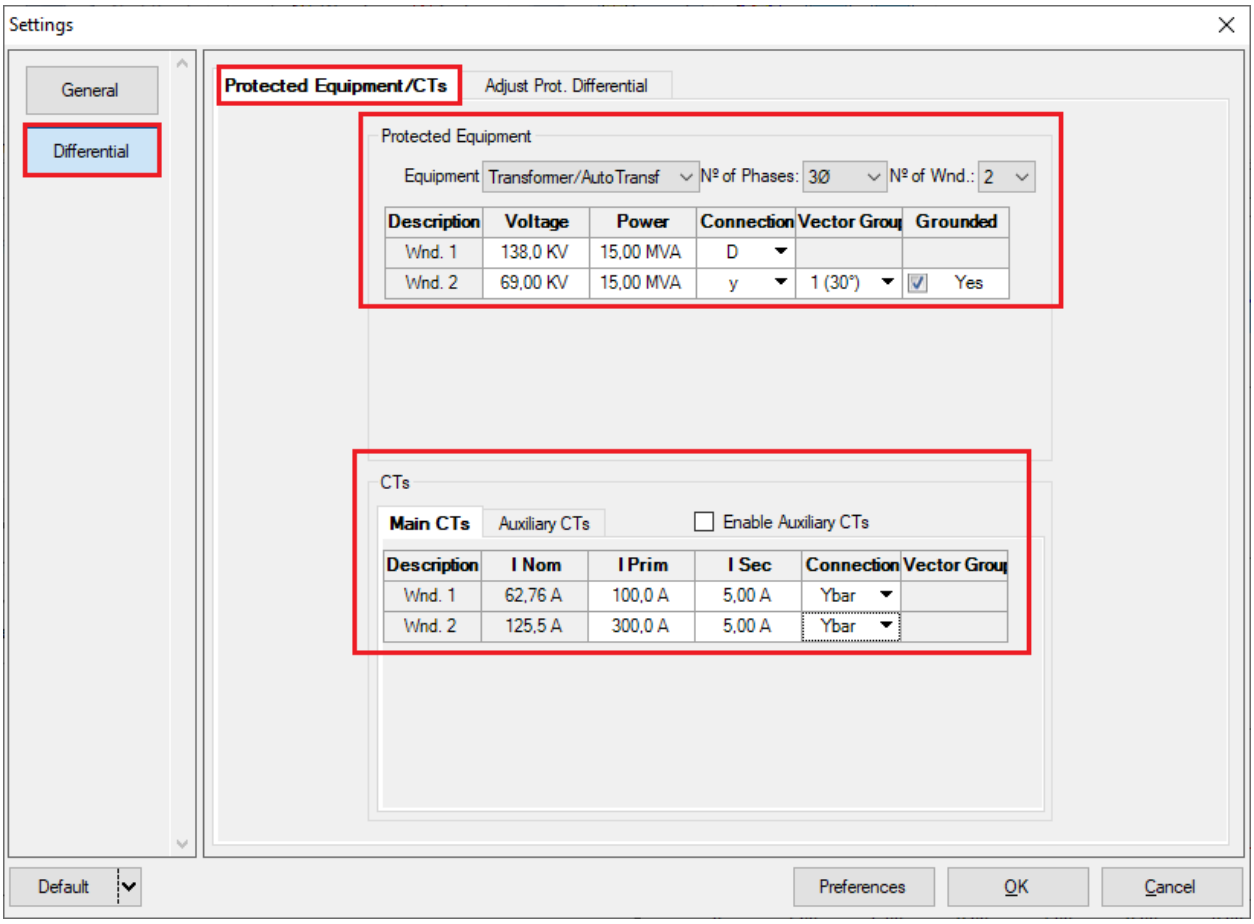

Figure 22

6.2 *Differential Screen > Adjust Prot. Differential > Settings*

The initial default for the *"Data Input"* field is set to *"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 relays from the list, only parameterized settings will be enabled. **The user must be aware that there are more current firmware versions that allow the user to parameterize which reference winding for mismatch correction (1, 2, N/A or automatic). The user must detect what is parameterized in the relay settings and inform this field in the DIFFERENTIAL software. Older versions fix this reference on winding 1.**

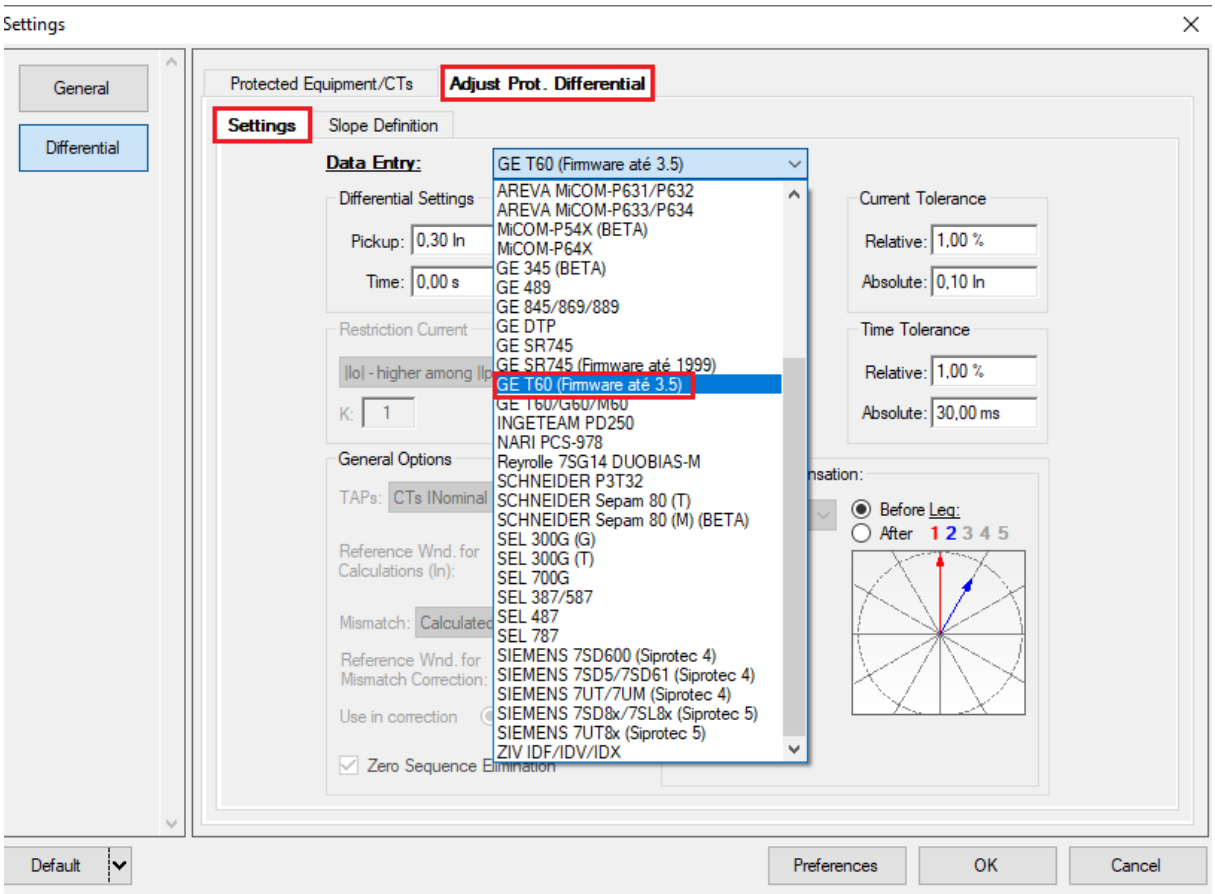

Figure 23

Choosing the mask *"GE T60 (firmware up to 3.5)"* makes adjustments easier. Current and time tolerances are taken from Appendix A.

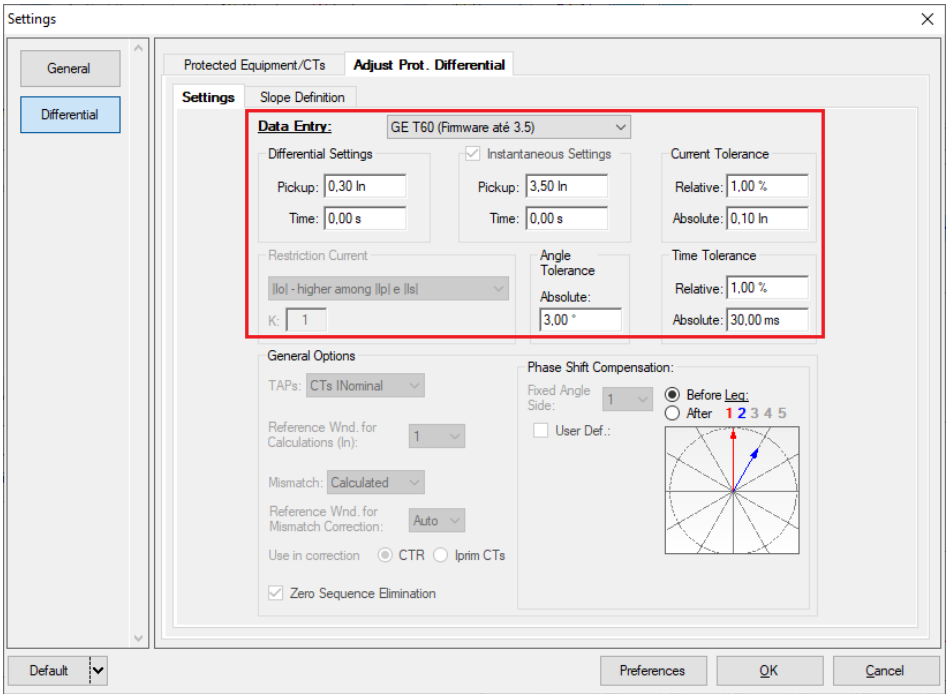

Figure 24

6.3 *Differential Screen > Adjust Prot. Differential > Slope Definition*

On this screen, the slope values and the *"Break Points"* must be entered.

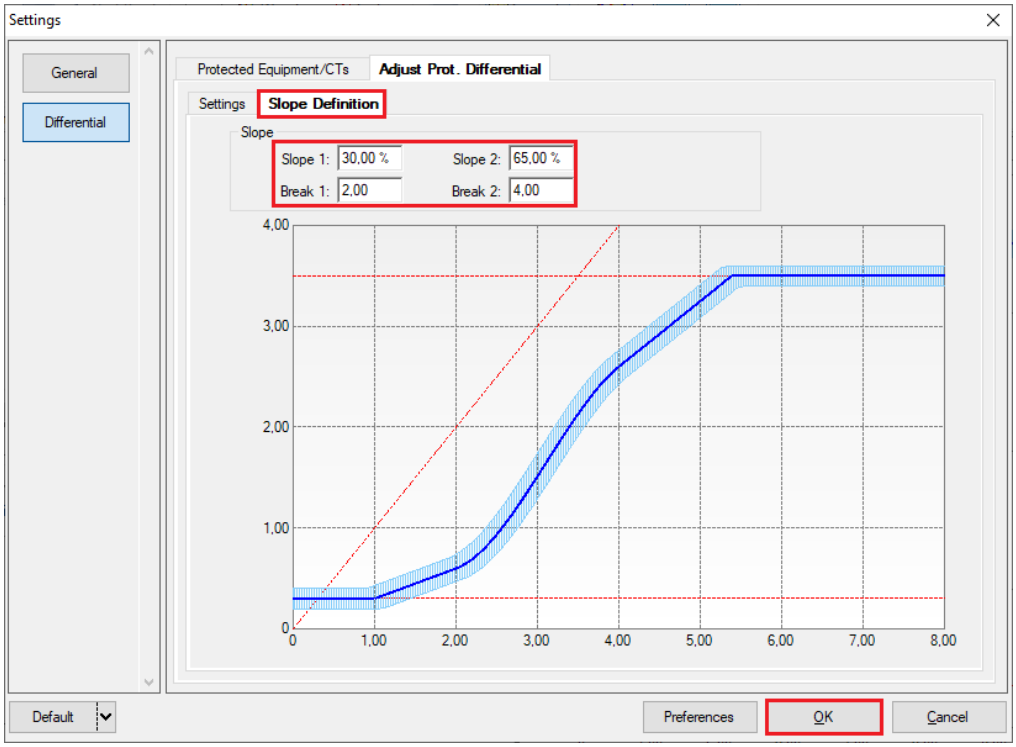

Figure 25

7. Channel Direction and Hardware Configurations

Click on the icon illustrated below.

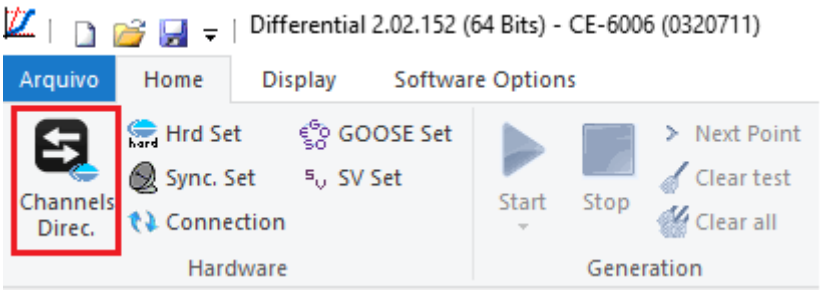

Figure 26

Then click on the highlighted icon to configure the hardware.

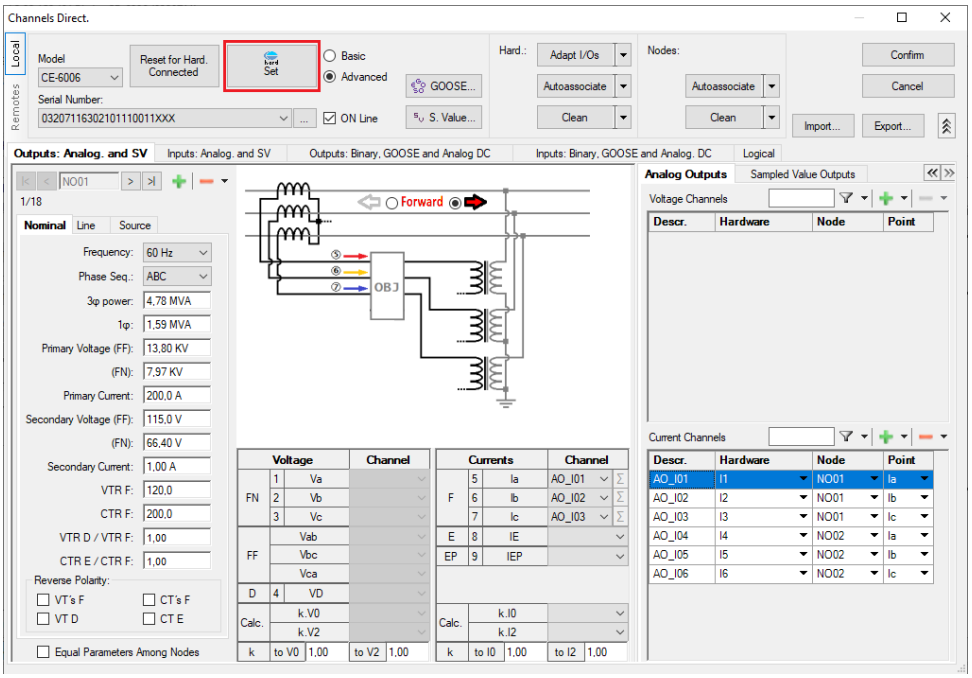

Figure 27

Choose the channel configuration; adjust the auxiliary source and the stopping method of the binary inputs. To finish click on *"OK"*.

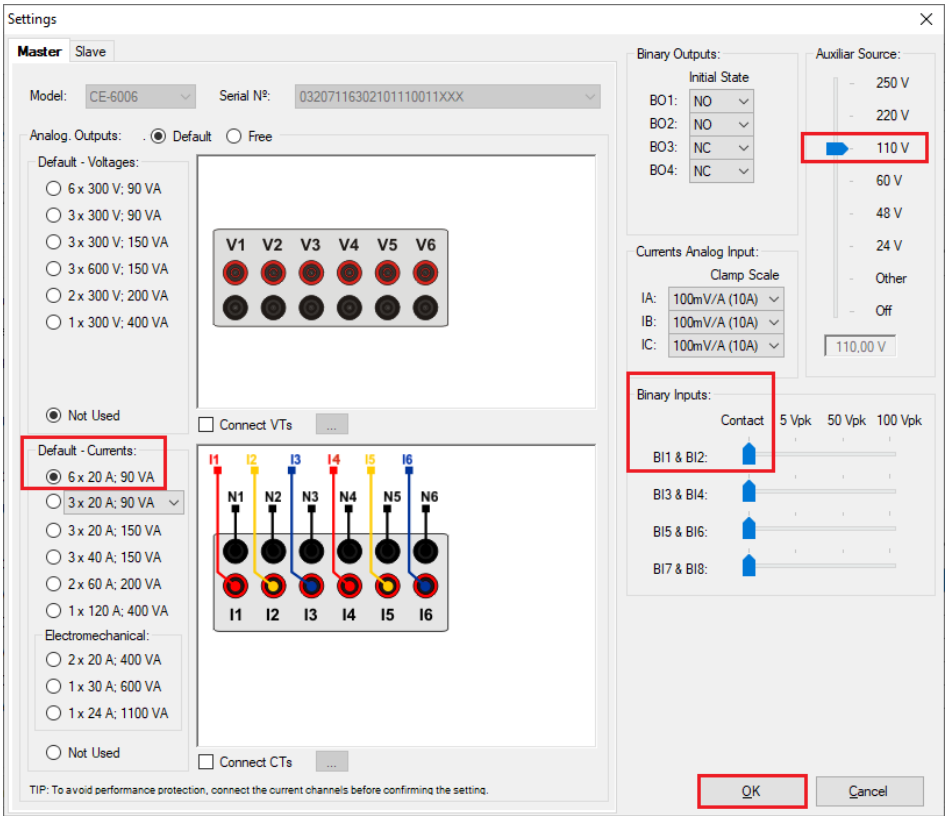

Figure 28

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

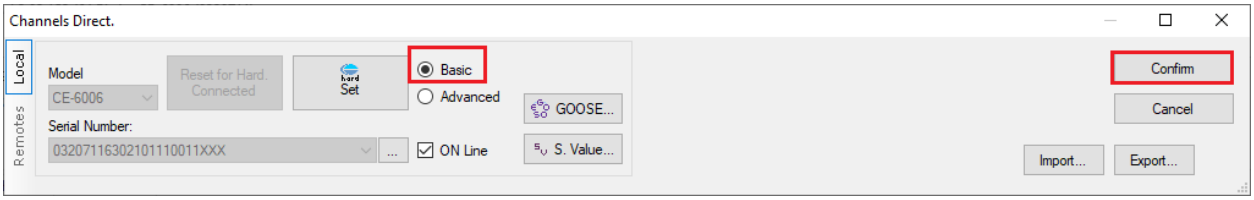

Figure 29

8. Test Structure for Function 87

8.1 *Test Settings*

In this tab, the trunk channels are associated with the relay phases; configure the trip signal with the binary input. An important detail is not to insert a pre-fault and finally choose the smart test mode as shown below. There are two test modes in the Differential software. In traditional mode IDIFF and IREST calculations are done based on the module. In intelligent mode, IDIFF and IREST calculations are made taking into account the angle. In this way it is possible to have a greater test range in the IDIFF x IREST characteristic.

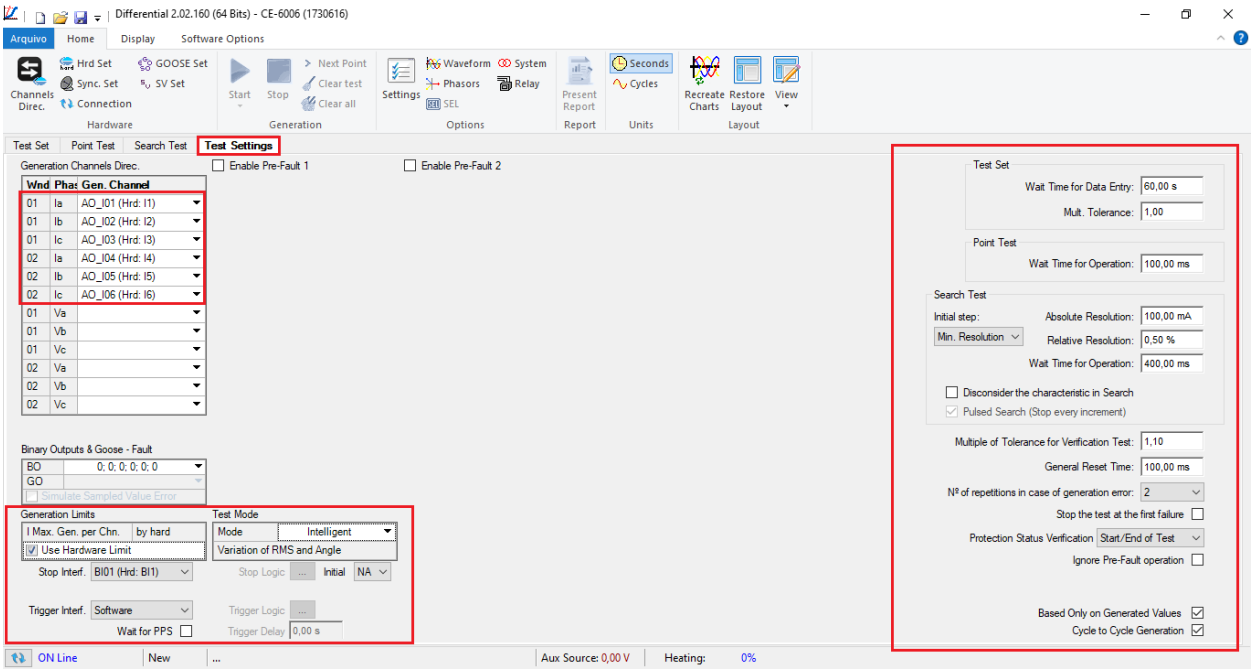

Figure 30

8.2 Test Set

The general idea of the *"Test Set"* is to verify that the relay settings and the settings parameterized in the software are compatible, as the software aims to simulate the behavior of the relay. To do so, enter a *"New Point"* according to the data below:

Point 1:

- **Data Entry:** IDiff e IRest
  - IDiff: 1,00 In
  - IRest: 2,00 In
- **Source Location:** Winding 1
- **Fault Location**: Winding 2
- **Fault Type:** ABC

By clicking on the option *"Chart"* you can see where the tested point is. For this test the point is in the operating region.

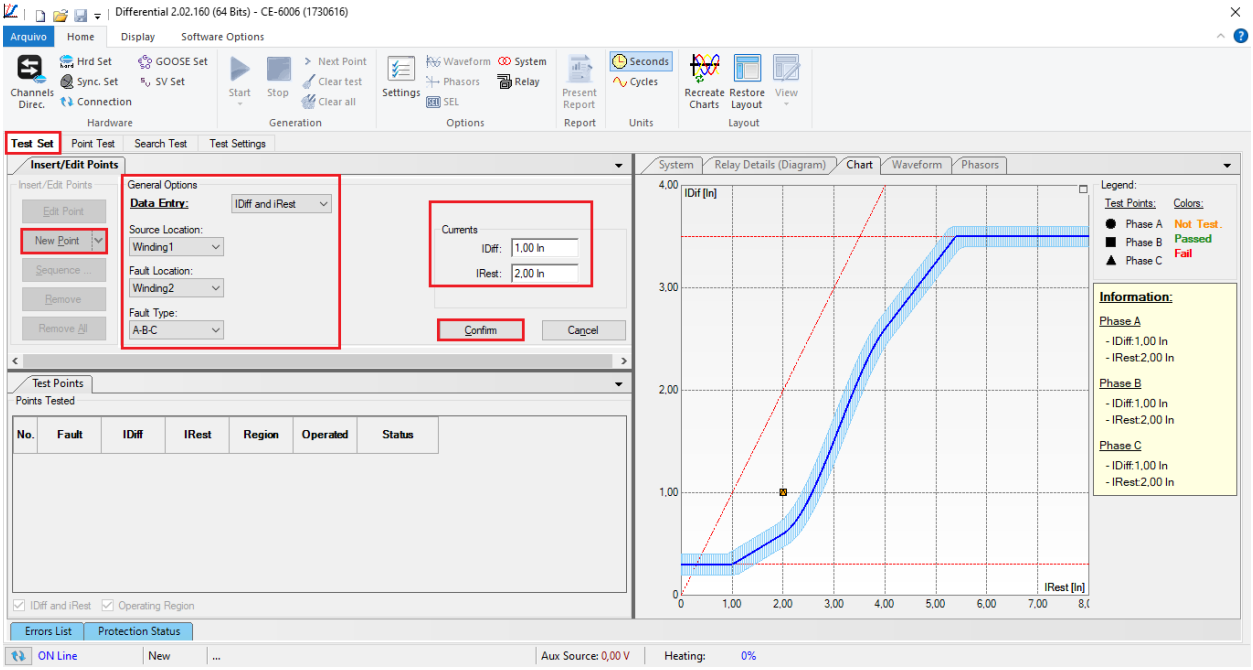

Figure 31

Click on the icon highlighted below or use the command *"Alt +G"*.

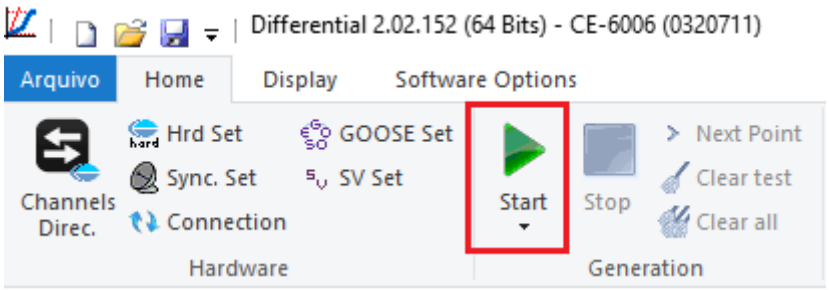

Figure 32

To view the measurement of the points click on the *"+"* signs near to *"Actual Values > Metering > Transformer"* and double click on *"Differential/Restraint"*.

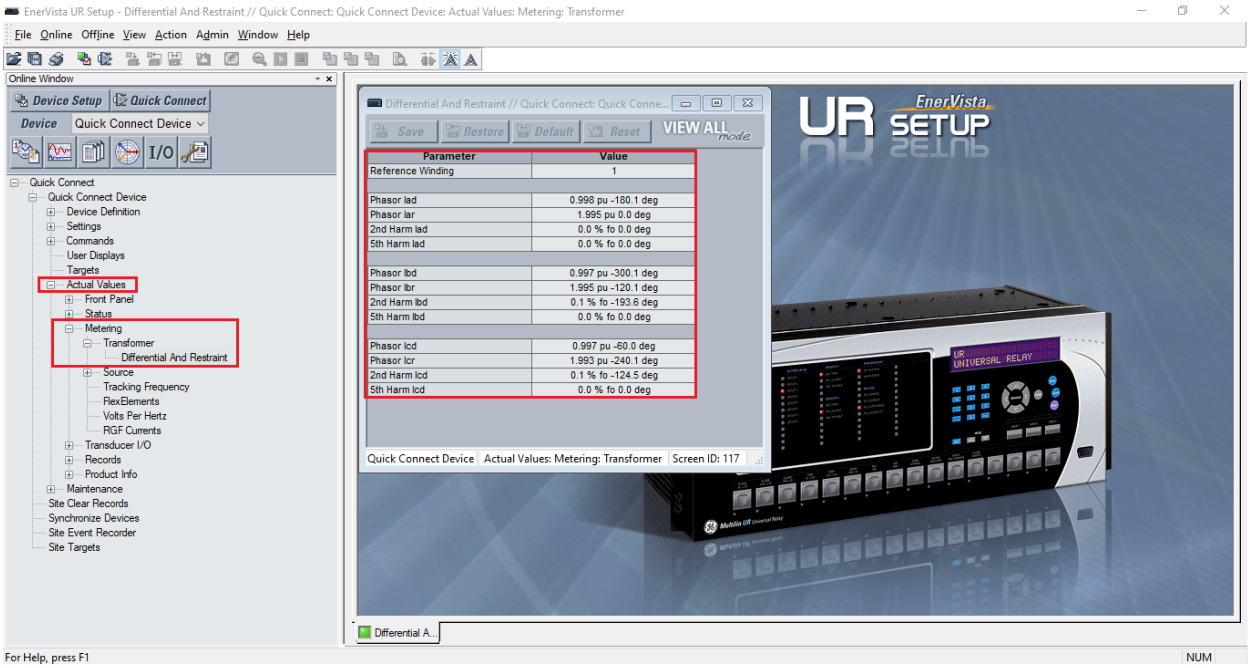

Figure 33

The next step is to write the values read in the *"Test Set Evaluation"* window.

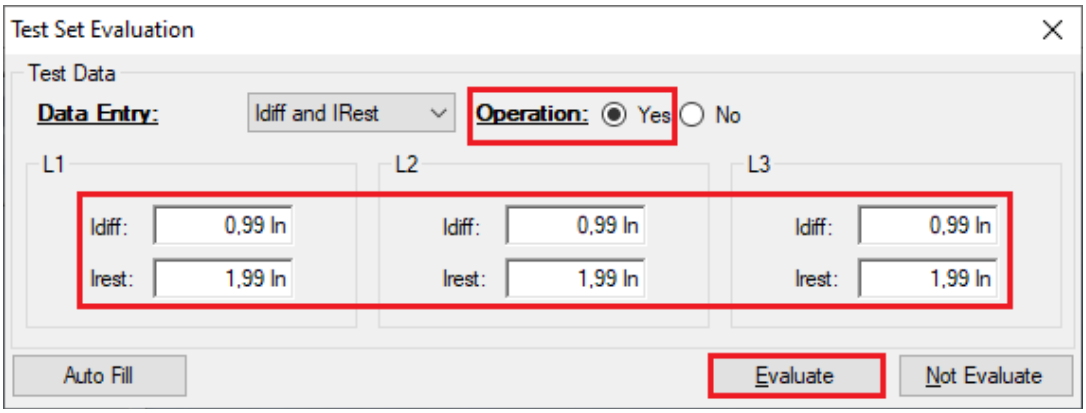

Figure 34

Passing the test set makes it possible for the other two tests to be carried out successfully. If there is a discrepancy between the values calculated by the software and those presented by the relay, the user must review his connections and settings.

9. Point Test

After the test set has passed, this means that the adjustment parameters passed to the software faithfully correspond to the behavior of the relay, in this way, the point test can be performed, since it analyzes don't only the operation of the relay , but also the shooting time.

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.

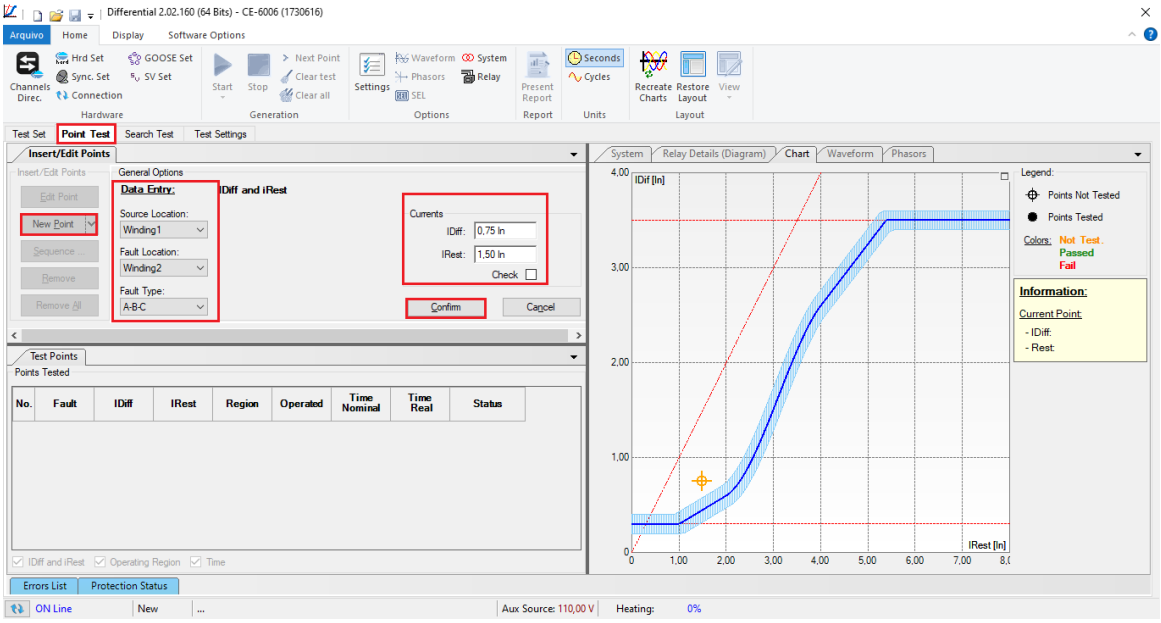

Figure 35

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.

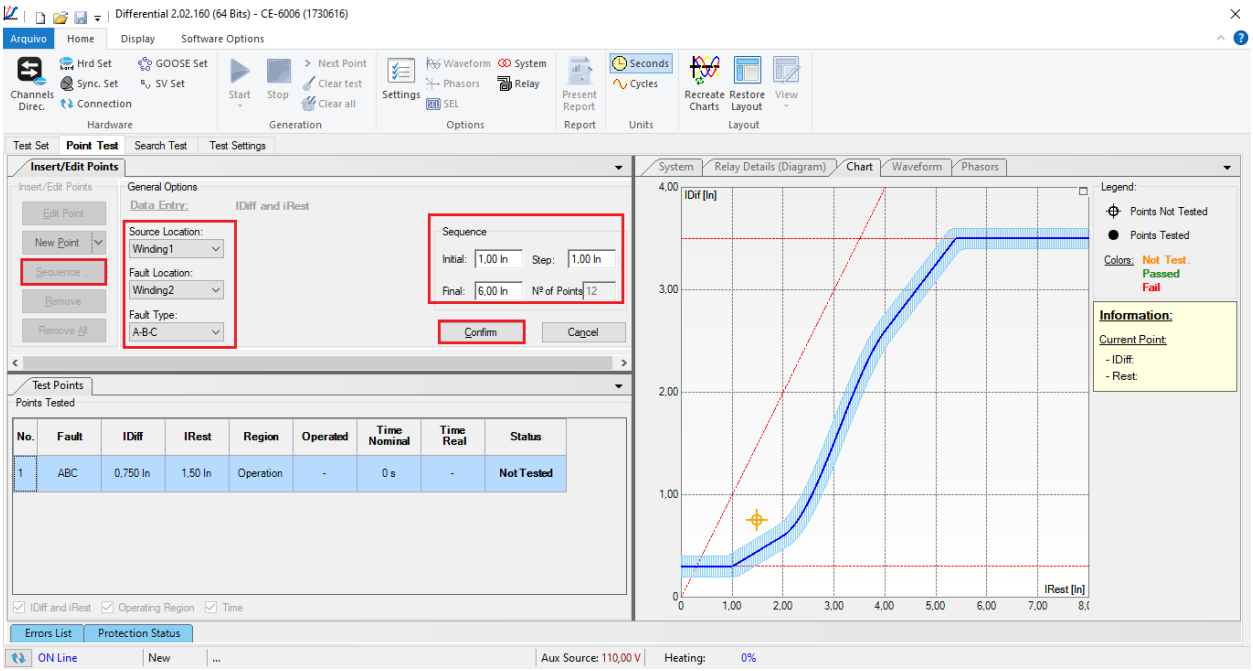

Figure 36

Click on the icon highlighted below or use the command *"Alt +G"*.

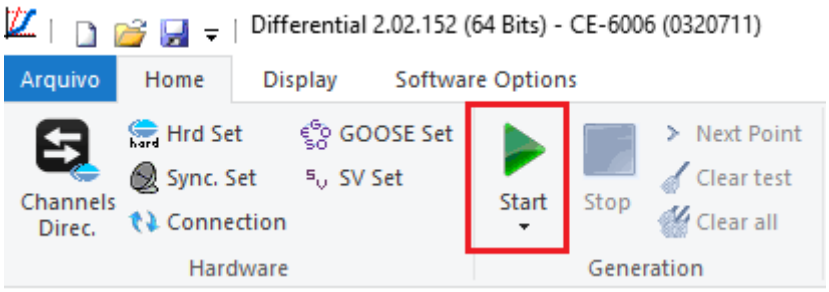

Figure 37

It is verified that all points were successfully approved.

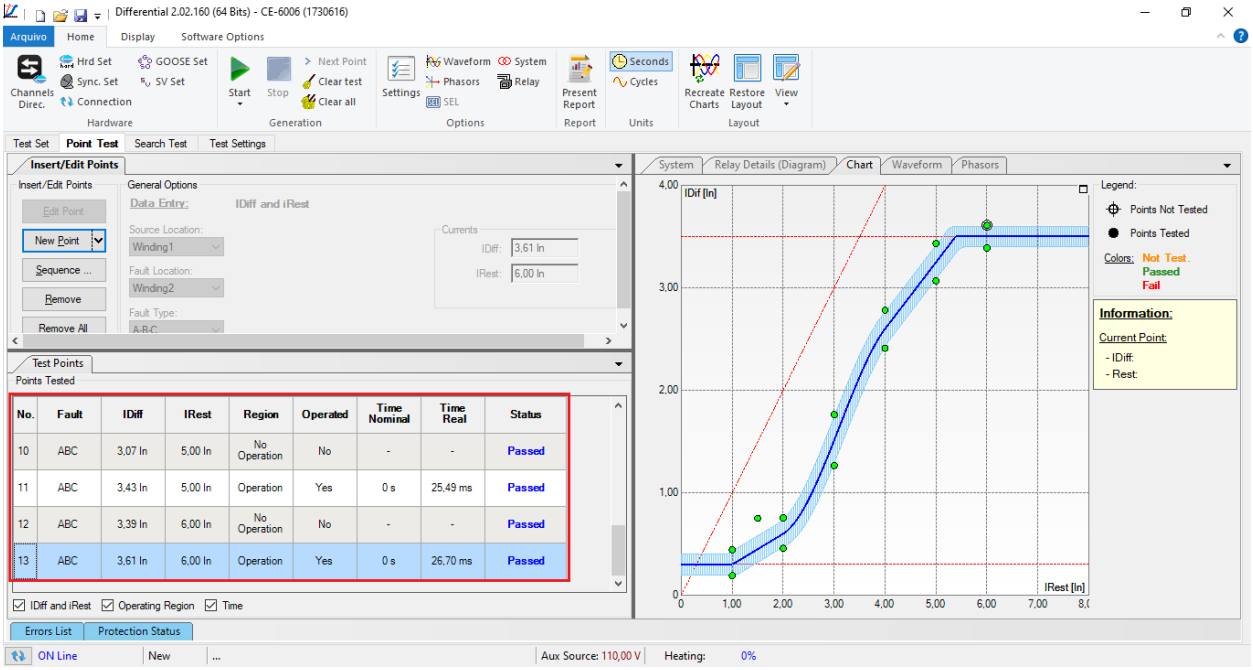

Figure 38

10. Search Test

To carry out the search test, click on the *"New Line"* field, choose the type of fault, the restraint current value and confirm.

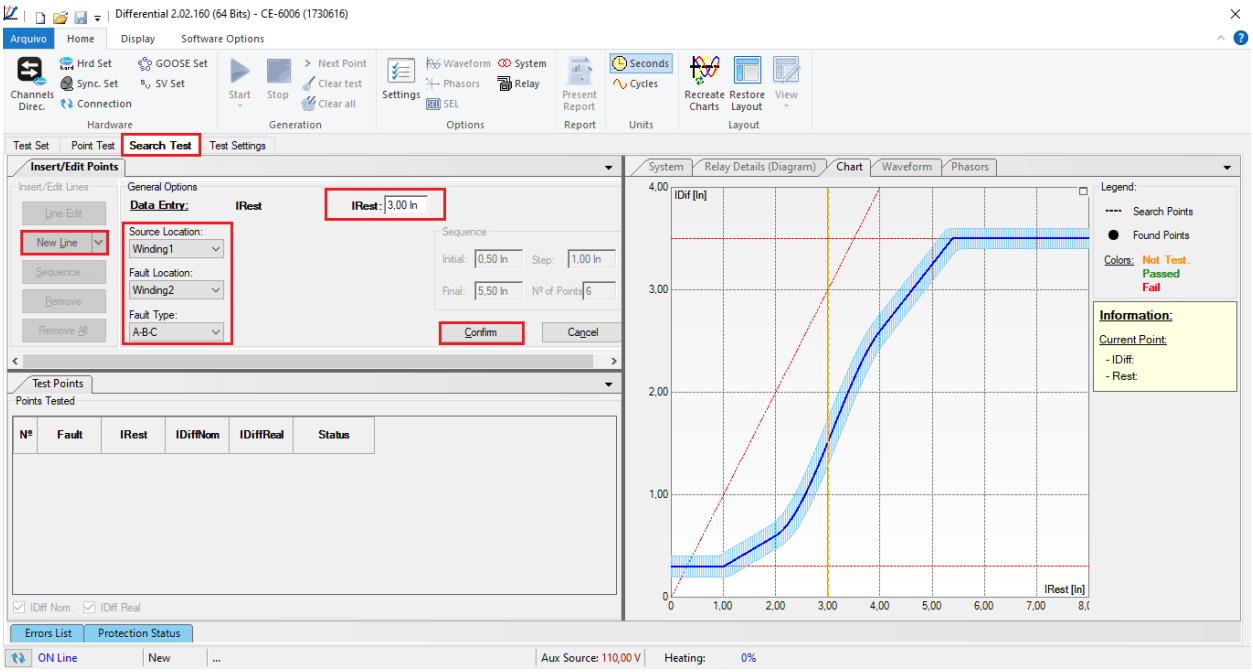

Figure 39

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 current of the search and the step between them.

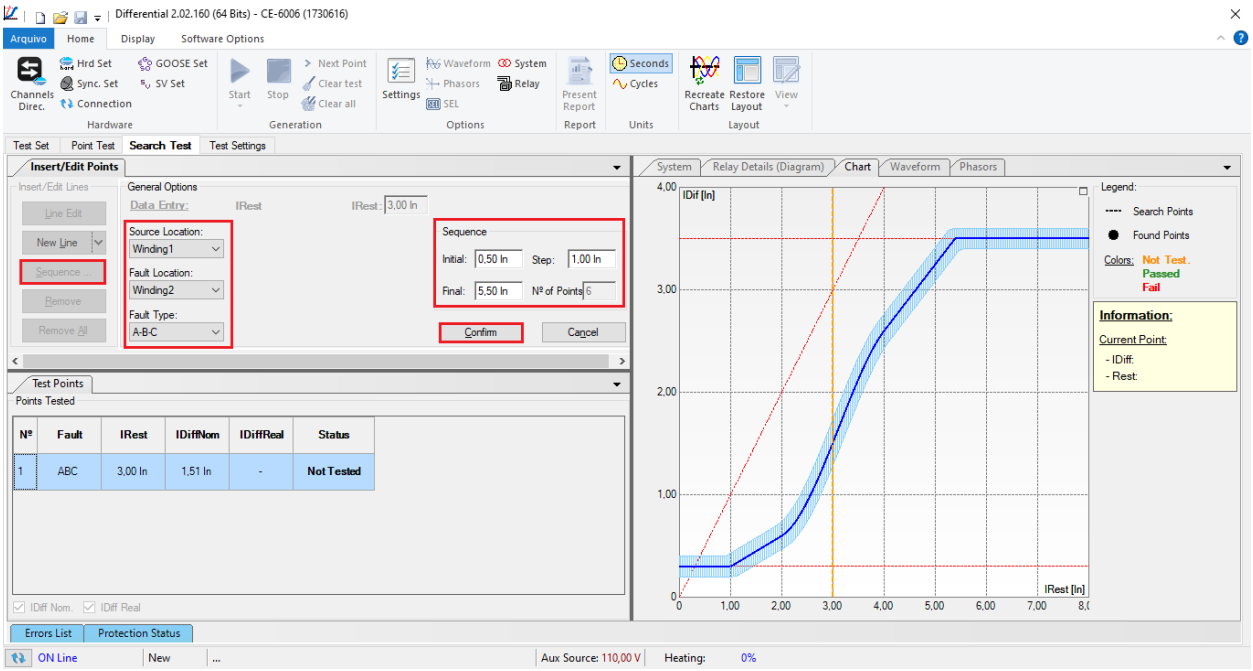

Figure 40

Click on the icon highlighted below or use the command *"Alt +G"*.

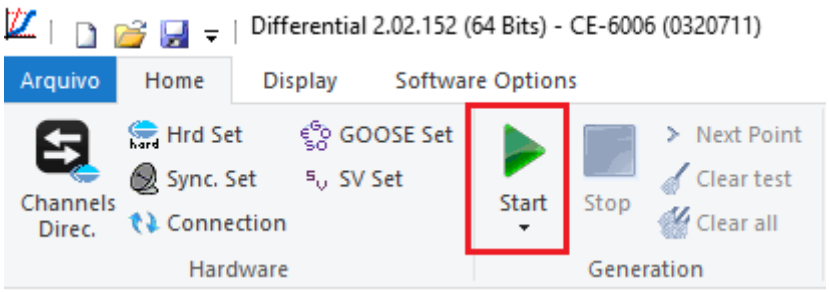

Figure 41

It is verified that all lines were successfully approved.

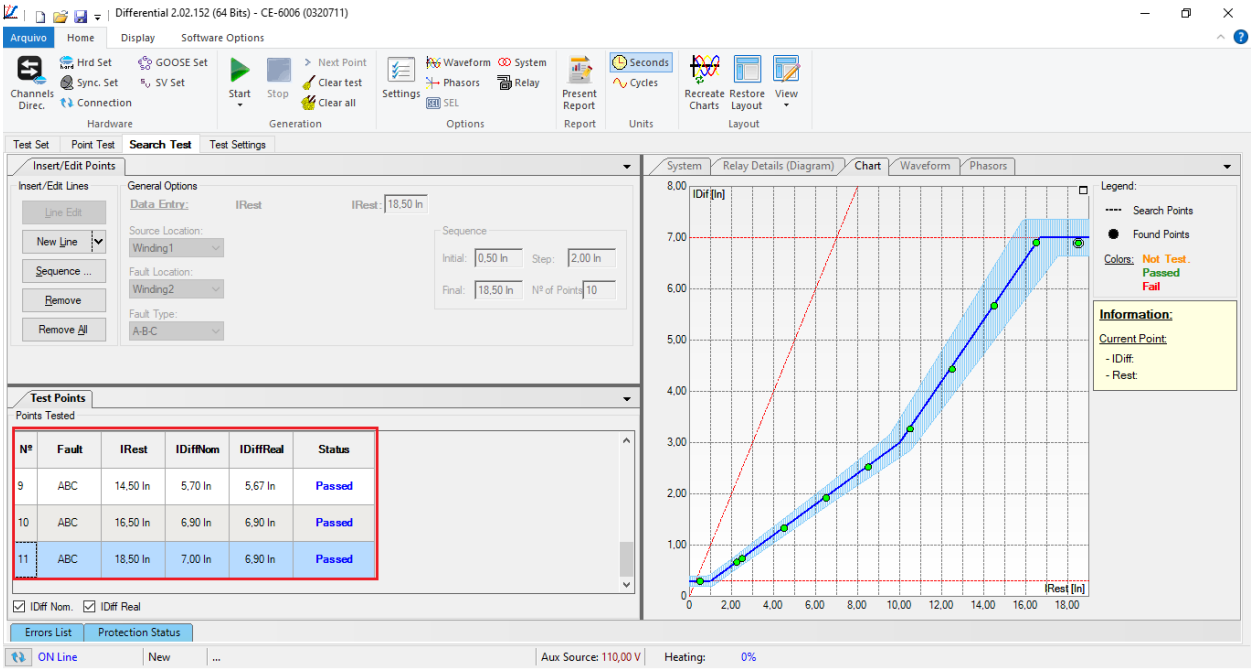

Figure 42

11. 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.

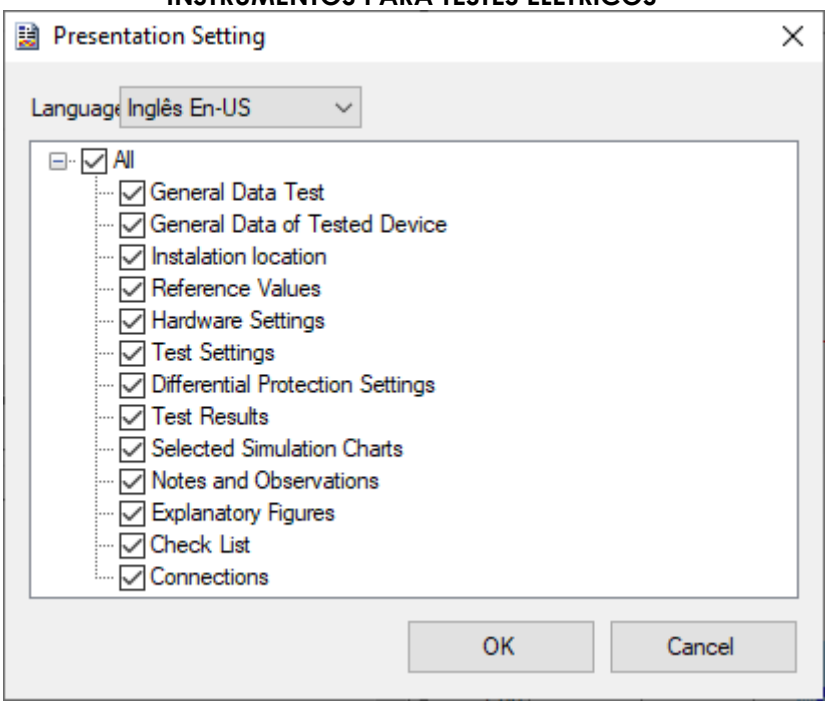

Figure 43

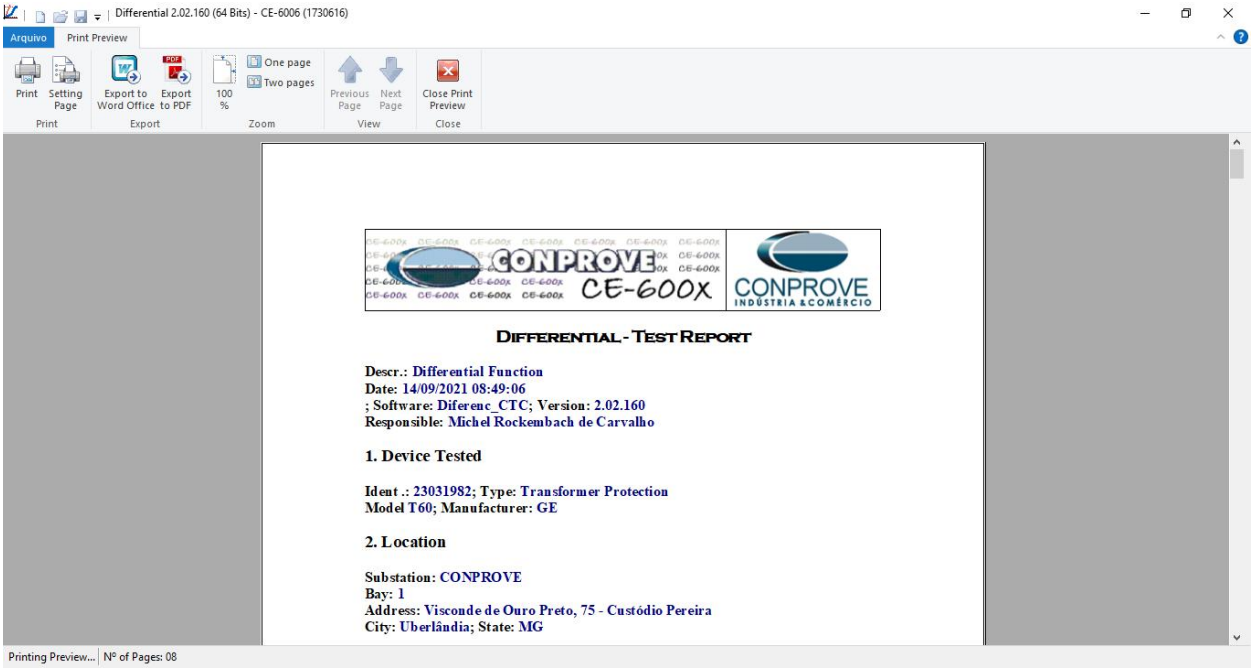

Figure 44

APPENDIX A

A.1 Terminal Designations

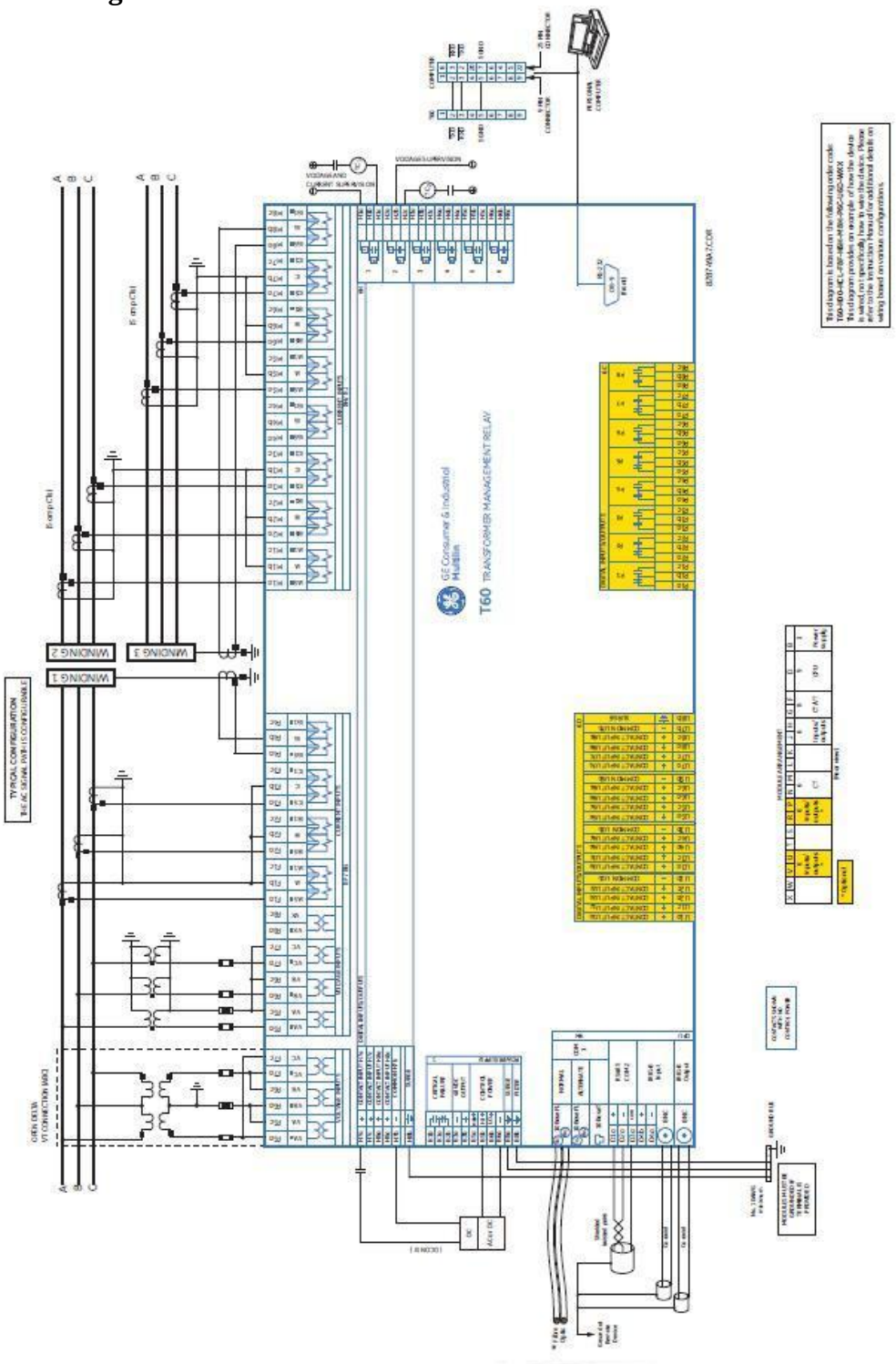

Figure 45

A.2 Technical Data

PERCENT DIFFERENTIAL

Characteristic:	Differential Restraint pre-set
Number of zones:	2
Minimum pickup:	0.05 to 1.00 pu in steps of 0.001
Slope 1 range:	15 to 100% in steps of 1%
Slope 2 range:	50 to 100% in steps of 1%
Kneepoint 1:	1.0 to 2.0 pu in steps of 0.0001
Kneepoint 2:	2.0 to 30.0 pu in steps of 0.0001

2^{nd} harmonic inhibit level: 1.0 to 40.0% in steps of 0.1

2^{nd} harmonic inhibit function: Adaptive, Traditional, Disabled

2^{nd} harmonic inhibit mode: Per-phase, 2-out-of-3, Average

5^{th} harmonic inhibit range: 1.0 to 40.0% in steps of 0.1

Operate times:

Harmonic inhibits selected: 20 to 30 ms at 60 Hz;
20 to 35 ms at 50 Hz

No harmonic inhibits selected: 5 to 20 ms

Dropout level:	97 to 98% of pickup
Level accuracy:	±0.5% of reading or ±1% of rated (whichever is greater)

INSTANTANEOUS DIFFERENTIAL

Pickup level:	2.00 to 30.00 pu in steps of 0.01
Dropout level:	97 to 98% of pickup
Level accuracy:	±0.5% of reading or ±1% of rated (whichever is greater)
Operate time:	< 20 ms at 3 × pickup at 60 Hz

APPENDIX B

Equivalence of software parameters and the relay under test.

Table 1

Differential Software		GE T60 Relay	
Parameter	**Figure**	**Parameter**	**Figure**
Voltage (Wind. 1)	22	Nominal Phs-phs Voltage	11
Voltage (Wind. 2)	22	Nominal Phs-phs Voltage	11
Power (Wind. 1 and 2)	22	Rated MVA	11
Vector Group (Wind. 2)	22	Angle Wrt Winding 1	11
I Prim (Wind. 1)	22	Phase CT Primary	08
I Prim (Wind. 2)	22	Phase CT Primary	08
I Sec (Wind. 1)	22	Phase CT Secondary	08
I Sec (Wind. 2)	22	Phase CT Secondary	08
Differential Settings (pickup)	24	Pickup	12
Instantaneous Settings (pickup)	24	Pickup	13
Slope 1	25	Slope 1	12
Slope 2	25	Slope 2	12
Break 1	25	Break Point 1	12
Break 2	25	Break Point 2	12