Test Tutorial

Equipment Type: Protection Relay

Brand: Siemens

Model: 7UT61

Function: 87 or PDIF Differential Protection

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	10/08/2021	M.R.C.	M.P.S

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Summary

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Statement of responsibility

The information contained in this tutorial is constantly verified. However, differences in description cannot be completely excluded; in this way, CONPROVE disclaims any responsibility for errors or omissions contained in the information transmitted.

Suggestions for improvement of this material are welcome, just user contacts us via email suporte@conprove.com.br.

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

This document is intended as a guide only; the manual of the equipment under 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.

Copyright

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 F1 (UH+) of the relay and the negative (black terminal) of the Vdc Aux. Source to pin F2 (UH-) of the relay.
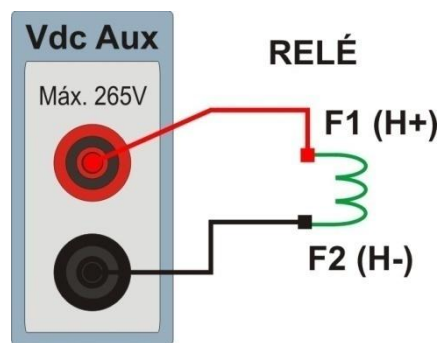
Figure 1

1.2 *Current Coils*

Connect the I1, I2 and I3 current channels of the CE-6006 to pins Q1, Q3 and Q5 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 Q2, Q4 and Q6 relay then forming the winding dial 1. Likewise, to establish the winding 2 connection, connect I4, I5 and I6 current channels to relay pins R1, R3 and R5 respectively, connecting the common three to pins R2, R4 and R6.

Figure 2

1.3 *Binary Input*

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

- BI1 to pin P1 and its common to pin P5;
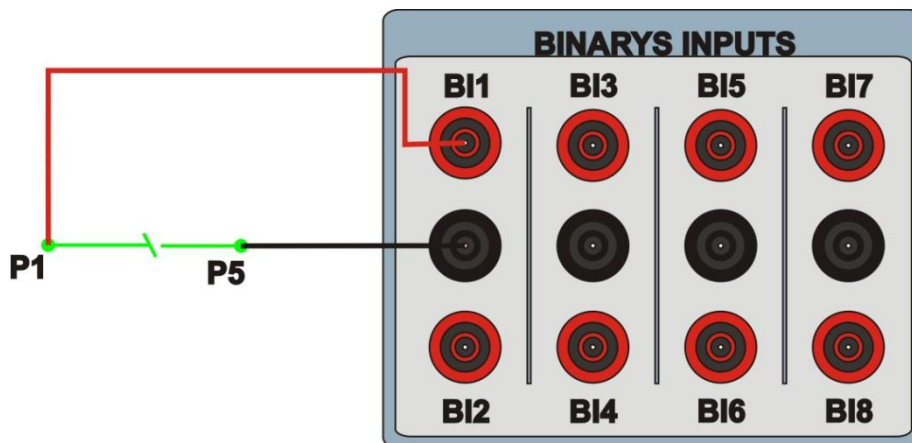
Figure 3

2. Communication with 7UT61 relay

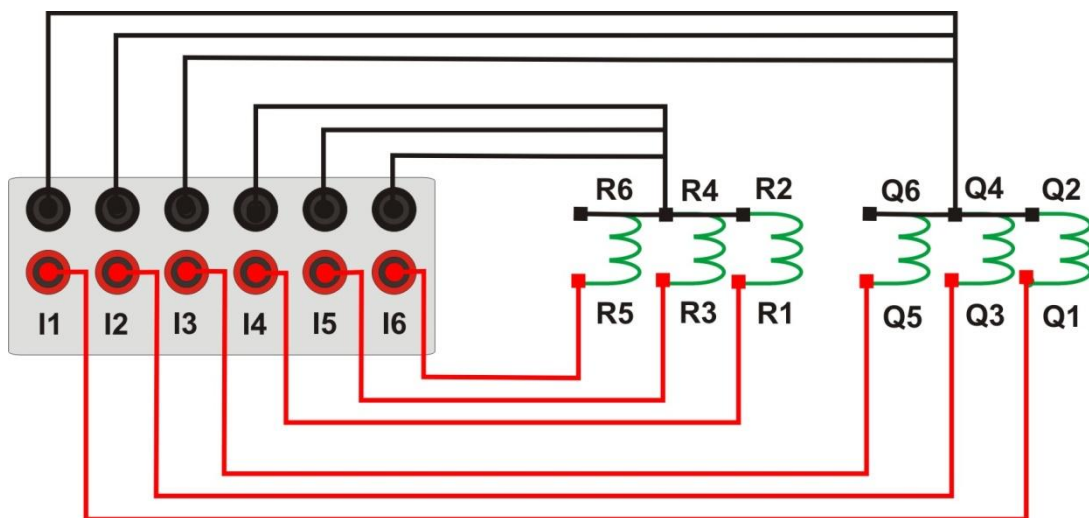First open the *"DIGSI"* and connect an Ethernet cable (or serial) from the notebook with the relay. Then double click on the software icon.

Figure 4

When opening the program, the substation that contains the relay is selected (7UT61). After selecting the relay, click the right button and select the *"Open Object"* and then select the connection mode, as is shown in s following figures.

Figure 5

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Figure 6

3. Tested System Data

Transformer, CT and differential function data are in the following tables:

3.1 *Protected Equipment Data / CT's*

Table 1

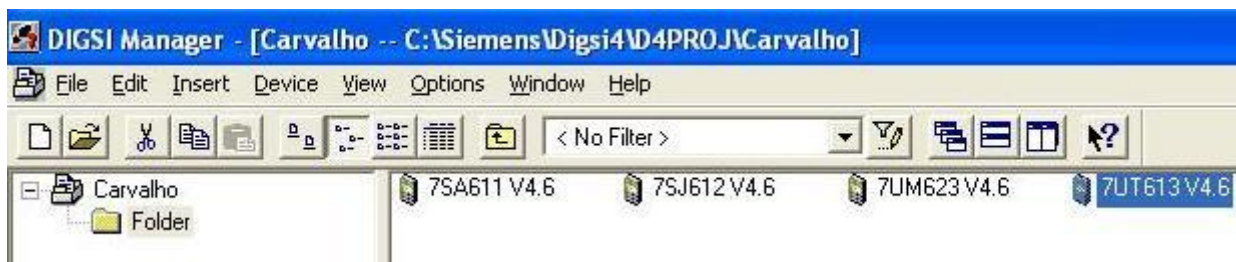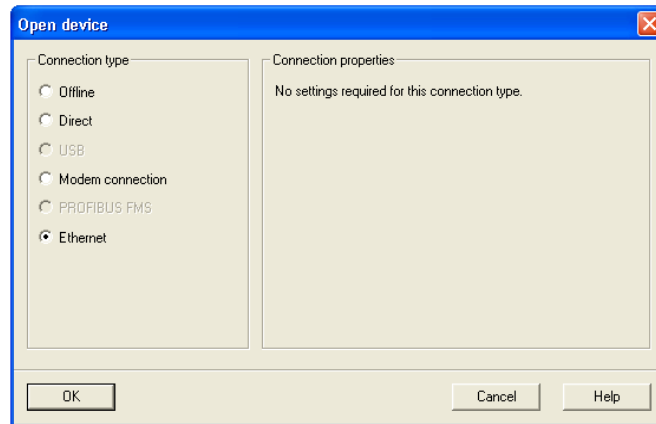| General data	Values
Number of Windings	two
Protected Equipment	Transformer
Primary Voltage (Side 1)	110 kV
Primary Power (Side 1)	38.1 MVA
Secondary Voltage (Side 2)	11 kV
Secondary Power (Side 2)	38.1 MVA
Connection (Side 1)	Δ
Connection (Side 2)	Y
Vector Group	1
RTC 1	200/1
RTC 2	2000/1

3.2 *Protection Data*

Table 2

General data	Values
Differential Pickup (87-1)	0.3 In
Differential Time	0 s *
Snapshot Pickup (87-2)	7 In
Snapshot Time	0 s *
Base Point 1	0
Base Point 2	5
slope 1	30%
slope 2	60%

*Theoretical value varies in practice between 20 ms to 50 ms depending on the relay.

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4. Parameterization of the relay 7UT61

4.1 *Device Configuration*

After the connection has been established, access the general relay settings by double left-clicking on *"Settings"* and repeat the operation for *"Device Configuration"*.
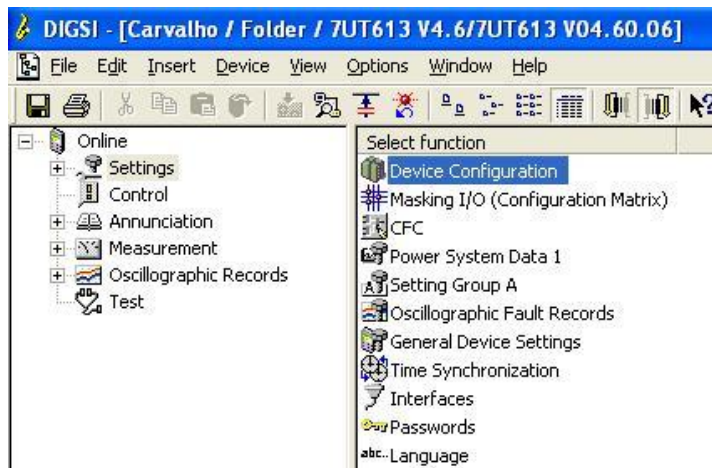
Figure 7

In the *"Functional Scope"* screen, disable all functions leaving only the *"87 Differential Protection"* function enabled. This does testing easier as it prevents the use of the trip signal from other functions. After the adjustments click *"OK"*.

Figure 8

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4.2 *Masking I/O*

The next step is to adjust the binary outputs of the relay. To access these parameters, double-click with the left button on *"Masking I/O (Configuration Matrix)"* as illustrated in the next figure.
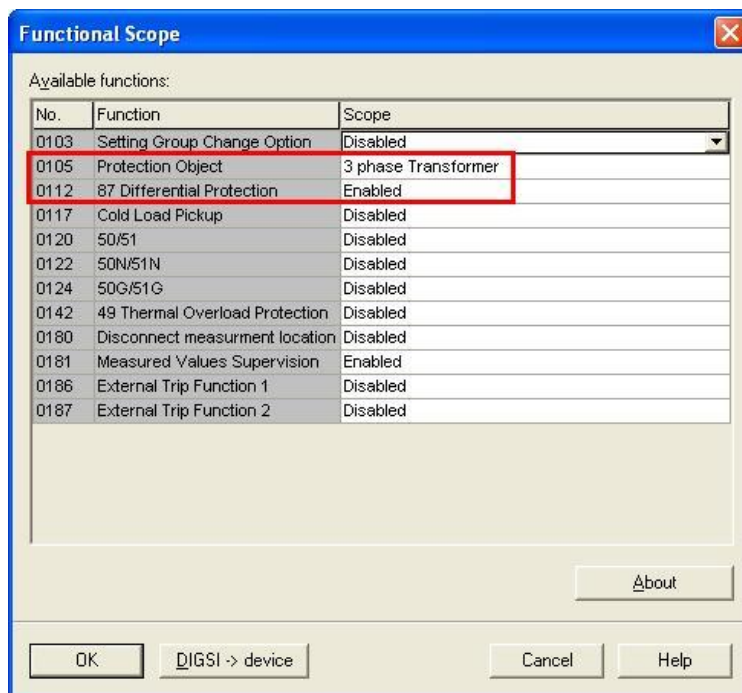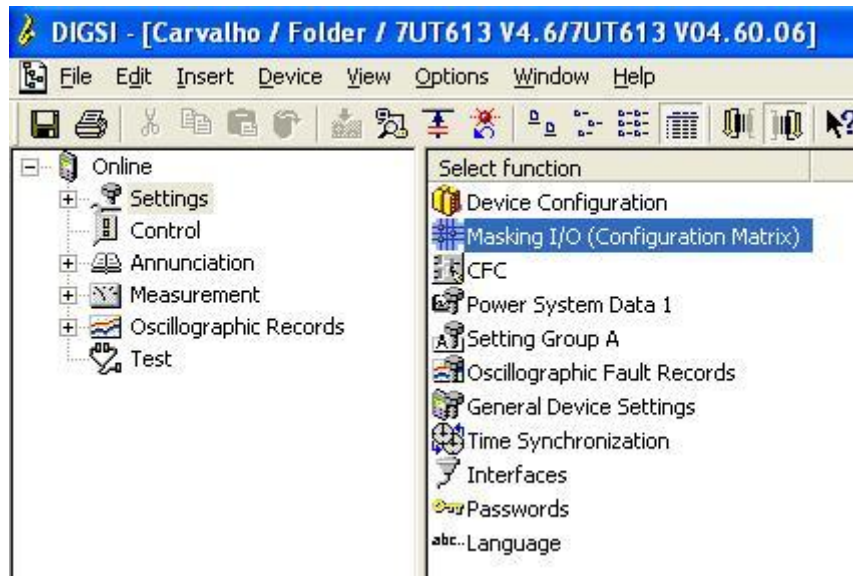

Figure 9

The trip signal from function 87 will be routed to output binary *"BO1"* of the relay. To facilitate the monitoring of this test, led 1 was designated for this function. The option *"U"* must be used, which means *"Unlatched"*, that is, the relay activates and when the problem ceases , it automatically returns to the initial binary state . If the user chooses the *"L"* or "*Latched*" option, the relay activates and remains activated even if the problem has been extinguished. (This option is not suitable for testing).
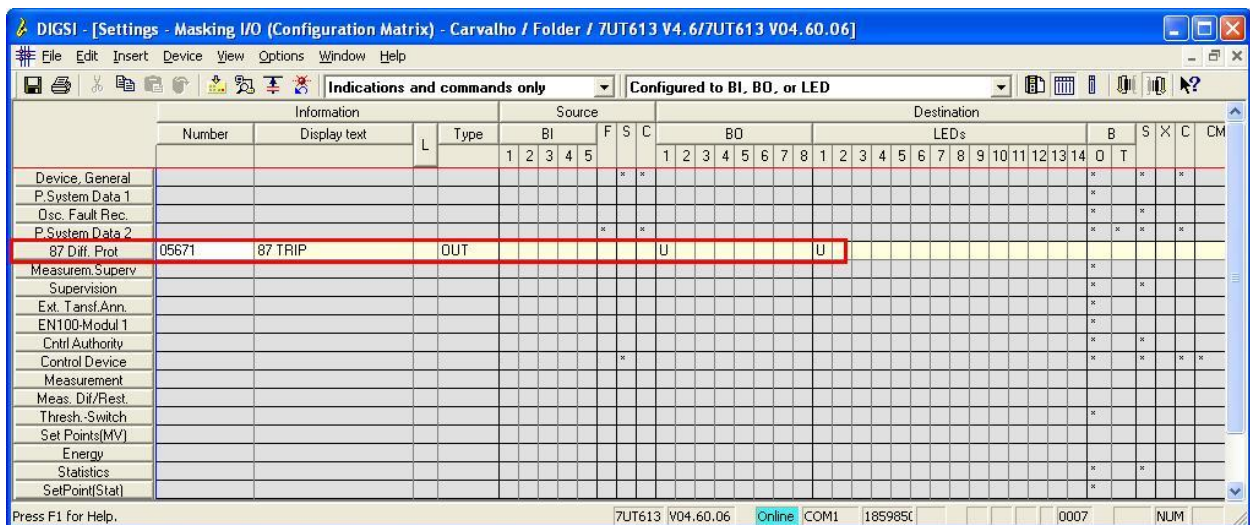

Figure 10

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4.3 *Power System Data 1*

Continuing the settings, double-click on *"Power System Data 1"*.
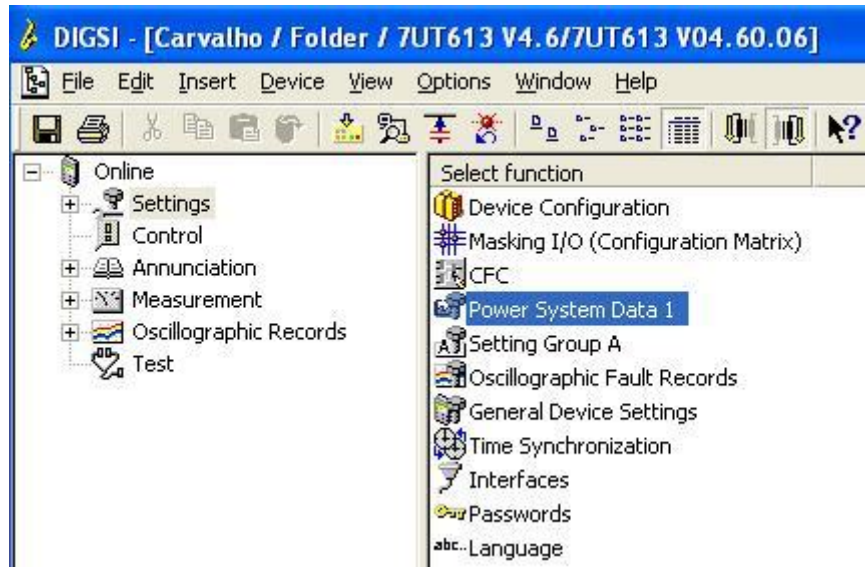
Figure 11

In the tab *"CT-Number"* the number of transformer windings is configured.
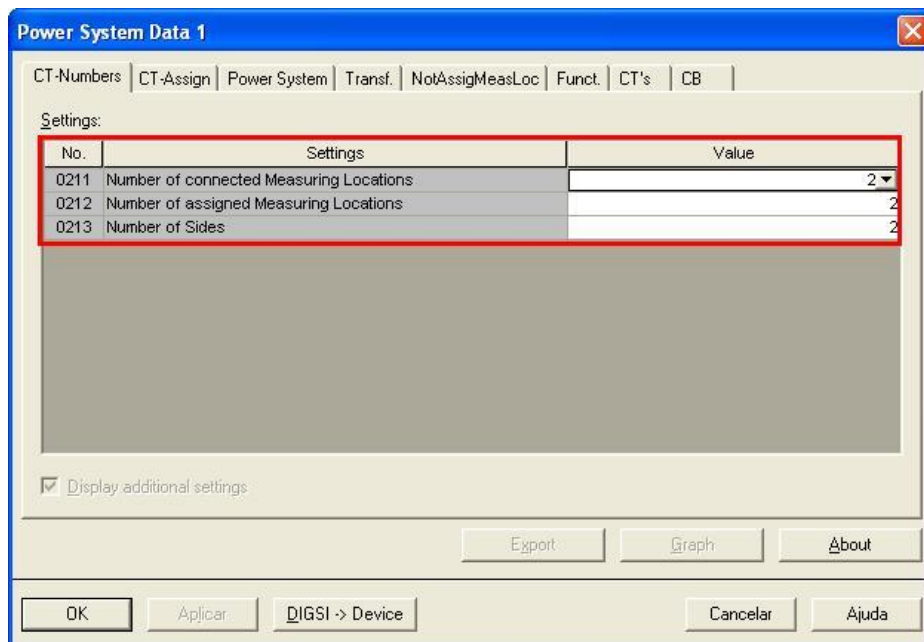
Figure 12

4.4 *CT-Assign*

In this tab you can insert how the auxiliary current transformers are connected. In this example, auxiliary CTs are not used.

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Figure 13

4.5 *Power System*

On the *"Power System"* tab, the nominal voltage, the phase sequence and the temperature unit are configured.

Figure 14

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4.6 *Transf.*

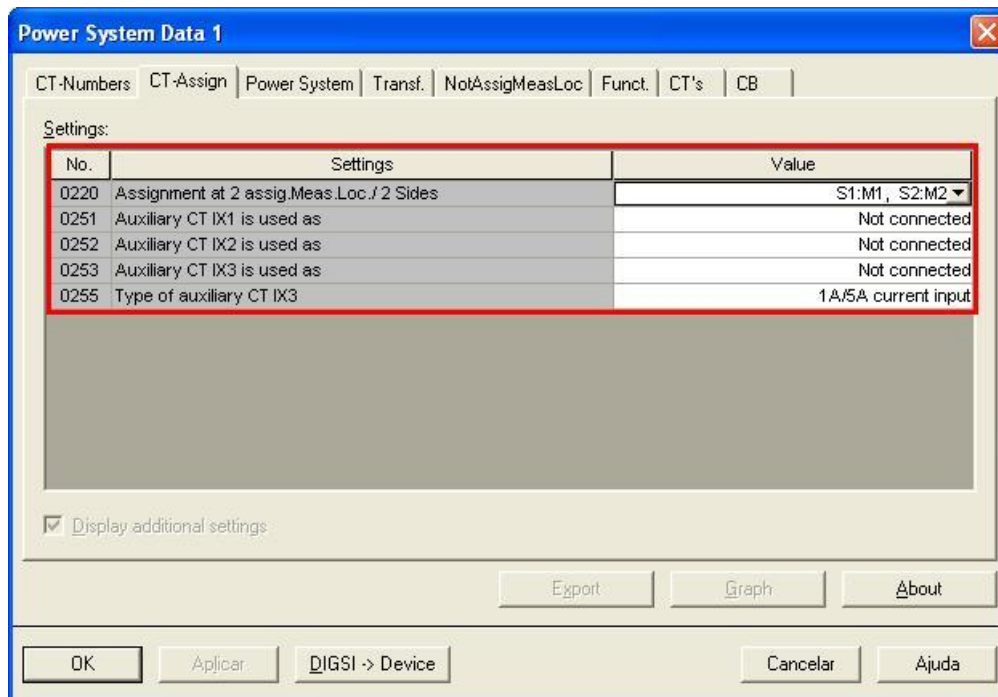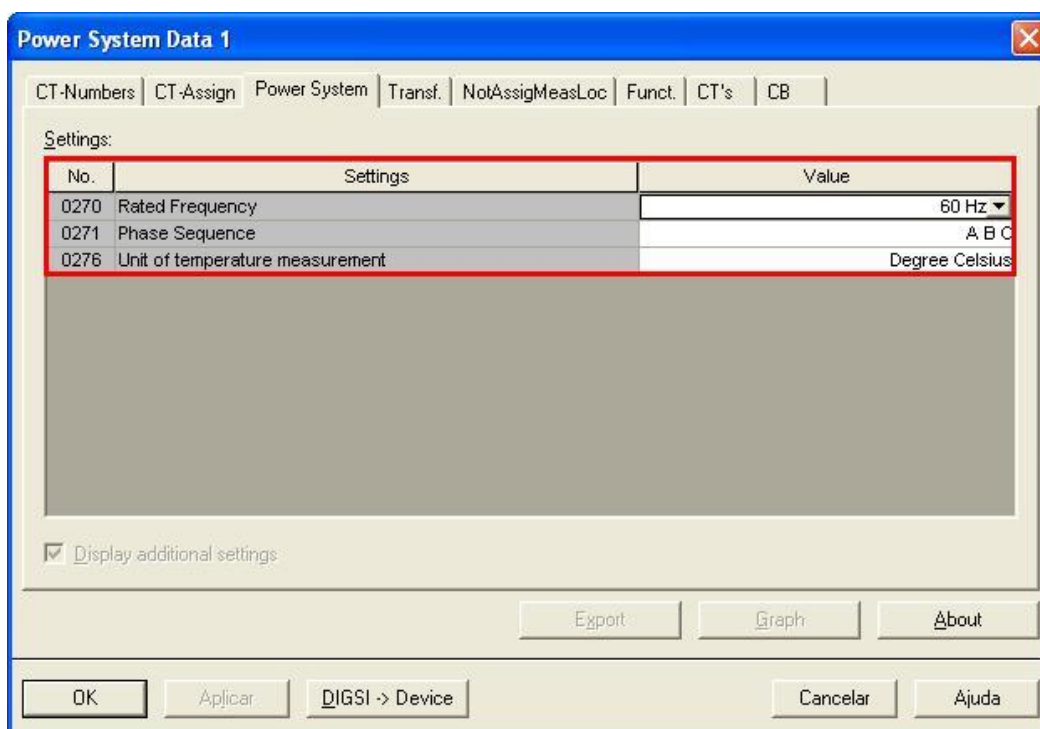In this option, the nominal values of the voltages and power of the transformer, the connection and the offset of the power transformer windings are adjusted.
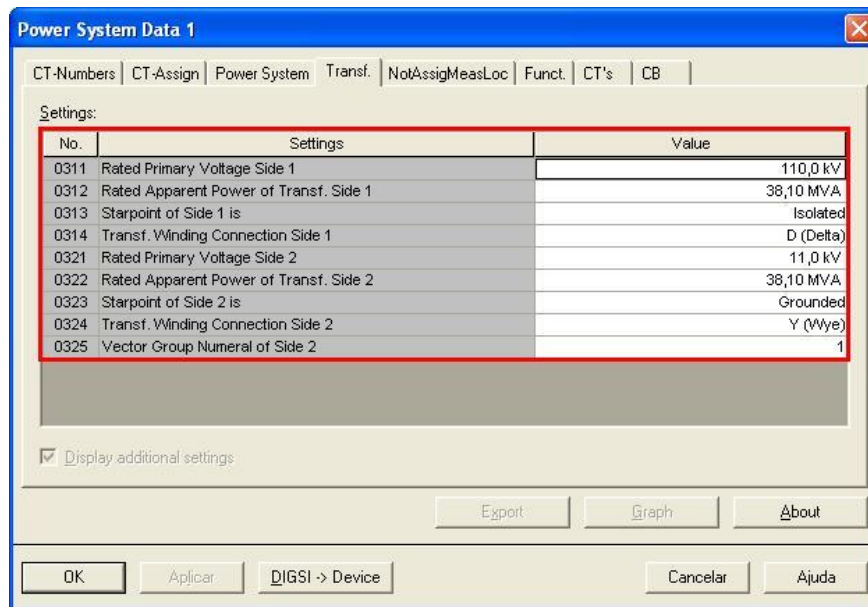
Figure 15

4.7 *CT's*

In this tab, the nominal values of primary and secondary current of the current transformers must be adjusted, as well as their polarities.
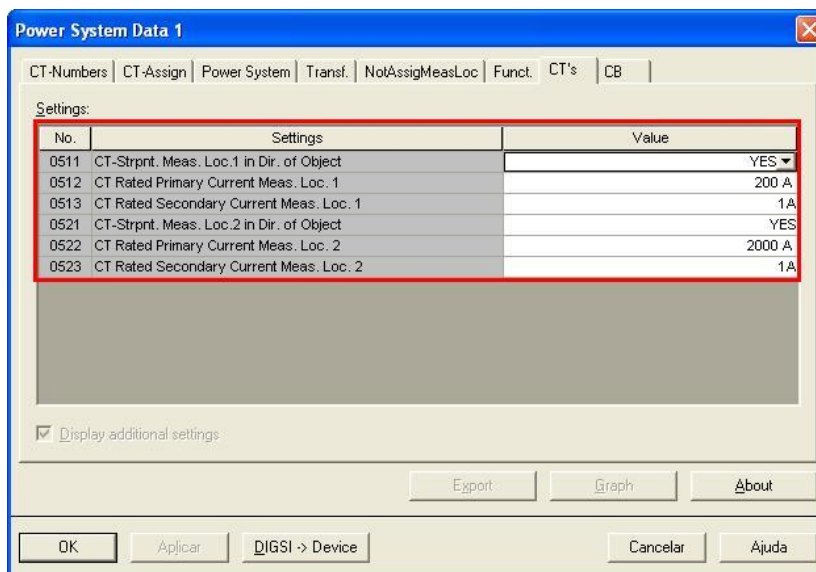
Figure 16

Note: The tabs *"NotAssigMeasLoc", "Funct."* and *"CB"* are not used in this tutorial.

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4.8 *Setting Group A*

In this option are the protection settings.
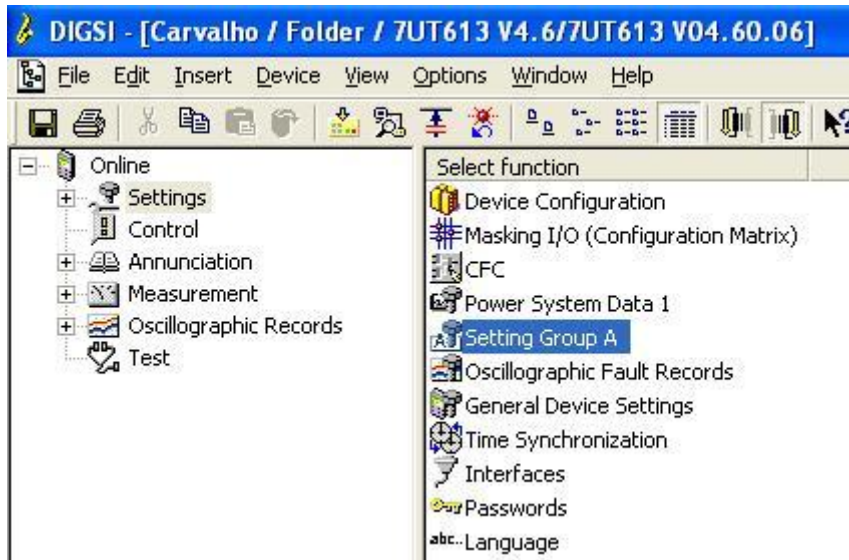
Figure 17

4.9 *Differential Protection*

The last step is to make the differential adjustments.

Figure 18

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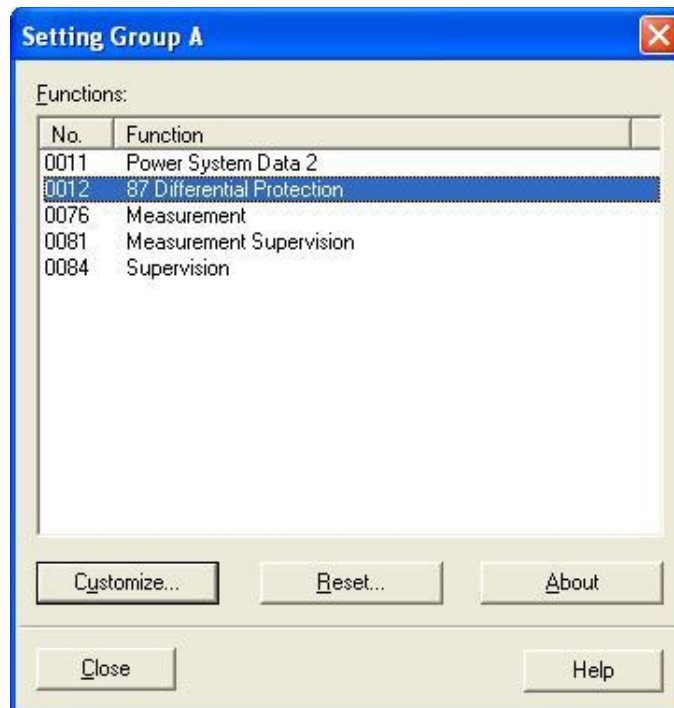
4.10 *General*

Address 1201 activates the differential function. The other options will not be tested and must be set to *"OFF"*.
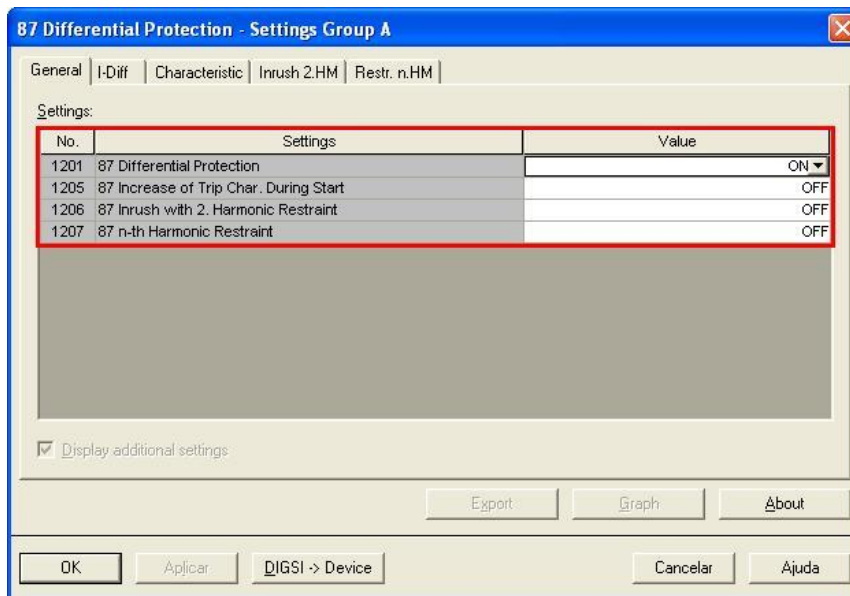
Figure 19

4.11 *I-Diff*

In this field the pick-up values of the percent differential element (87-1) and instantaneous differential element (87-2) are configured, as well as both acting times.

Figure 20

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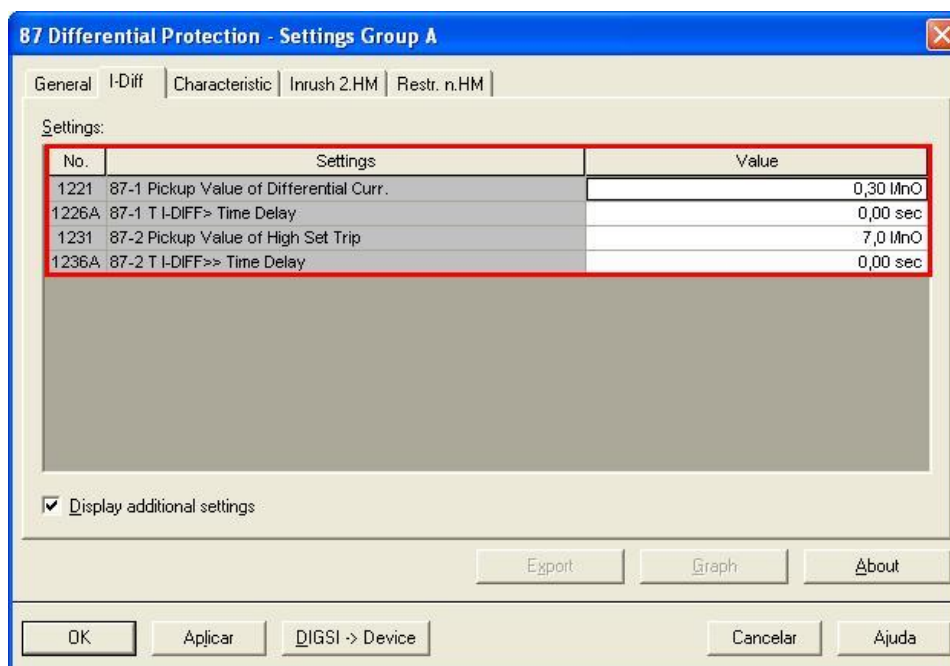
4.12 *Characteristic*

This option adjusts the values of *"Slope 1"* and *"Slope 2"* as well as the *"Base Points"* values.
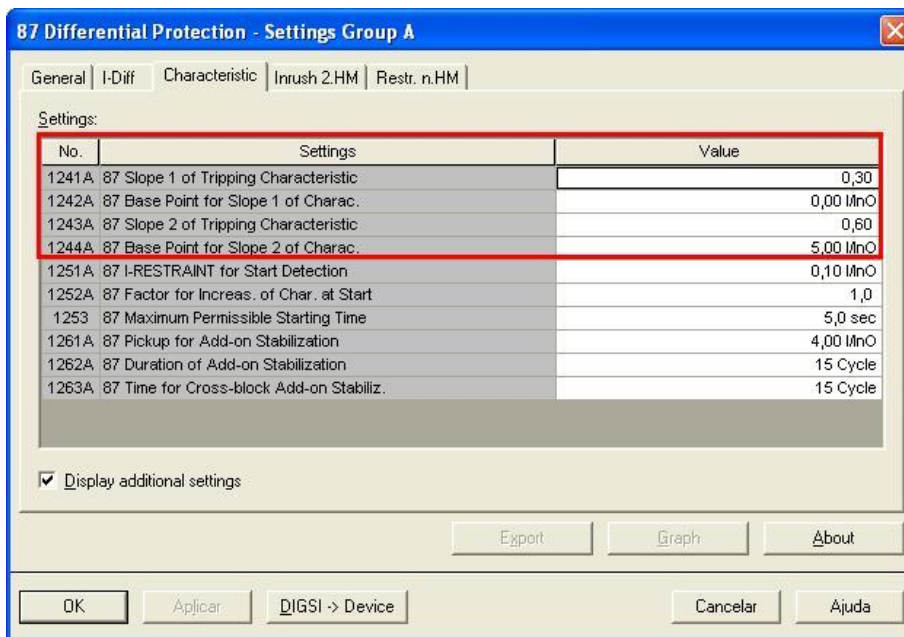
Figure 21

The options *"Inrush 2HM "* and *"Rest. nHM"* are not used. The next step is to submit the changes. To do this click on the icon highlighted below:
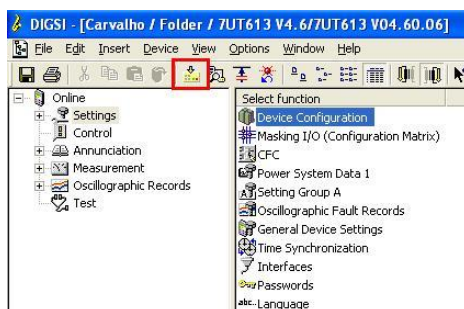
Figure 22

Then enter the password and click on *"OK"*.

Figure 23

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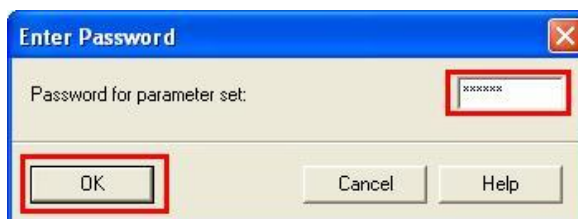
5. Difference software settings

5.1 *Opening the Differential*

Click on the *"Conprove Test Center"* application manager icon.
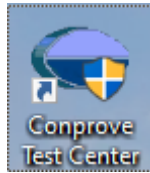
Figure 24

Click on the *"Differential"* software icon.

Figure 25

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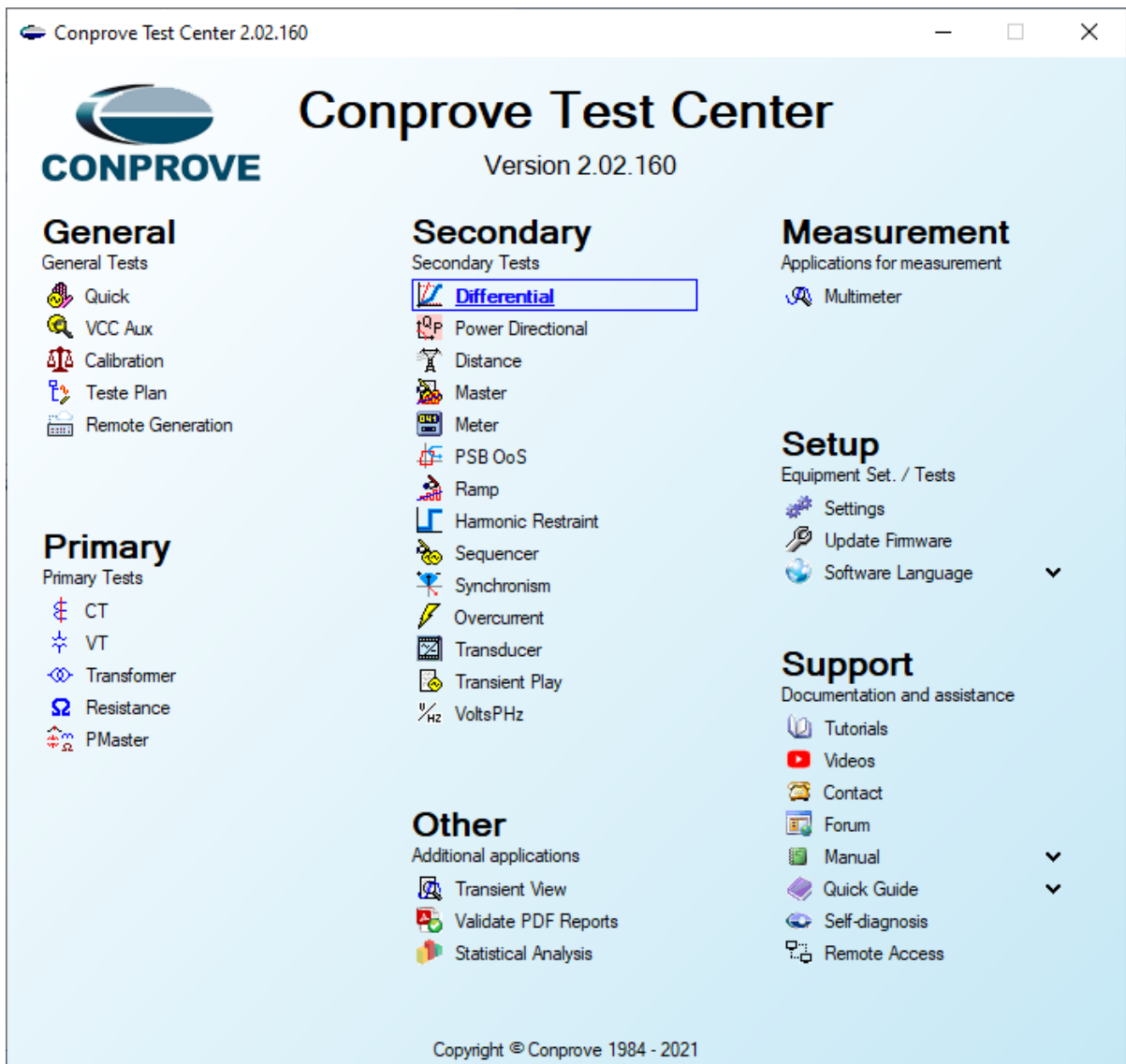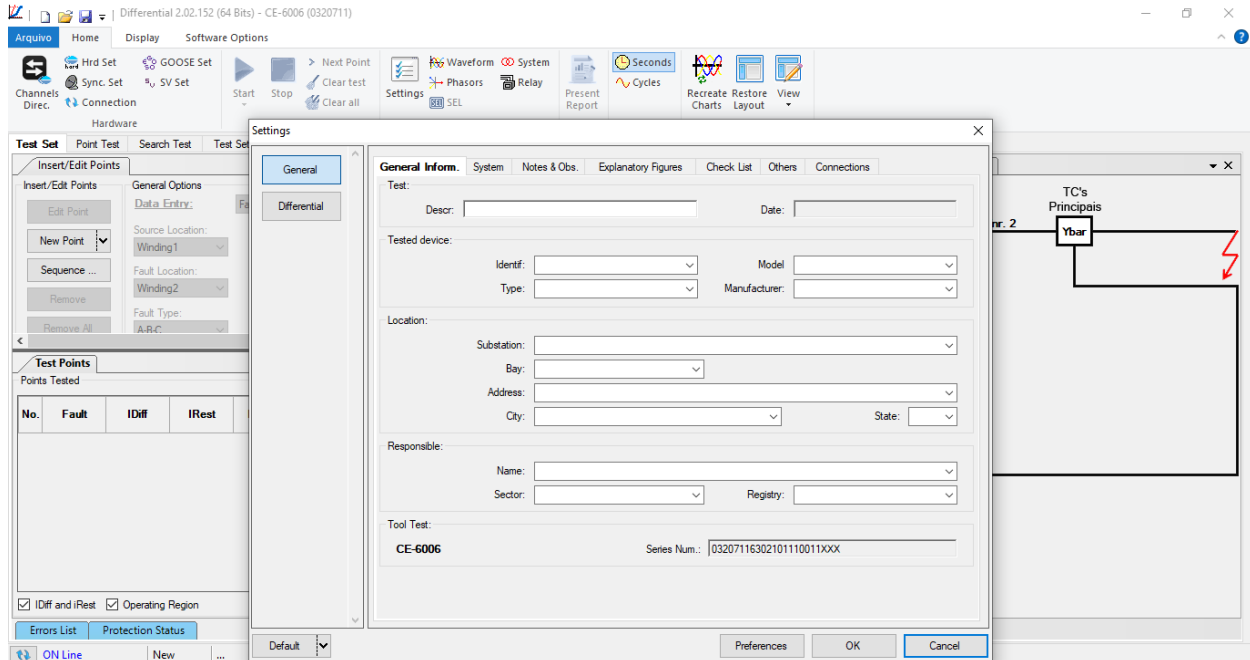
Figure 26

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.
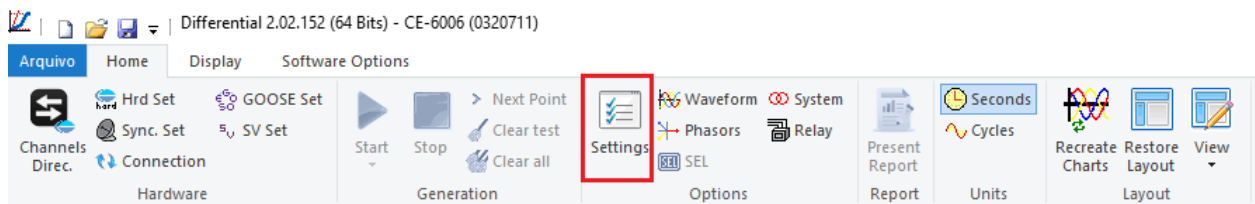
Figure 27

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.

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Figure 28

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.

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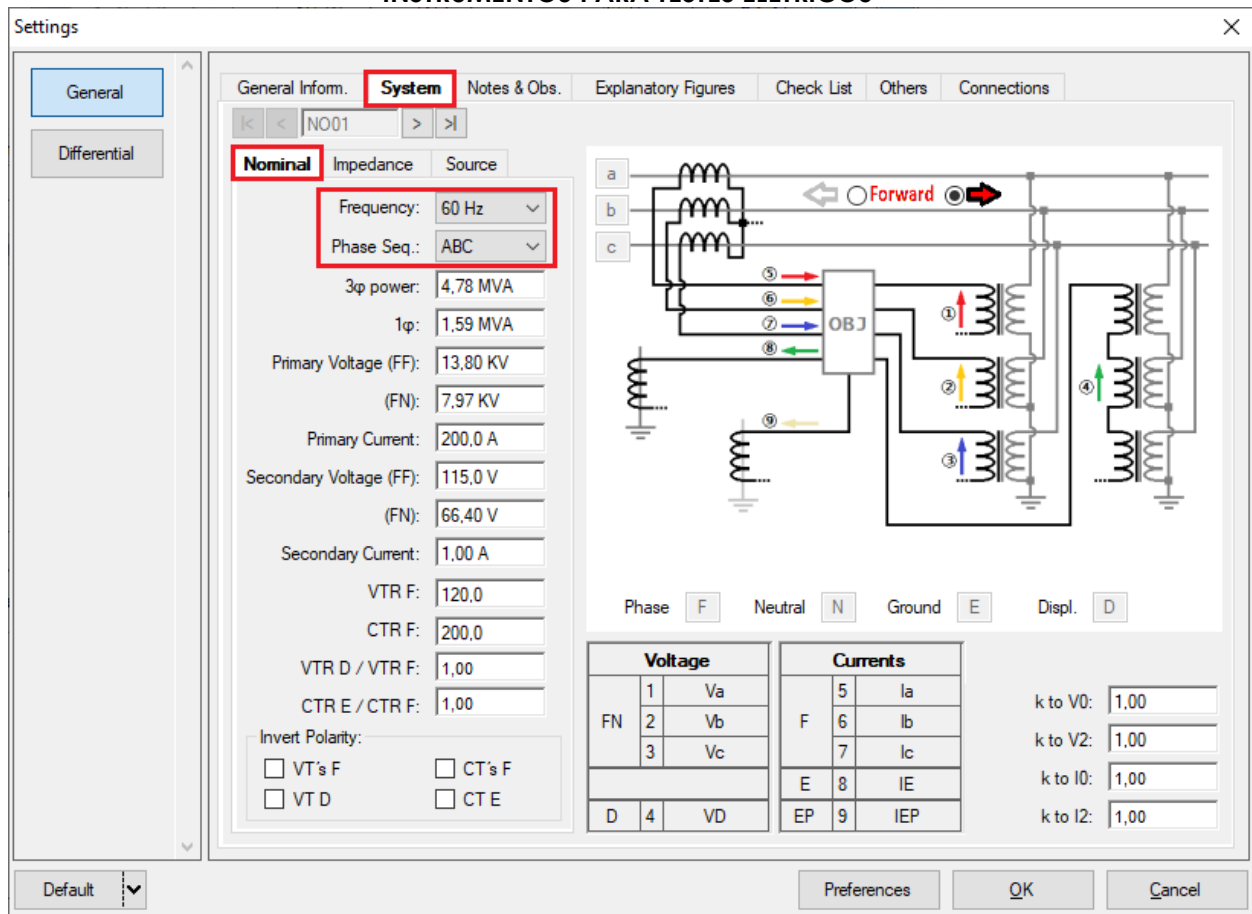
Figure 29

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*

This tab should inform the protected equipment, the number of windings, nominal voltage, nominal power, the primary and secondary currents of the main CTs and the currents of the auxiliary CT, if necessary. This test uses the settings for a relay that is protecting a transformer. However, it is possible to test protections of bus, generator, motor and line. For transformer protection there is the possibility of testing up to four windings automatically.

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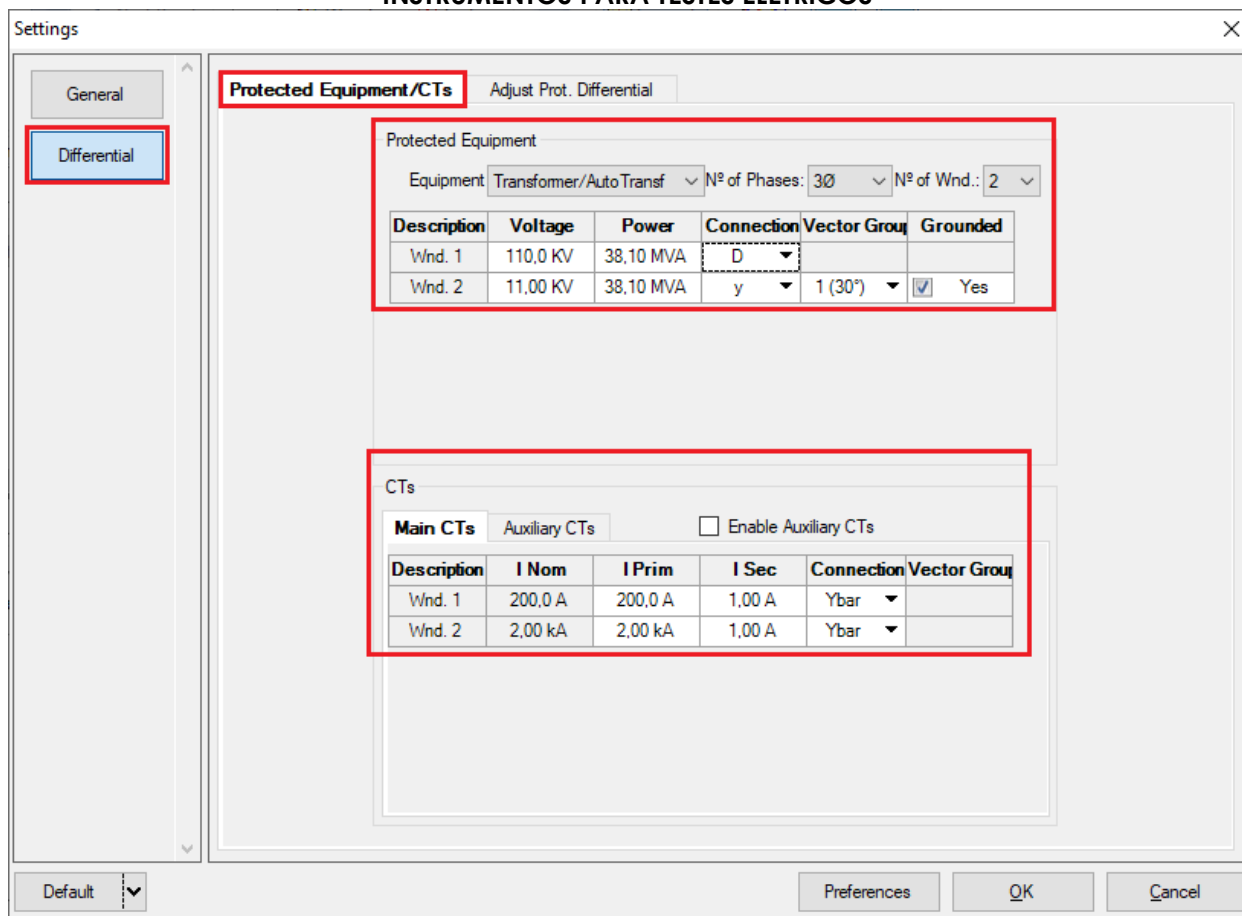
Figure 30

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

The initial default for the *"Data Entry"* 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 lists of relays, only the configurable settings are enabled. Choose the *"SIEMENS 7UT/7UM (Siprotec 4)"* mask.

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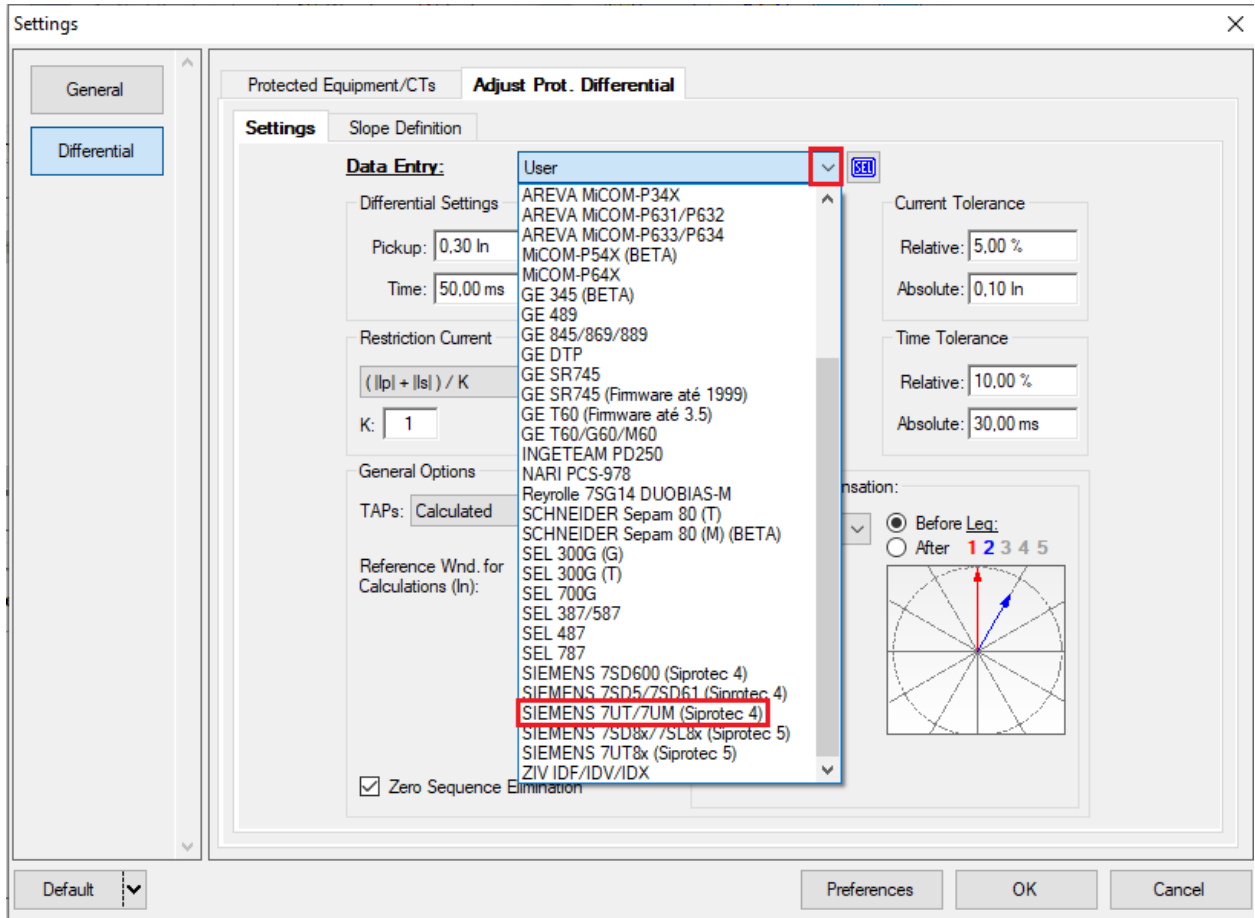
Figure 31

Parameterize the *"Differential Settings"* and *"Instantaneous Settings"*. Set the time to 0.0s. Use the tolerances for current and time given in the Appendix.

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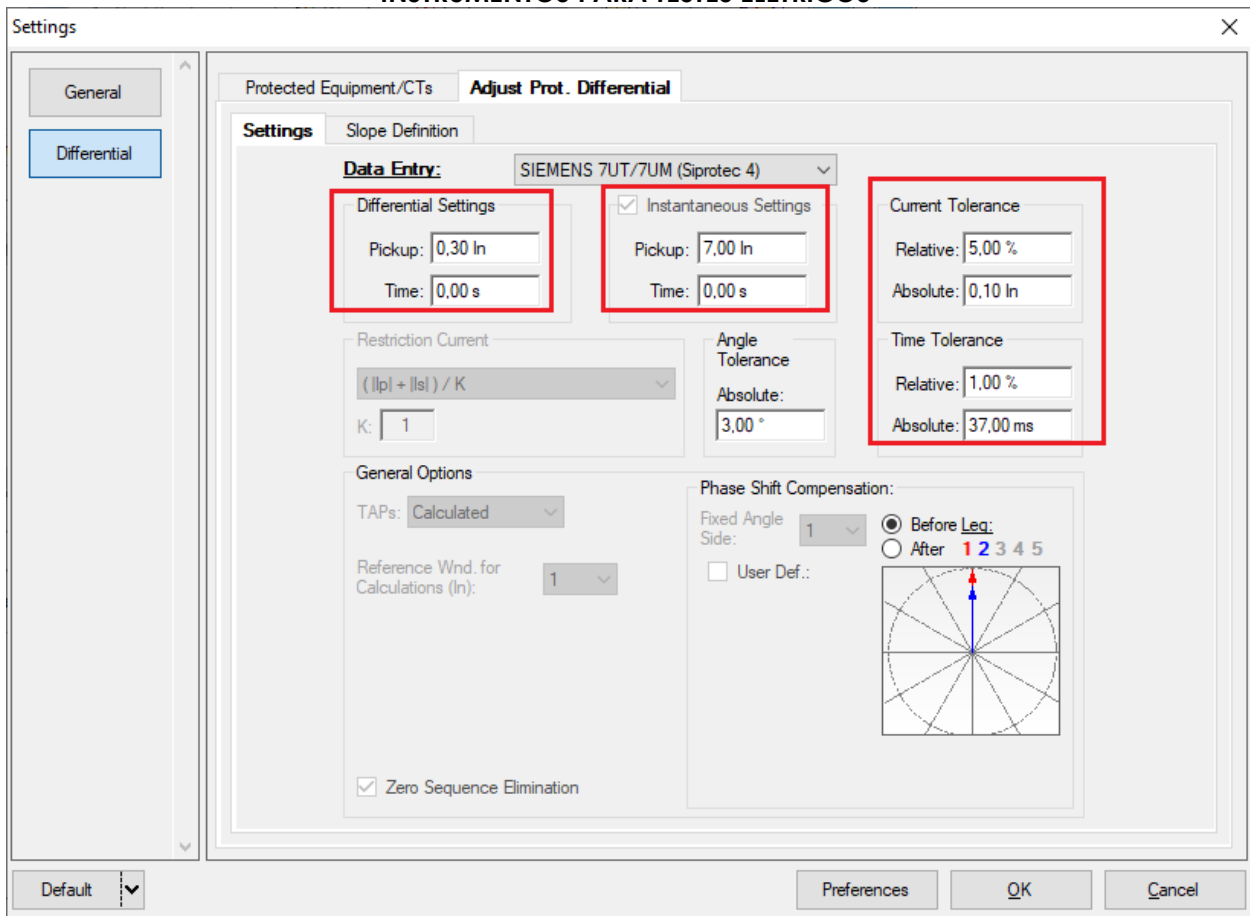
Figure 32

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

On this screen, the values for *"Slopes"* and *"Base Points"* must be entered.

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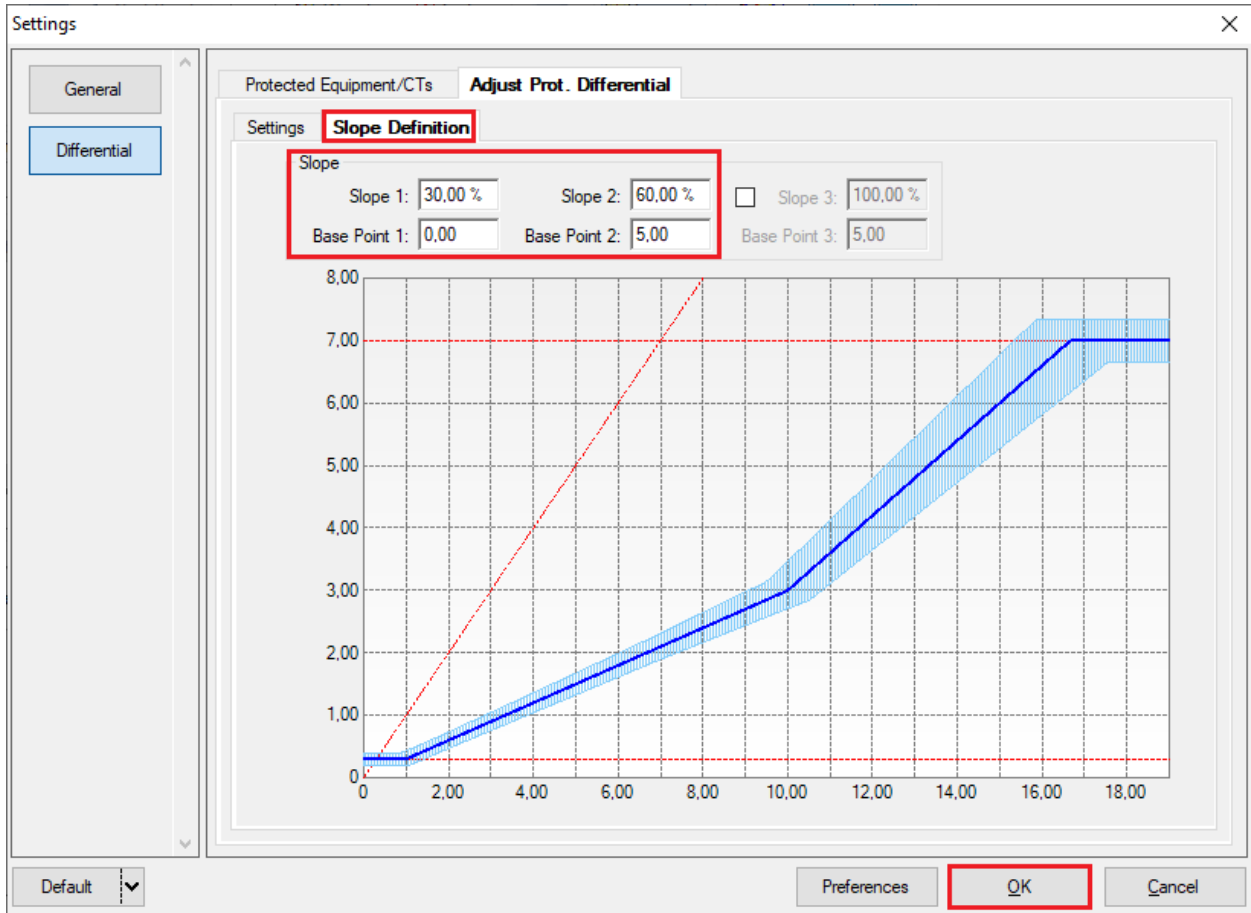
Figure 33

7. Channel Direction and Hardware Configurations

Click on the icon illustrated below.
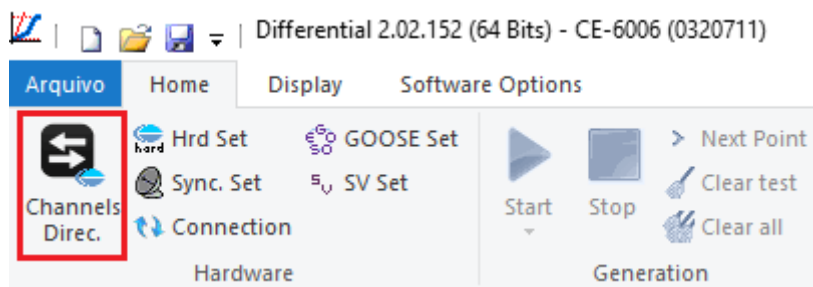
Figure 34

Then click on the highlighted icon to configure the hardware.

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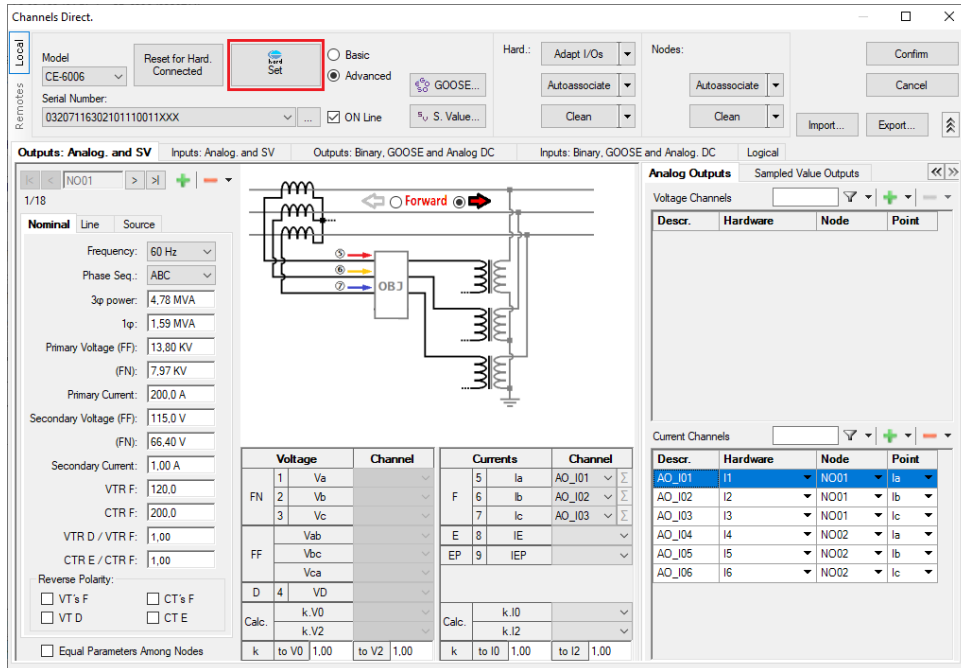
Figure 35

Choose the channel configuration; adjust the auxiliary source and the stopping method of the binary inputs. To finish click on *"OK"*.
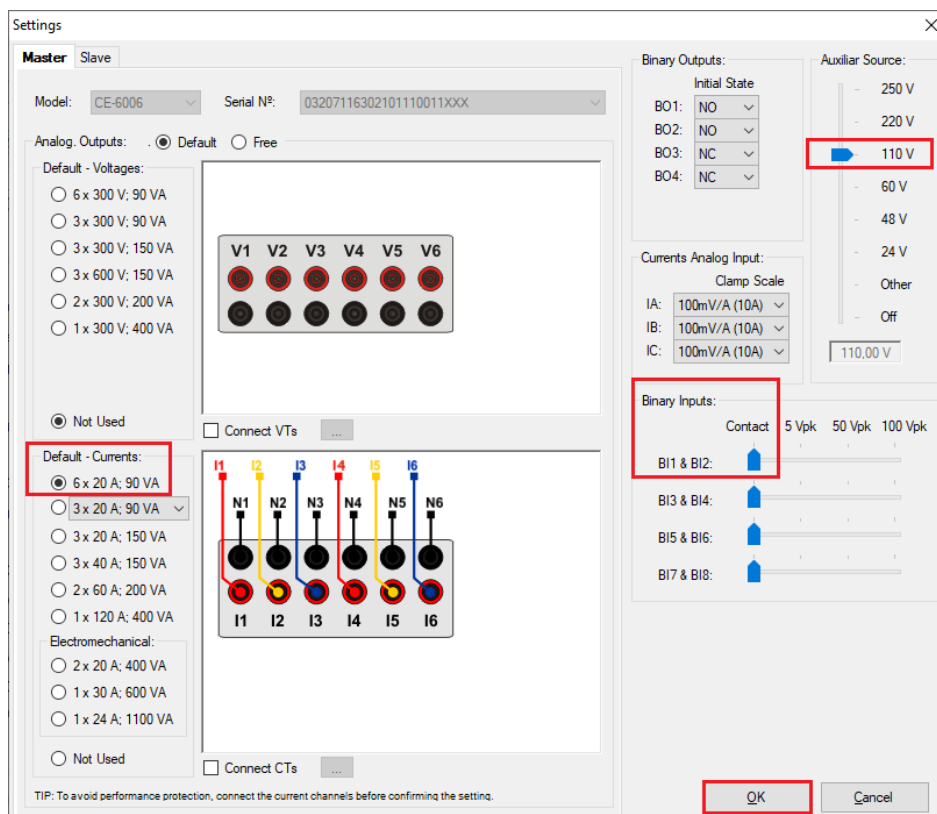
Figure 36

On the next screen choose *"Basic"* and on the next window (not shown) choose *"YES",* finally click on "Confirm".
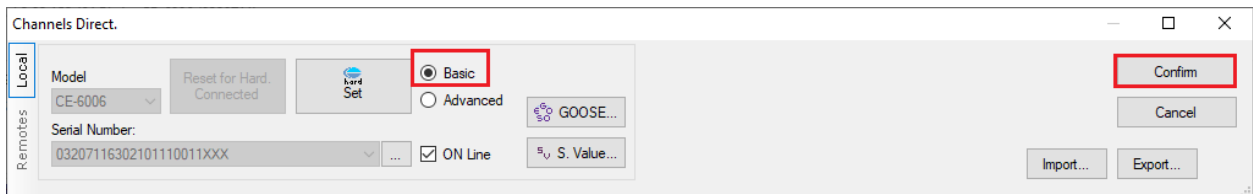
Figure 37

8. Test Structure for Function 87

8.1 *Test Settings*

In this tab, the test set channels are associated with the relay phases; the trip signal is configured with the binary input.
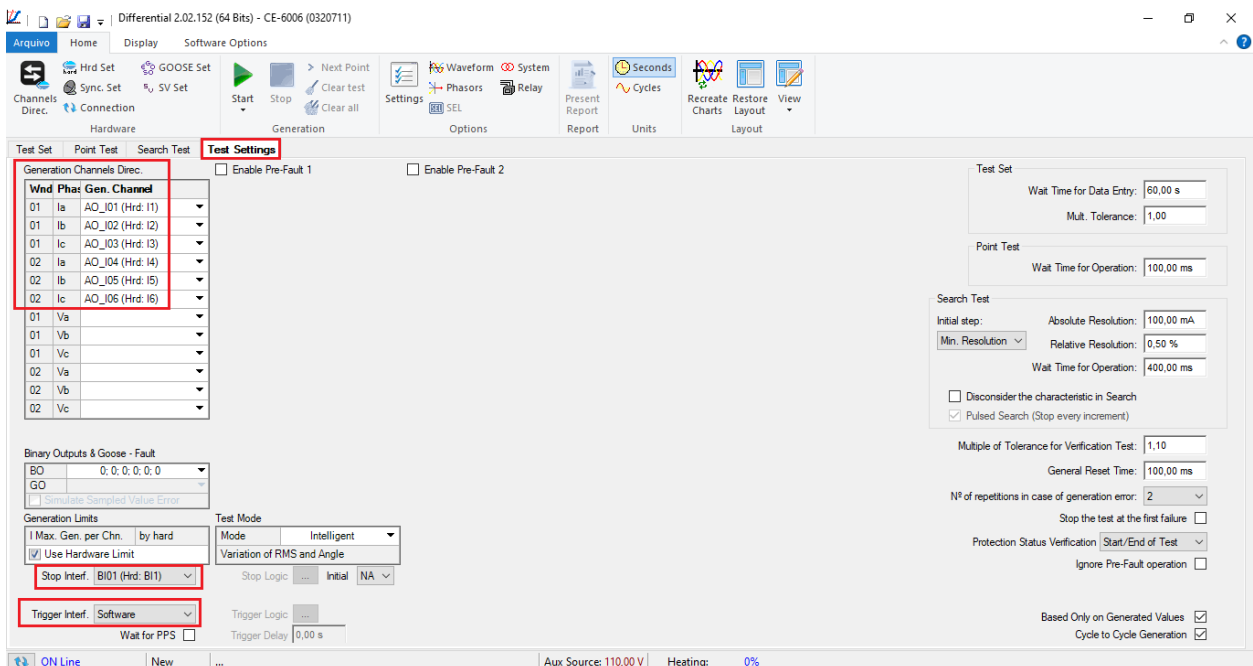
Figure 38

9. Test Set

The general idea of the configuration test 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:

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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.
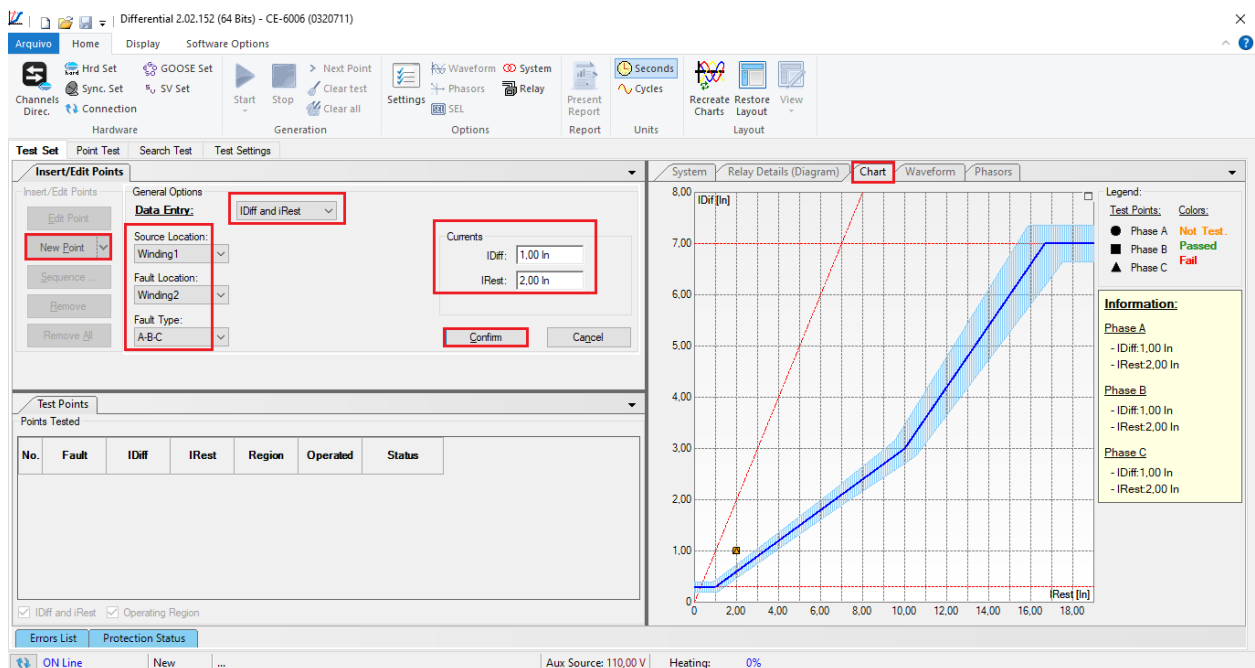
Figure 39

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

Figure 40

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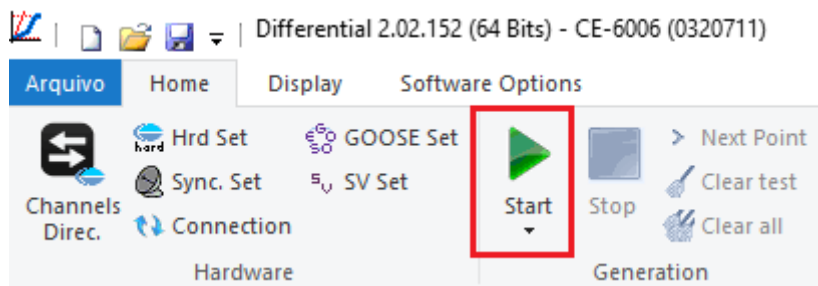
After starting the test, the user must enter the differential and restraint current values read in the relay, which must be in the range of values calculated in the software that will perform the automatic data comparison.
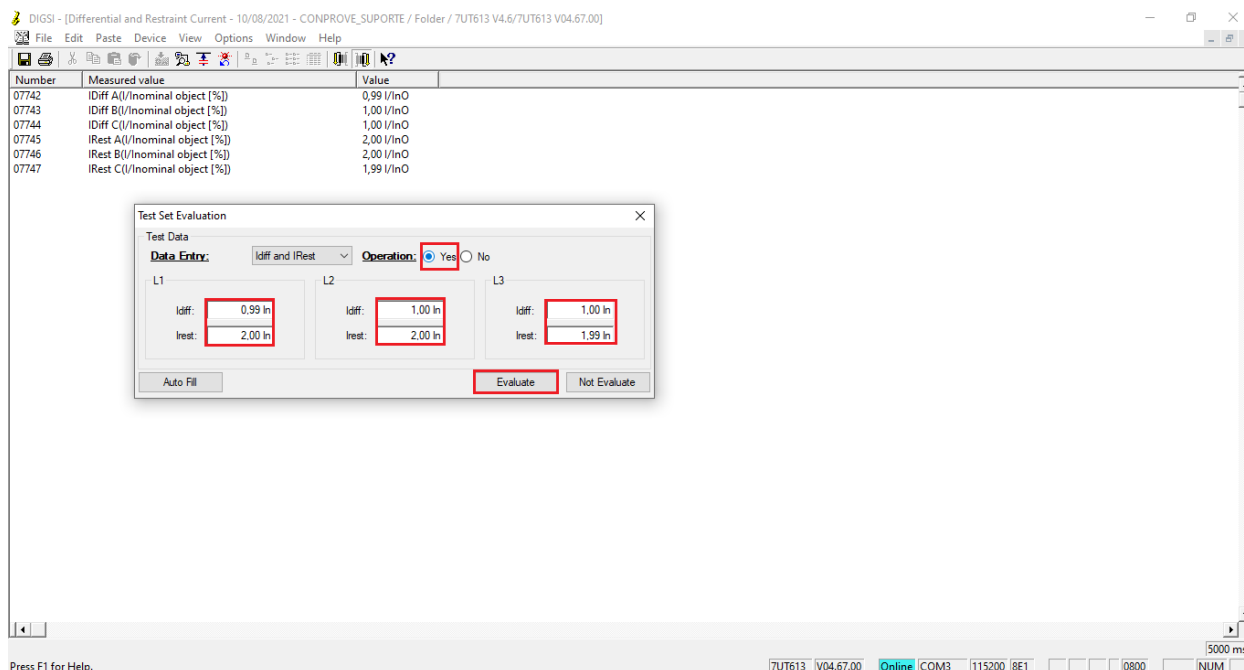
Figure 41

Passing the configuration test 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 its connections and settings.

10. Point Test

After the configuration test 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 not 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.

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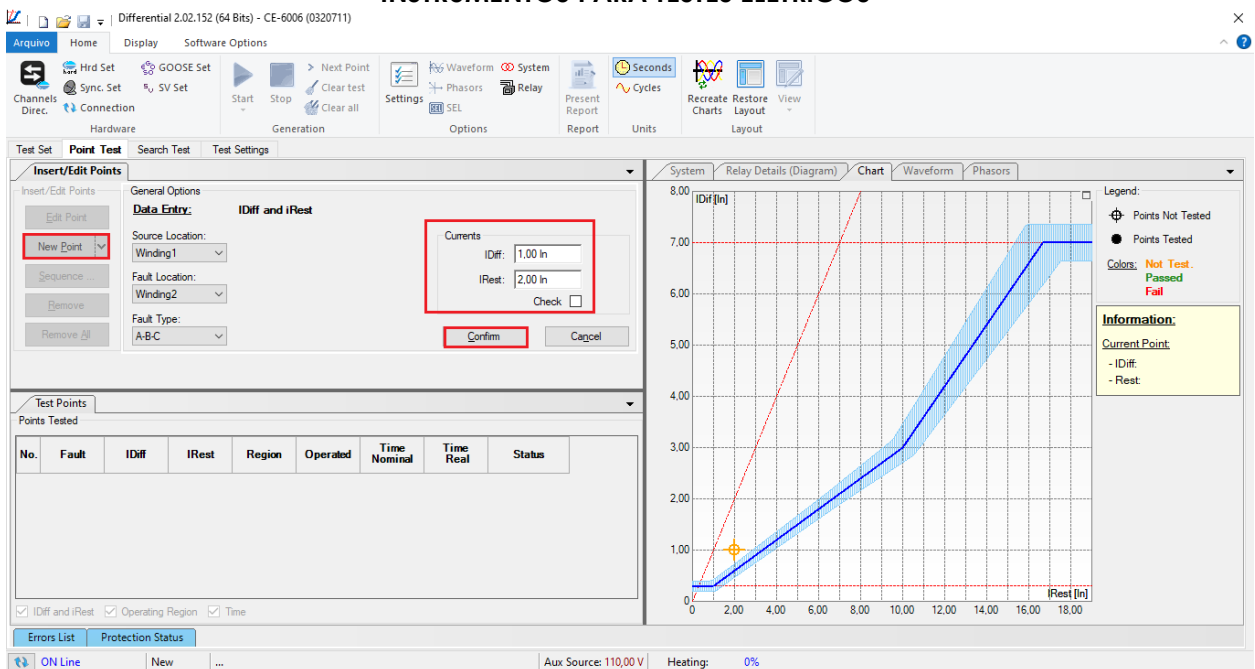
Figure 42

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.
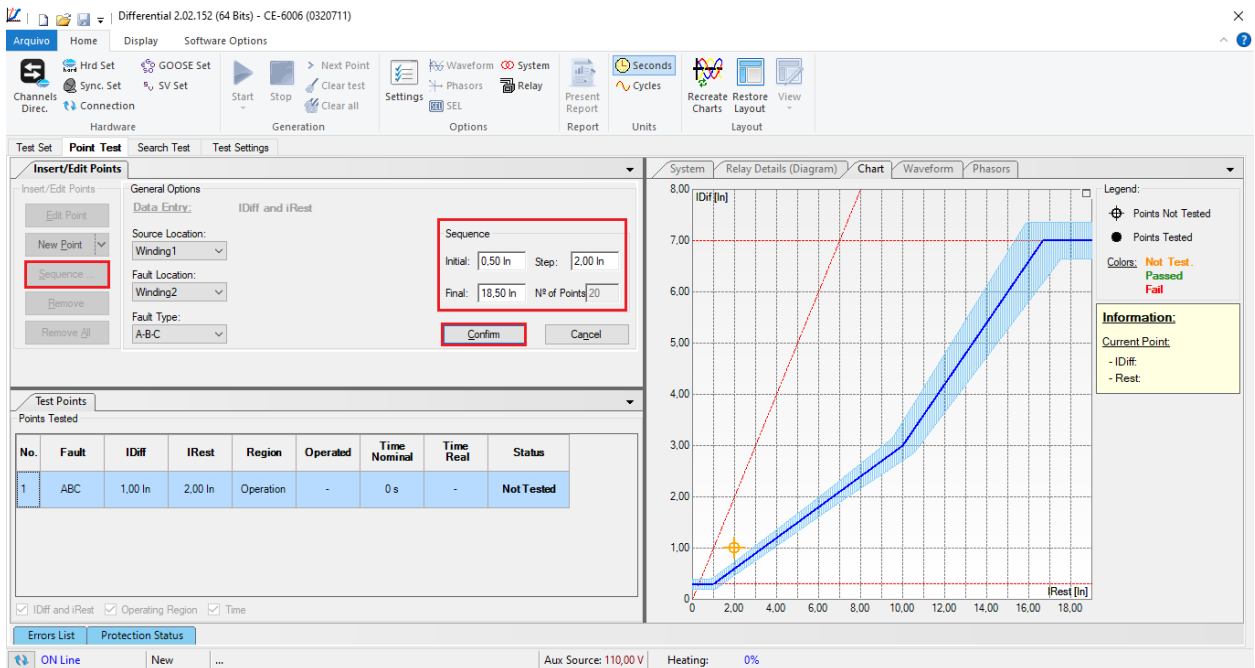
Figure 43

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

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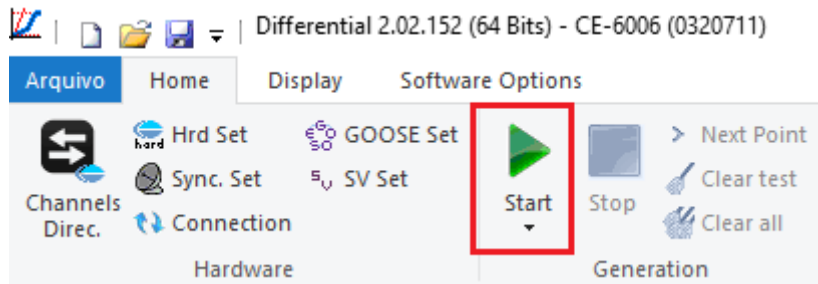
Figure 44

It is verified that all points were successfully approved.
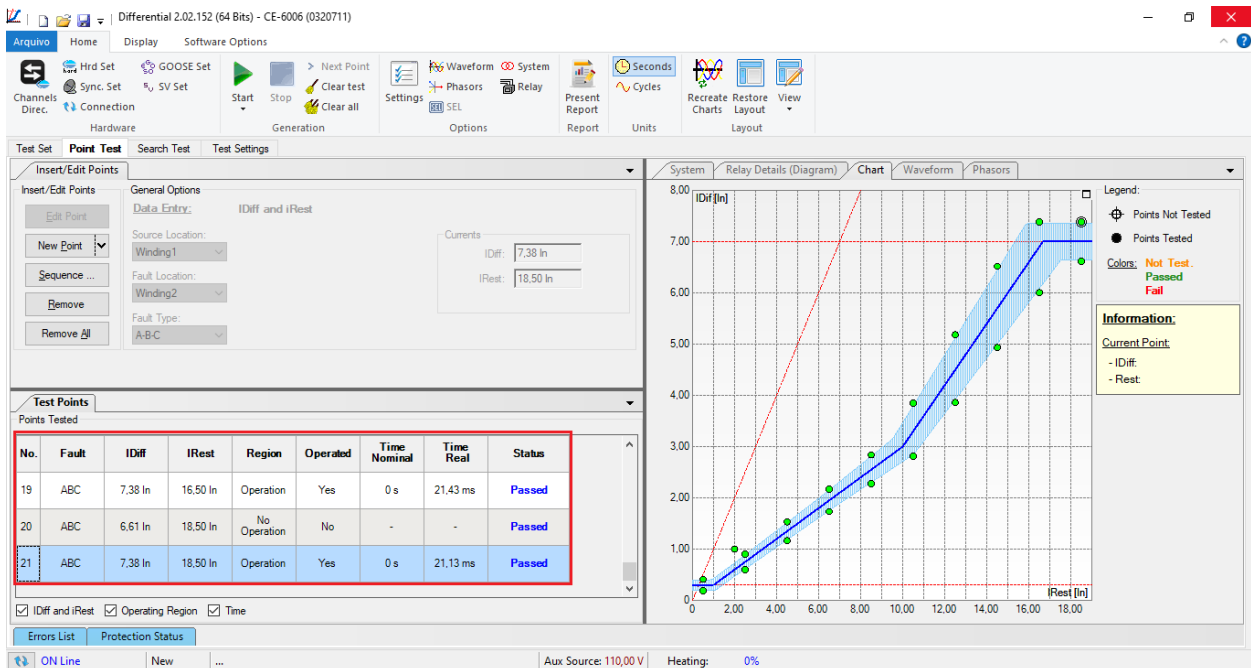
Figure 45

11. 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.

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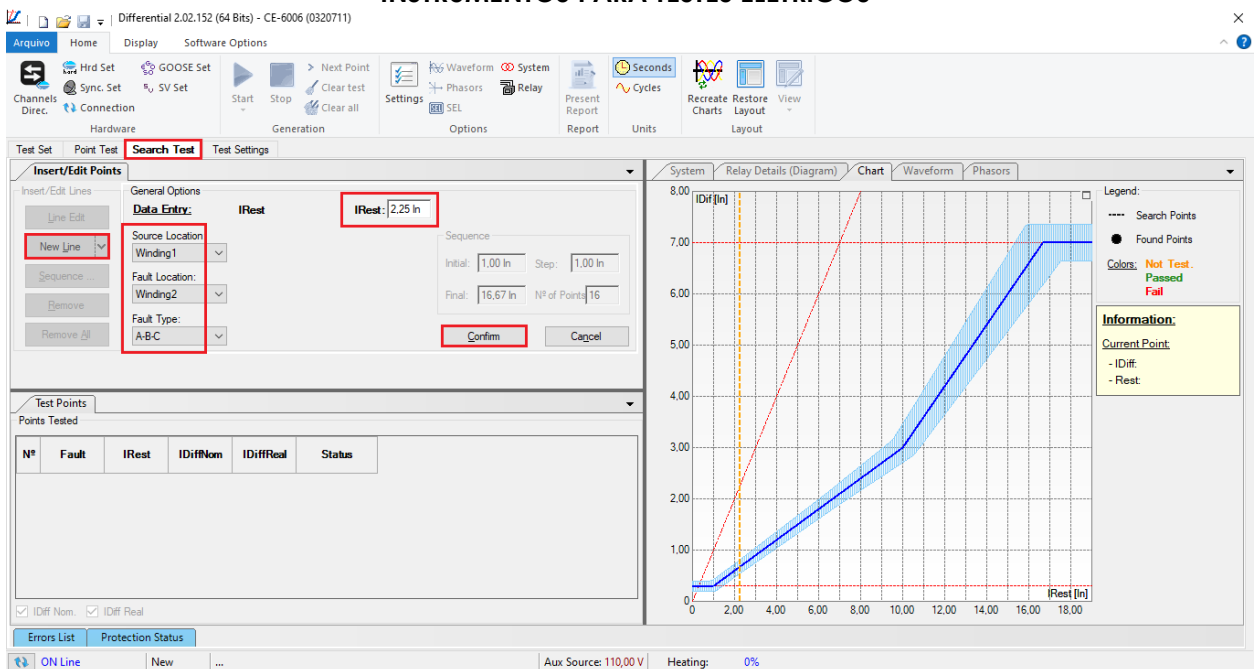
Figure 46

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.
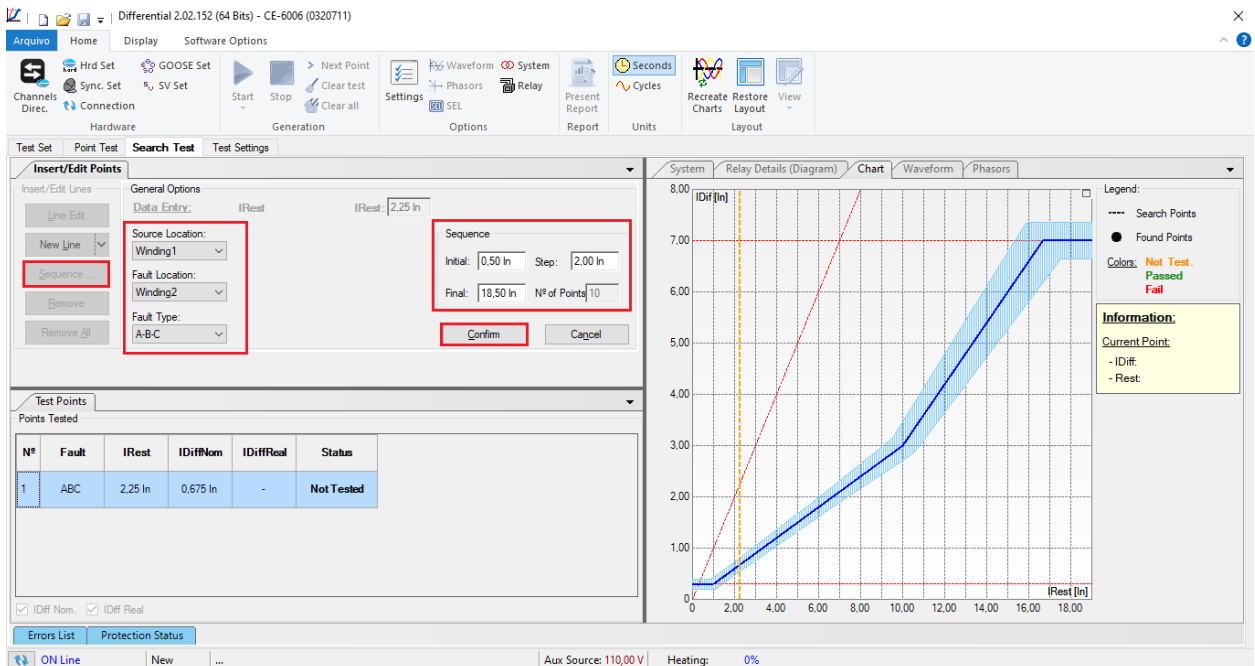
Figure 47

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

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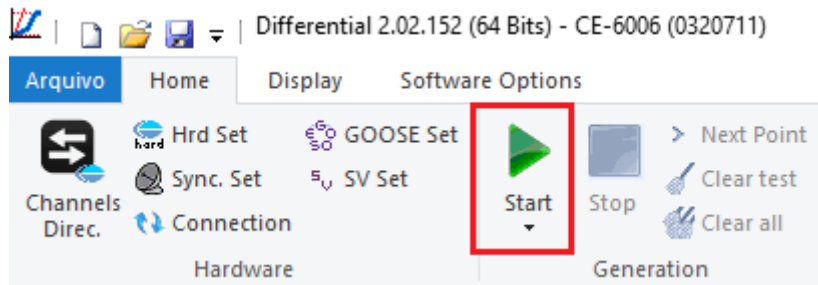
Figure 48

It is verified that all lines were successfully approved.
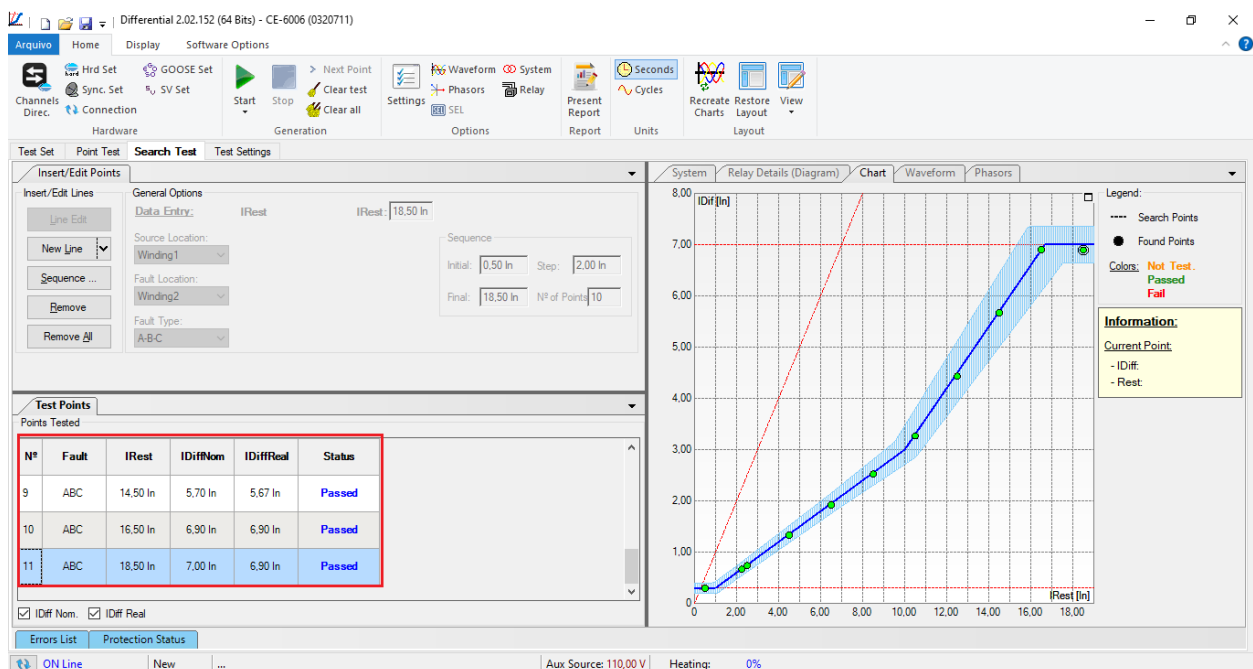
Figure 49

12. 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.

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Figure 50

Figure 51

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APPENDIX A

A.1 Terminal Designations

7UT613*-*D/E
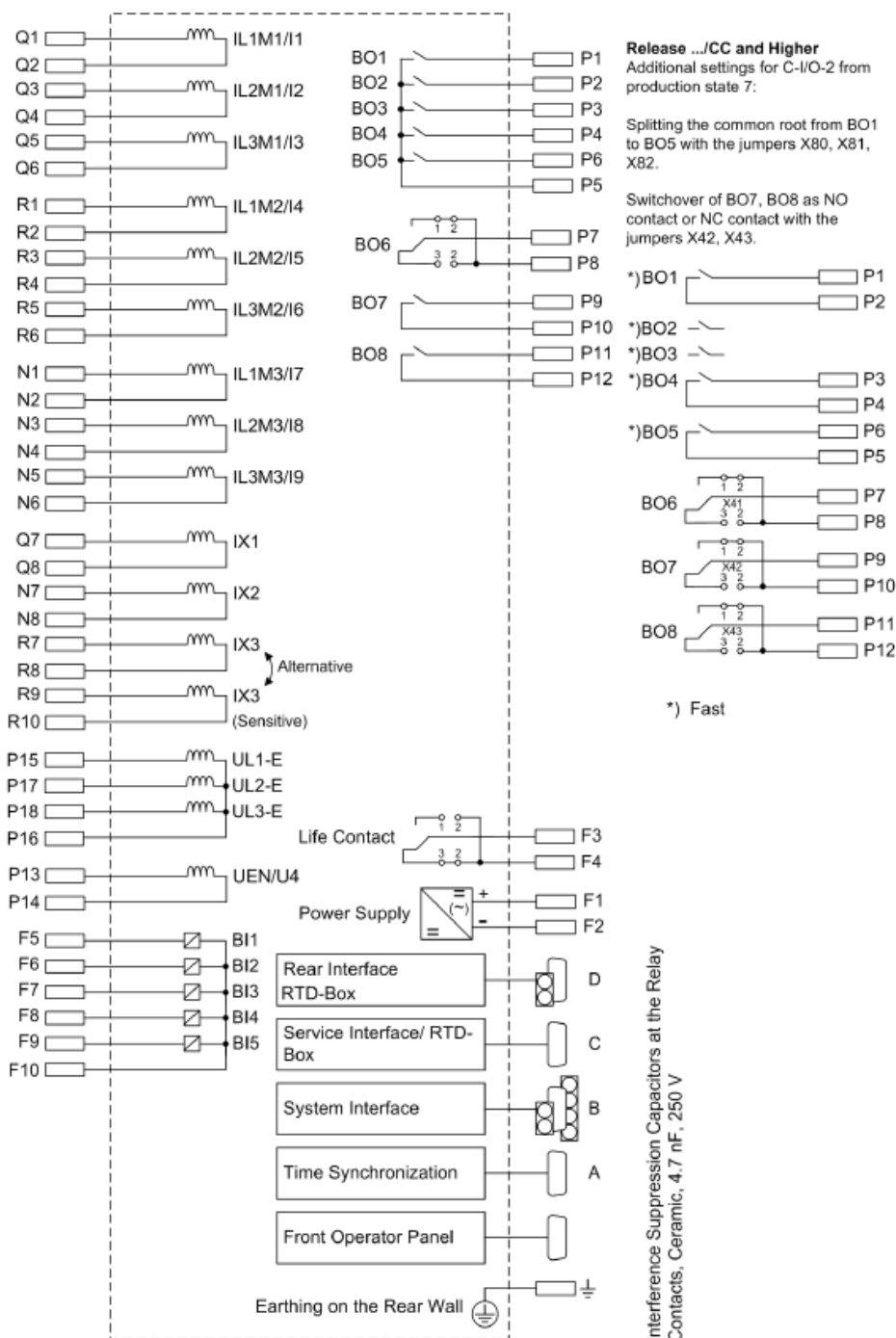
Figure A-1   Overview diagram 7UT613 (panel flush and cubicle mounting)

Figure 52

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A.2 Technical Data

Pickup Values

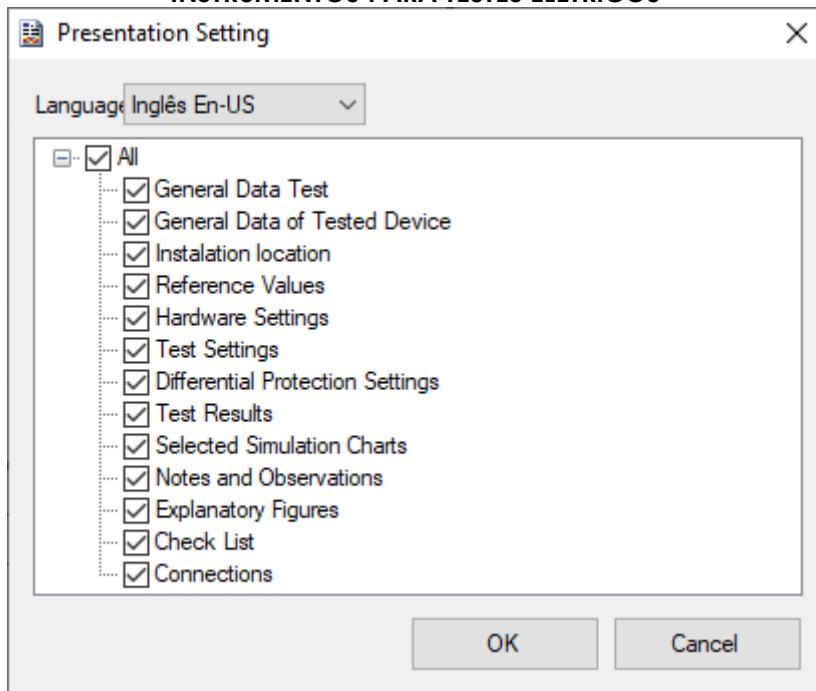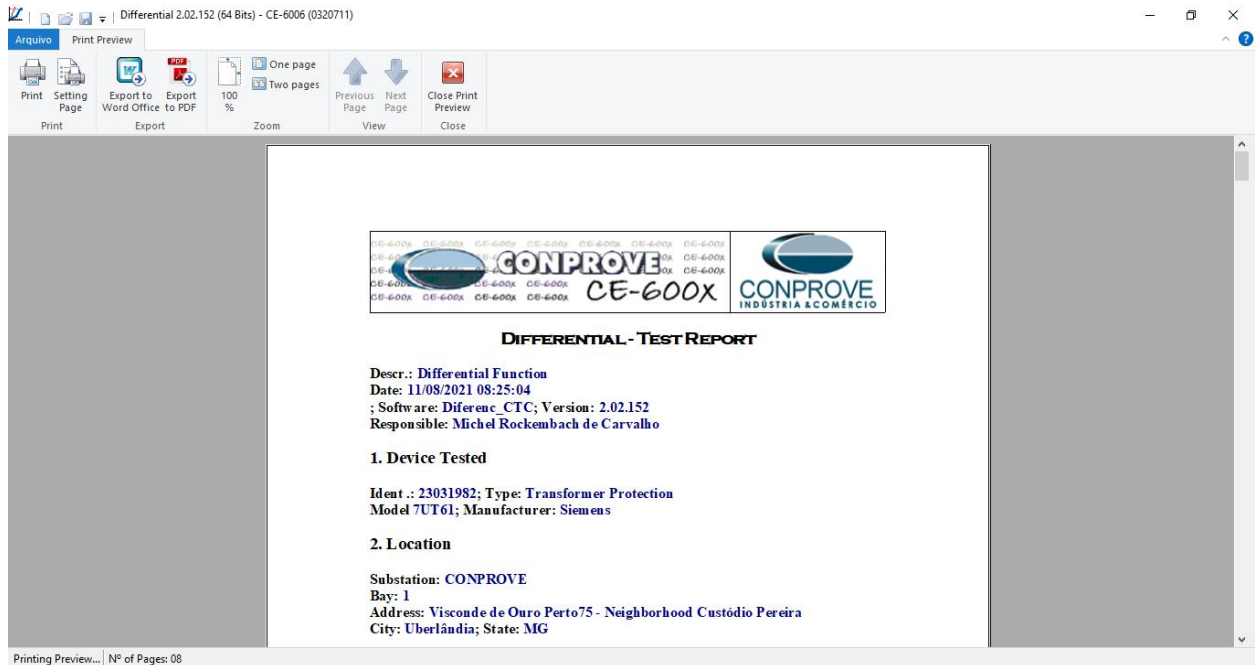| Differential current	$I_{Diff}>/I_{NObj}$	0.05 to 2.00	Steps 0.01
High-current stage	$I_{Diff}>>/I_{NObj}$	0.5 to 35.0 or ∞ (ineffective)	Steps 0.1
Increase of the pickup value when connecting as a factor of $I_{Diff}>$		1.0 to 2.0	Steps 0.1
Add-on restraint on external fault			
(I_{stab} > setting value) Action time	I_{Add-on}/I_{NObj}	2.00 to 15.00 2 to 250 cycles or ∞ (active until dropout)	Steps 0.01 Increments 1 cycle
Trip characteristic		see Figure 4-1	
Tolerances (with preset characteristic parameters, for 2 sides with 1 measuring location each)			
$I_{Diff}>$ stage and characteristic		5 % of set value	
$I_{Diff}>>$ stage		5 % of set value	

Time Delays

Delay of $I_{Diff}>$ stage	$T_{IDiff>}$	0.00 s to 60.00 s or ∞ (no trip)	Steps 0.01 s
Delay of $I_{Diff}>>$ stage	$T_{IDiff>>}$	0.00 s to 60.00 s or ∞ (no trip)	Steps 0.01 s
Time tolerance		1 % of set value or 10 ms	
The set times are pure delay times			

Operating Times (Transformers)

Pickup time / dropout time with single-side infeed				
Pickup time at frequency		50 Hz	60 Hz	16.7 Hz
$I_{Diff}>$ min	high-speed relays	30 ms	27 ms	78 ms
	high-speed relays	25 ms	22 ms	73 ms
$I_{Diff}>>$ min	high-speed relays	11 ms	11 ms	20 ms
	high-speed relays	6 ms	6 ms	15 ms
Dropout time, approx.		54 ms	46 ms	150 ms
Dropout ratio		approx. 0.7		

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APPENDIX B

Equivalence of software parameters and the relay under test.

Table 3

Differential Software		Siemens 7UT61 Relay	
Parameter	**Figure**	**Parameter**	**Figure**
N° of Wind.	**30**	**Number of Sides**	**12**
Voltage (Wind. 1)	**30**	**Rated Primary Voltage Side 1**	**15**
Voltage (Wind. 2)	**30**	**Rated Primary Voltage Side 2**	**15**
Power (Wind. 1)	**30**	**Rated Apparent Power of Transf. Side 1**	**15**
Power (Wind. 2)	**30**	**Rated Apparent Power of Transf. Side 2**	**15**
Connection (Wind. 1)	**30**	**Transf. Winding Connection Side 1**	**15**
Connection (Wind. 2)	**30**	**Transf. Winding Connection Side 2**	**15**
Vector Group (Wind. 2)	**30**	**Vector Group Numeral of Side 2**	**15**
I Prim (Wind. 1)	**30**	**CT Rated Primary Current Meas. Loc. 1**	**16**
I Prim (Wind. 2)	**30**	**CT Rated Primary Current Meas. Loc. 2**	**16**
I Sec (Wind. 1)	**30**	**CT Rated Secondary Current Meas. Loc. 1**	**16**
I Sec (Wind. 2)	**30**	**CT Rated Secondary Current Meas. Loc. 2**	**16**
Connection CT (Wind. 1)	**30**	**CT- Strpnt. Meas. Loc.1 in Dir. of Object**	**16**
Connection CT (Wind. 2)	**30**	**CT- Strpnt. Meas. Loc.2 in Dir. of Object**	**16**
Differential Settings (pickup)	**32**	**87-1 Pickup Value of Differential Curr.**	**20**
Instantaneous Settings (pickup)	**32**	**87-2 Pickup Value of High Set Trip**	**20**
Slope 1	**33**	**87 Slope 1 of Tripping Characteristic**	**21**
Base Point 1	**33**	**87 Base Point for Slope 1 of Charac.**	**21**
Slope 2	**33**	**87 Slope 2 of Tripping Characteristic**	**21**
Base Point 2	**33**	**87 Base Point for Slope 2 of Charac.**	**21**

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