



INSTRUMENTOS PARA TESTES ELÉTRICOS

Test Tutorial

Equipment Type: Protection Relay

Brand: SEL

Model: 787

Function: 87-1 or PDIF-1 Percent Differential and 87-2 or PDIF-2 Instantaneous Differential.

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	13/08/2021	M.R.C.	M.P.S

INSTRUMENTOS PARA TESTES ELÉTRICOS

Summary

1. Relay connection to CE-6006	4
1.1 <i>Auxiliary Source</i>	4
1.2 <i>Current Coils</i>	4
1.3 <i>Binary Input</i>	5
2. Communication with relay	5
3. Parameterization of the SEL 787 relay	7
3.1. <i>General</i>	7
3.2. <i>Configuration</i>	8
3.3. <i>Transformer Differential Elements</i>	8
4. Binary Output Adjustments	9
4.1. <i>Slot A</i>	9
4.2. <i>Submitting the Adjustments</i>	10
5. Differential software settings	11
5.1. <i>Opening the Differential</i>	11
5.2. <i>Configuring the Settings</i>	12
5.3. <i>System</i>	13
6. Differential Adjustments	14
6.1. <i>“Differential” screen > “Adjust Prot. Differential” > “Settings”</i>	14
6.2. <i>“Differential” screen > “Adjust Prot. Differential” > “Slope Definition”</i>	15
6.3. <i>“Differential” screen > “Protected Equipment / CT's”</i>	16
7. Channel Targeting and Hardware Configurations	17
8. Test Settings	19
9. Test Set	19
10. Point Test	21
11. Search Test	23
11.1. Final Search Test Result	23
12. Report	24
APPENDIX A	26
A.1 Terminal Designations	26
A.2 Technical Data	27
APPENDIX B	28

Statement of responsibility

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Suggestions for improvement of this material are welcome, just the 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 must always be consulted.



ATTENTION!

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

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

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INSTRUMENTOS PARA TESTES ELÉTRICOS
Sequence for 787 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 the “Power +” pin (A01) of the relay, connect the negative (black terminal) of the Vdc Aux. Source to the “Power -” pin (A02) of the relay.

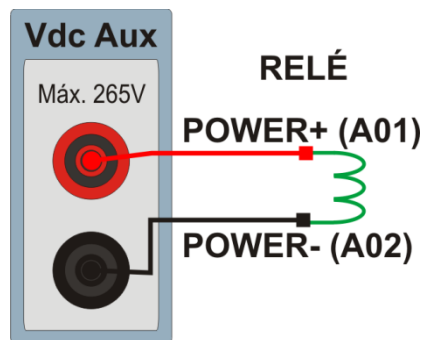


Figure 1

1.2 Current Coils

Connect the I1, I2 and I3 current channels of the CE-6006 to pins Z01, Z03 and Z05 of the relay respectively, connect the three common of CE-6006 to pin Z02 of the relay, thus forming the connection of winding one. In the same way, to establish the connection of winding 2, connect I4, I5 and I6 current channels to relay pins Z07, Z09 and Z11 respectively, connecting the three common to pin Z08.

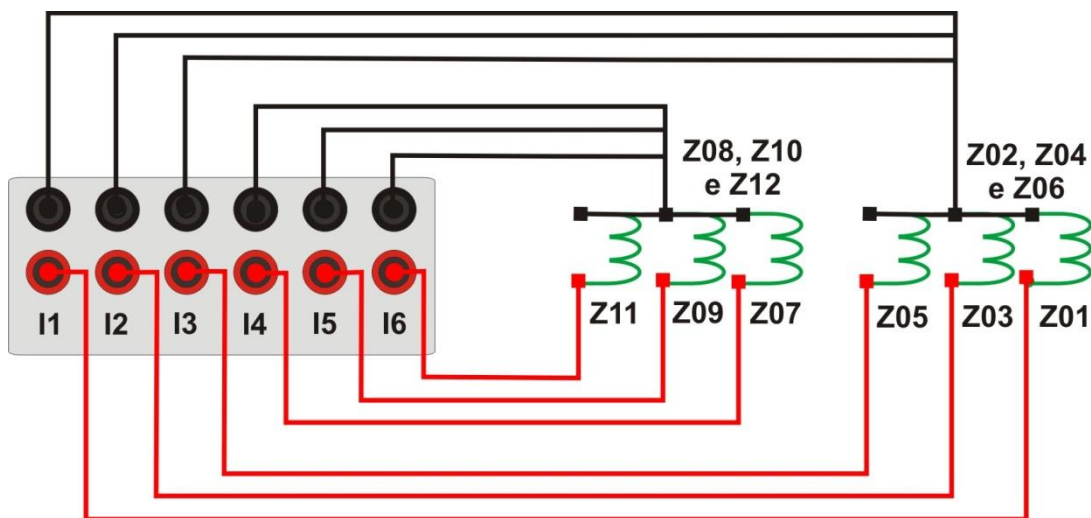


Figure 2

1.3 Binary Input

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

- BI1 to pin A03 and its common to pin A04 of the relay.

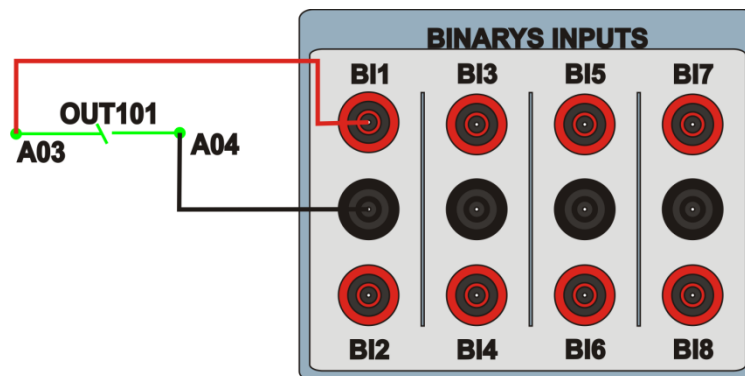


Figure 3

2. Communication with relay

First, open the “*AcSELerator QuickSet*” and connect an Ethernet (or serial) cable from the notebook to the relay. Then double click on the software icon.



Figure 4

When opening the program, the relay file is selected if communication has already been carried out. Otherwise click on “New”.

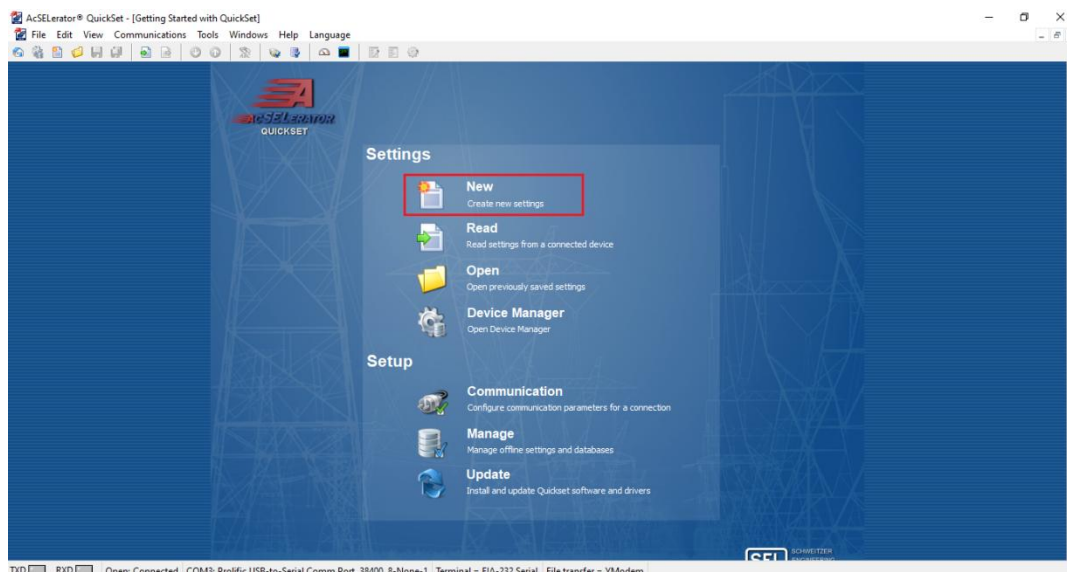


Figure 5

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In the next screen, adjust the model and version of the tested relay. Check on the front panel via the following path “*Status > Relay Status > FID*”.

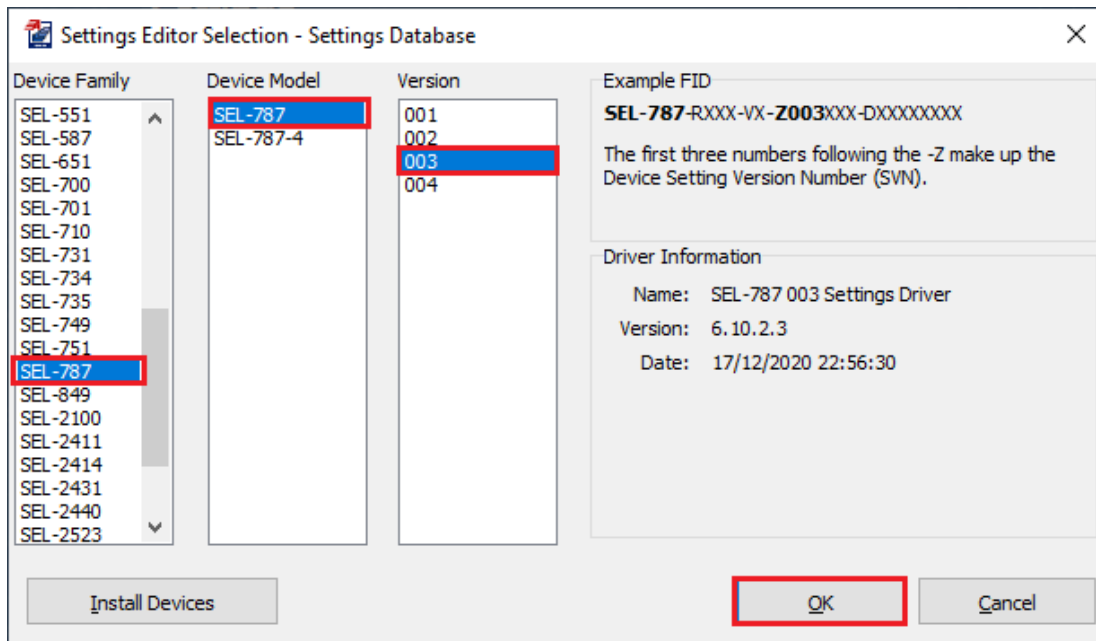


Figure 6

Then the “*Part Number*” must be set. Use the following path to view “*Status > Relay Status > PART NUM*”.

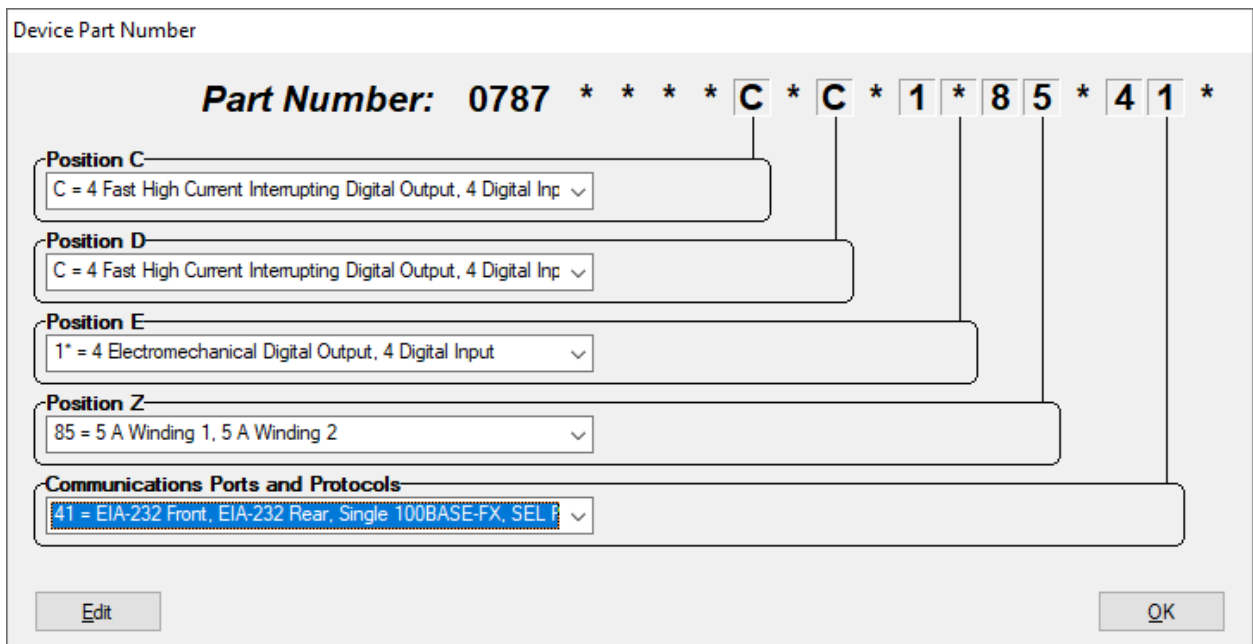


Figure 7

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Then click on the highlighted icon according to the figure below:

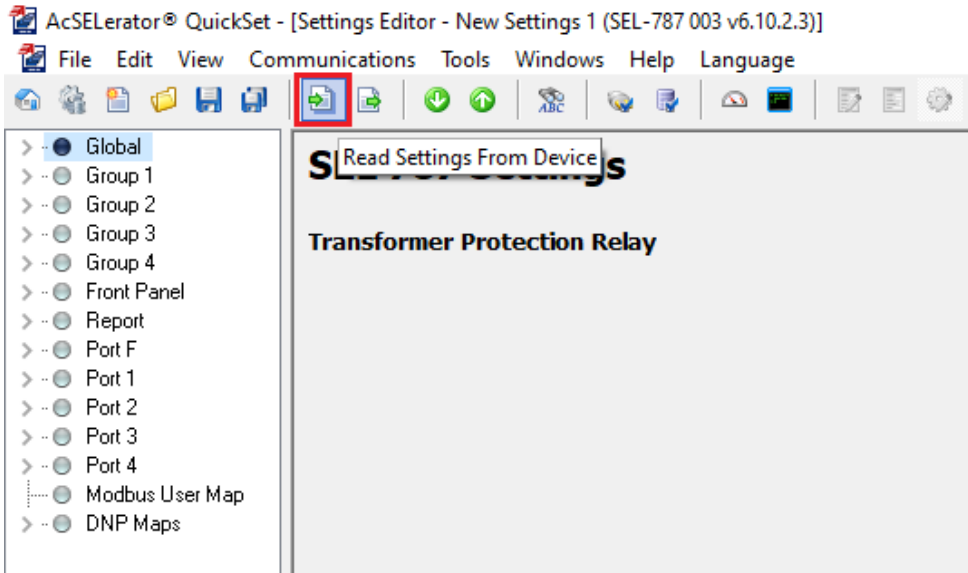


Figure 8

3. Parameterization of the SEL 787 relay

3.1. General

After the connection has been established, click on “Global” and “General” and adjust the value of the phase sequence and frequency.

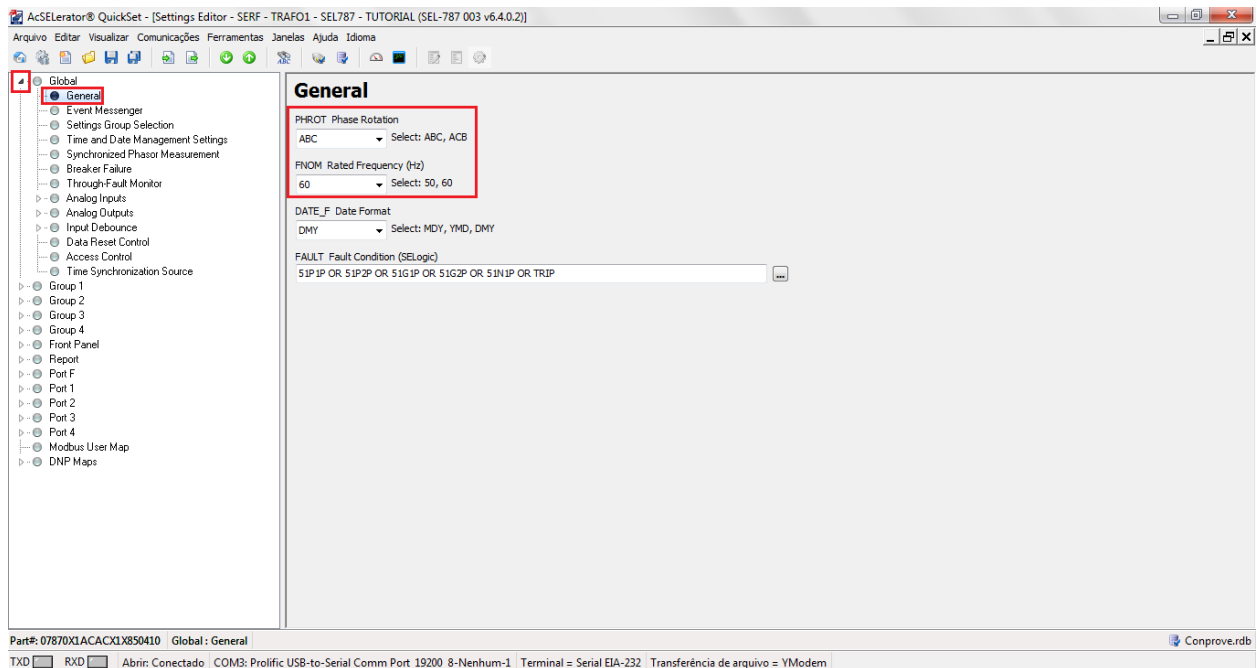


Figure 9

3.2. Configuration

Click on “Group 1 > Set 1” and choose the “Configuration” option. This window adjusts: the rated power of the power transformer, if the offset compensation is done by the relay itself, the type of CT connection, the CT transformation ratio, the angular compensation matrices and the rated voltage of each winding. The other adjustments in this window are not active.

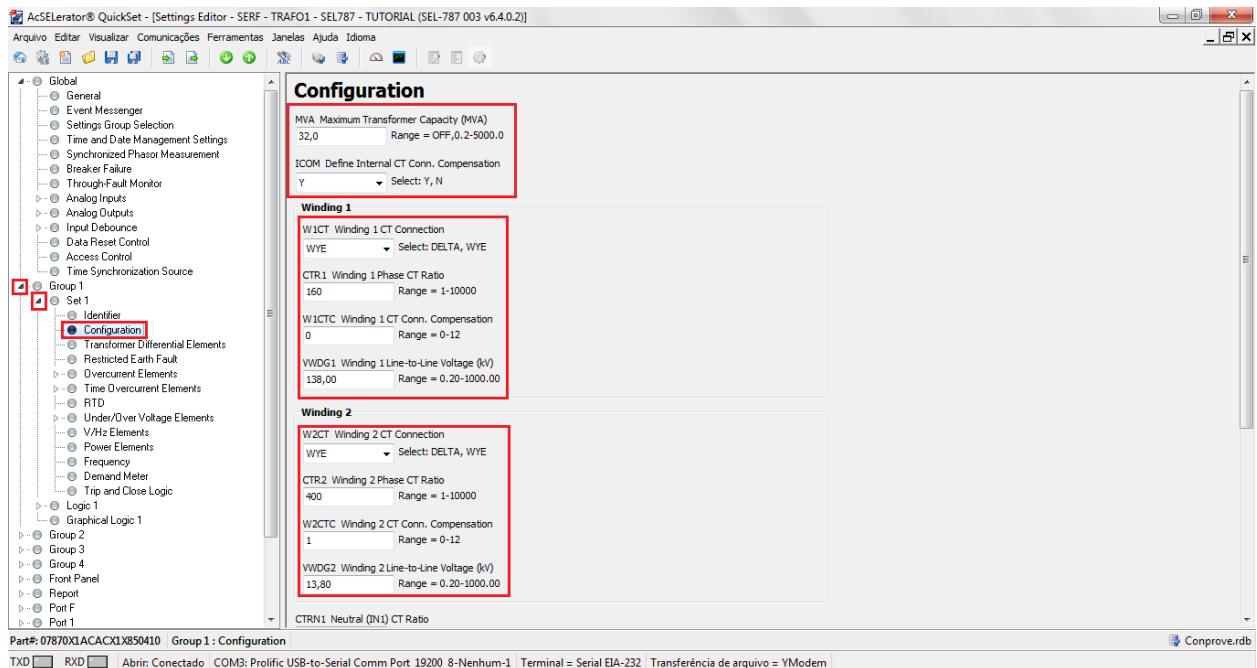


Figure 10

3.3. Transformer Differential Elements

In this option, the differential function is enabled, the TAP's values are displayed (automatically calculated) and the minimum differential current value is adjusted for TRIP and for alarm, the two slopes, the knee point and the current of the unrestricted differential. The other settings are related to the harmonic restraint function and they are not relevant for this tutorial.

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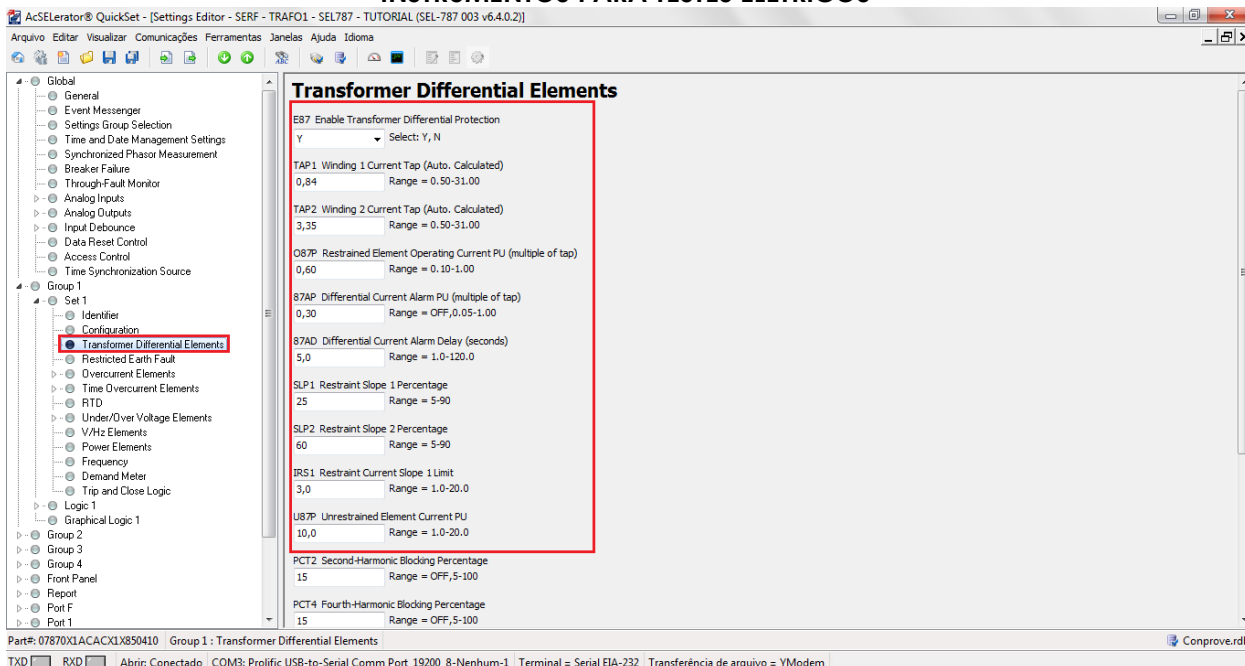


Figure 11

4. Binary Output Adjustments

4.1. Slot A

Click on “Logic 1 > Outputs” and select the option “Slot A” and make the following adjustment for the field “OUT101”.

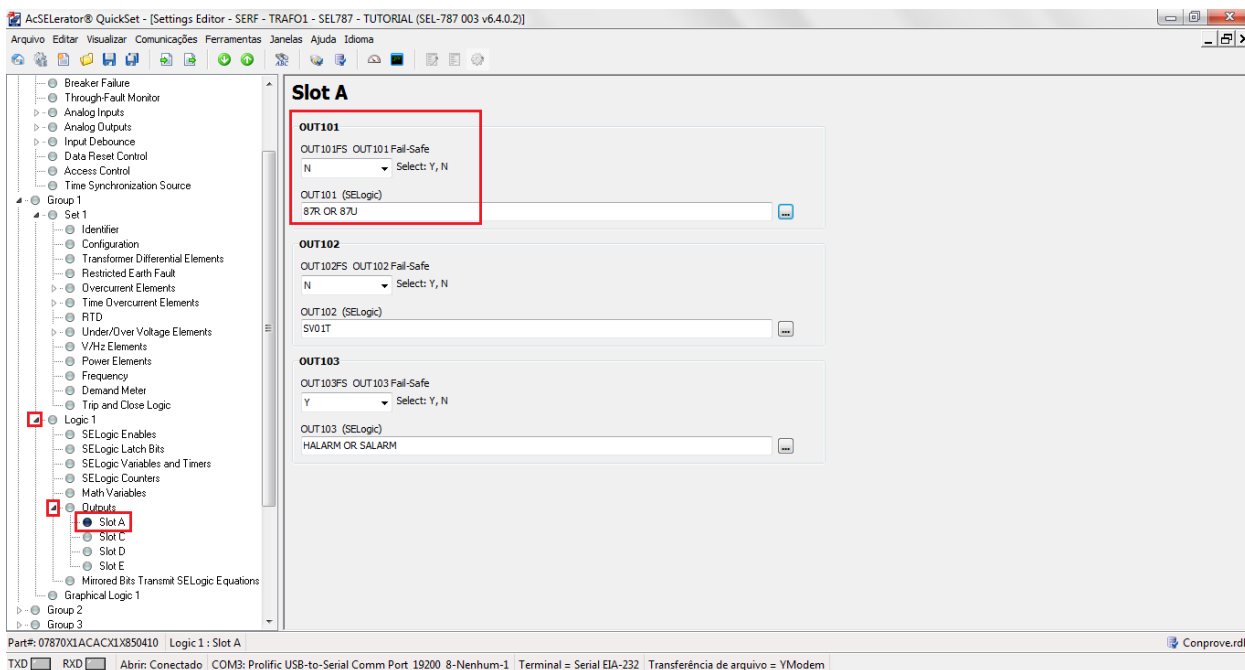


Figure 12

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4.2. Submitting the Adjustments

Click on the selected icon and submit at least the following adjustments.

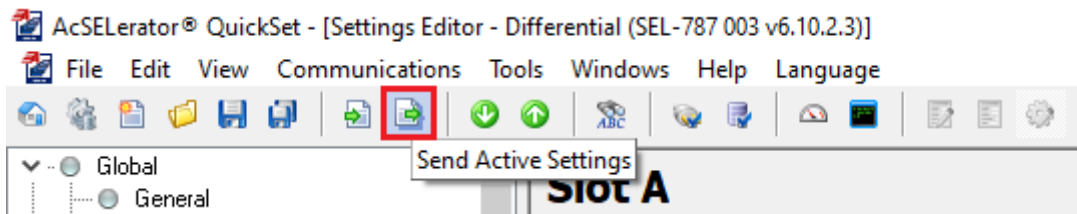


Figure 13

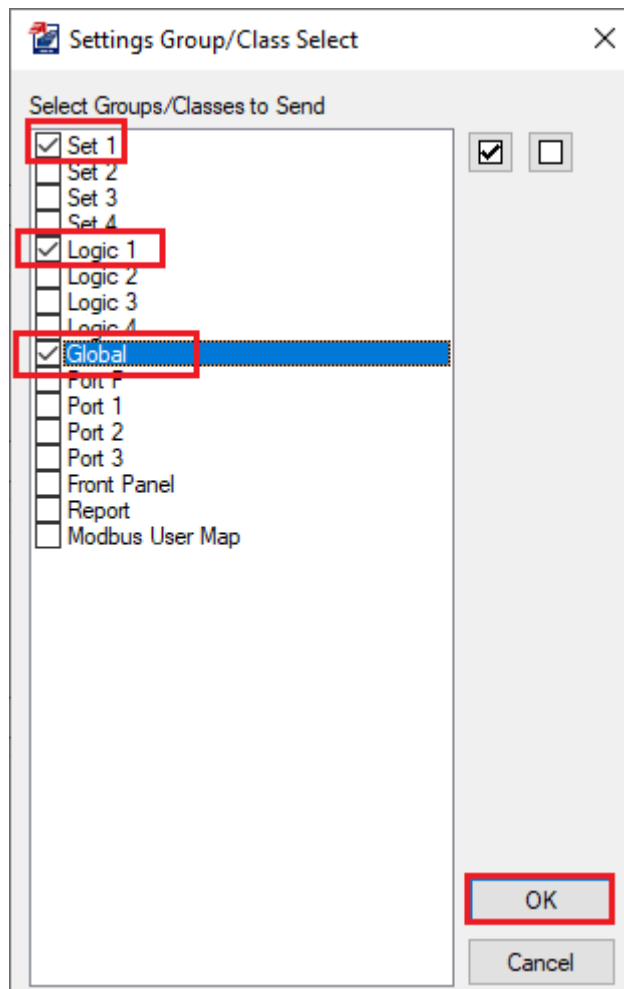


Figure 14

5. Differential software settings

5.1. Opening the Differential

Click on the “Conprove Test Center” application manager icon.



Figure 15

Click on the “Differential” software icon.

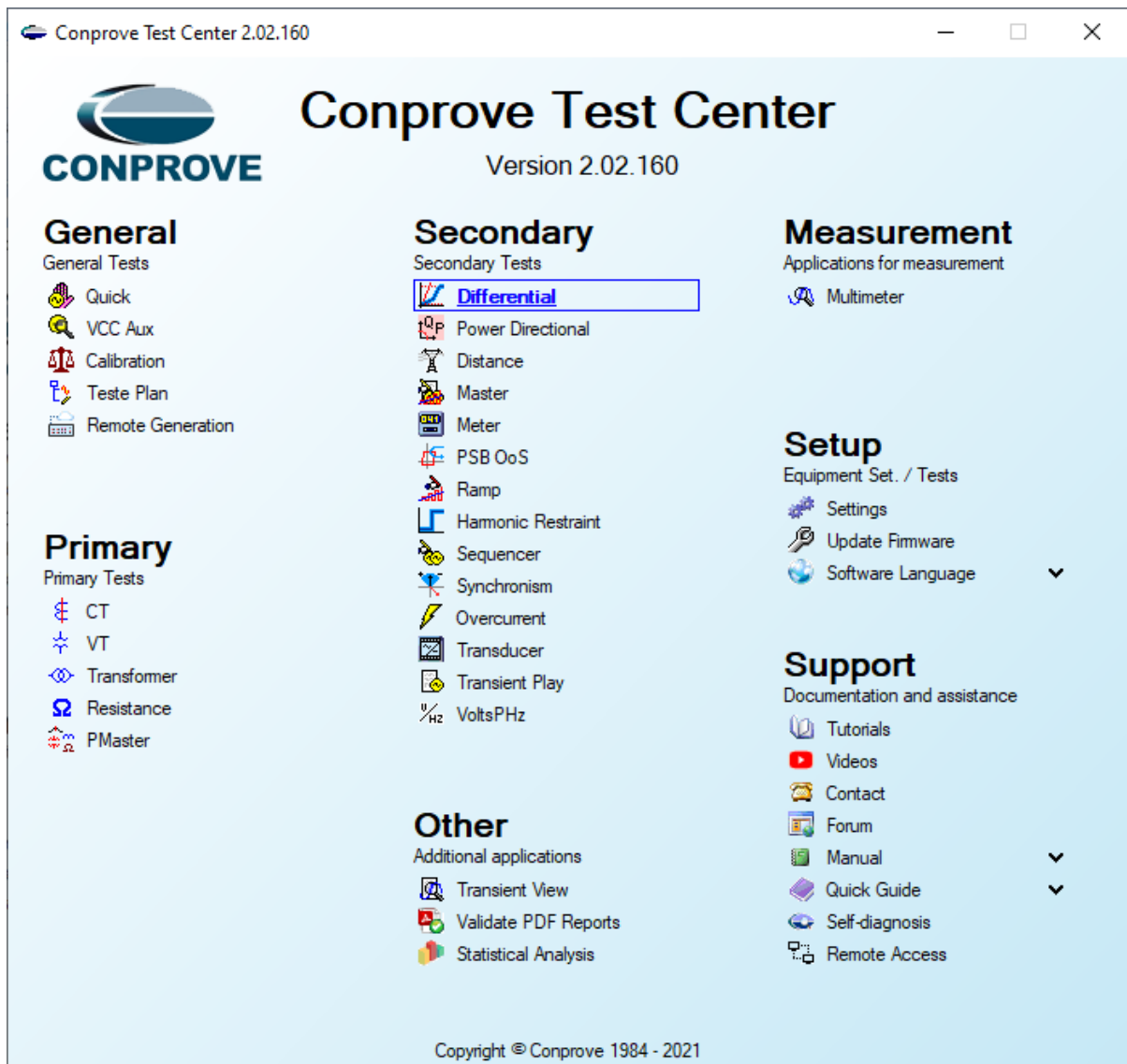


Figure 16

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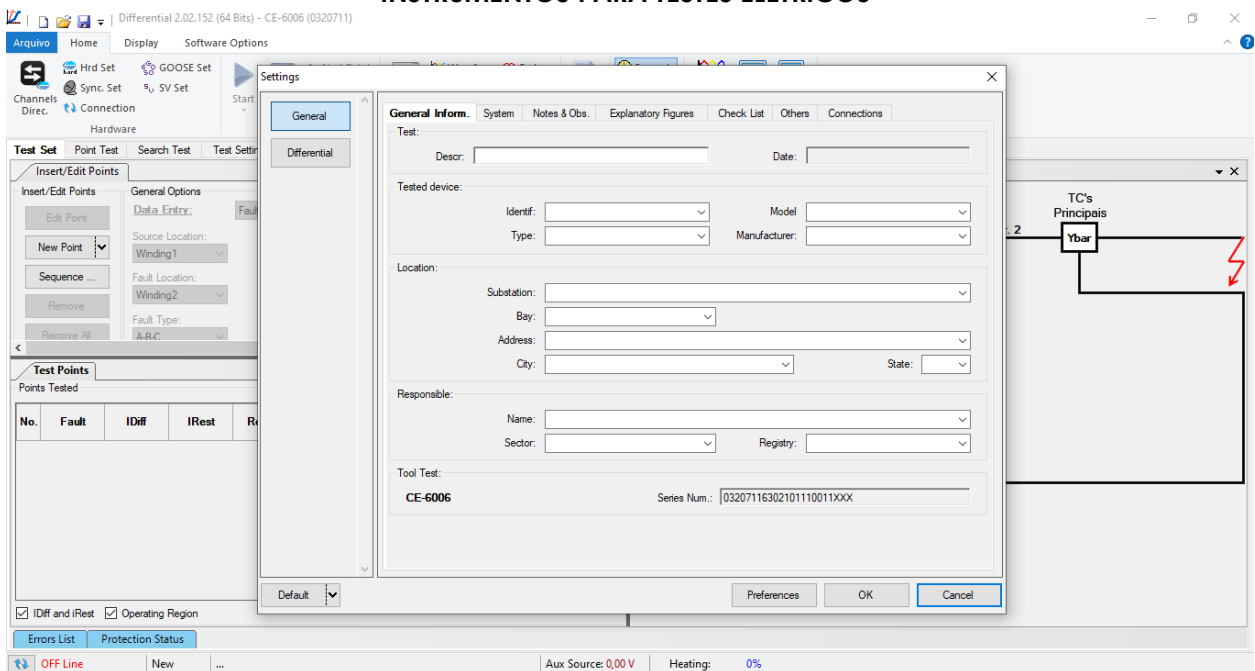


Figure 17

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.

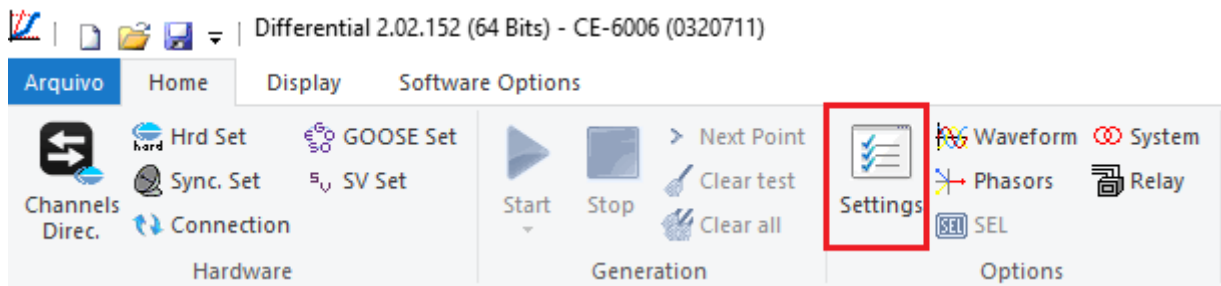


Figure 18

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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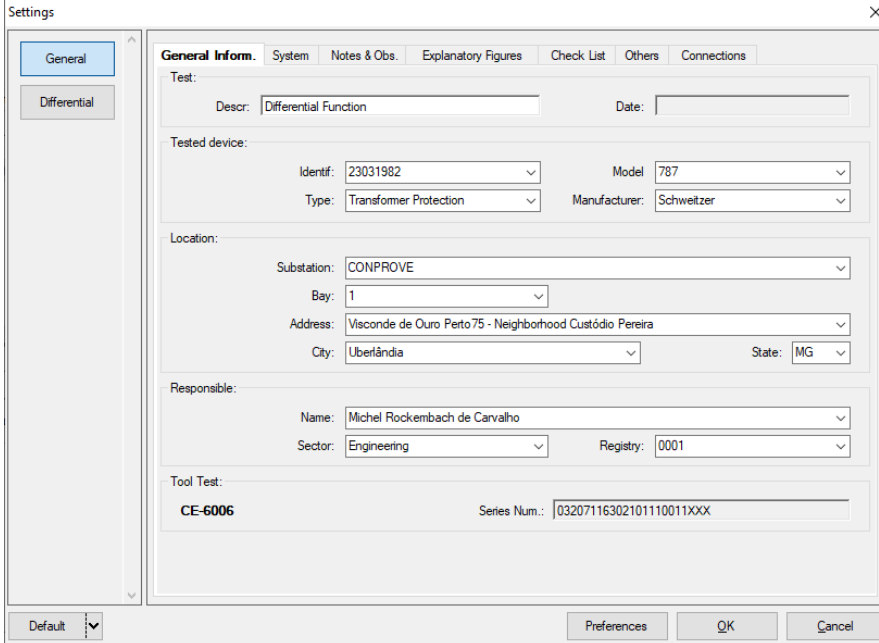
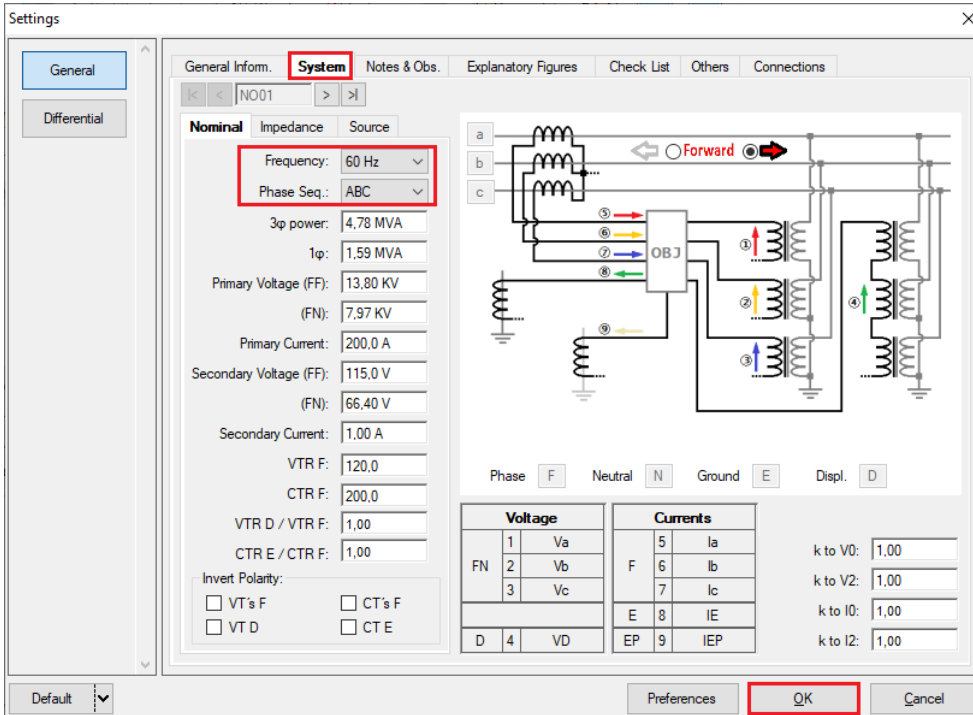


Figure 19

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.



Voltage		Currents	
1	Va	5	Ia
2	Vb	6	Ib
3	Vc	7	Ic
FN		E	IE
D		EP	IEP

k to V0: 1,00
k to V2: 1,00
k to I0: 1,00
k to I2: 1,00

Figure 20

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

6. Differential Adjustments

6.1. “Differential” screen > “Adjust Prot. Differential” > “Settings”

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

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

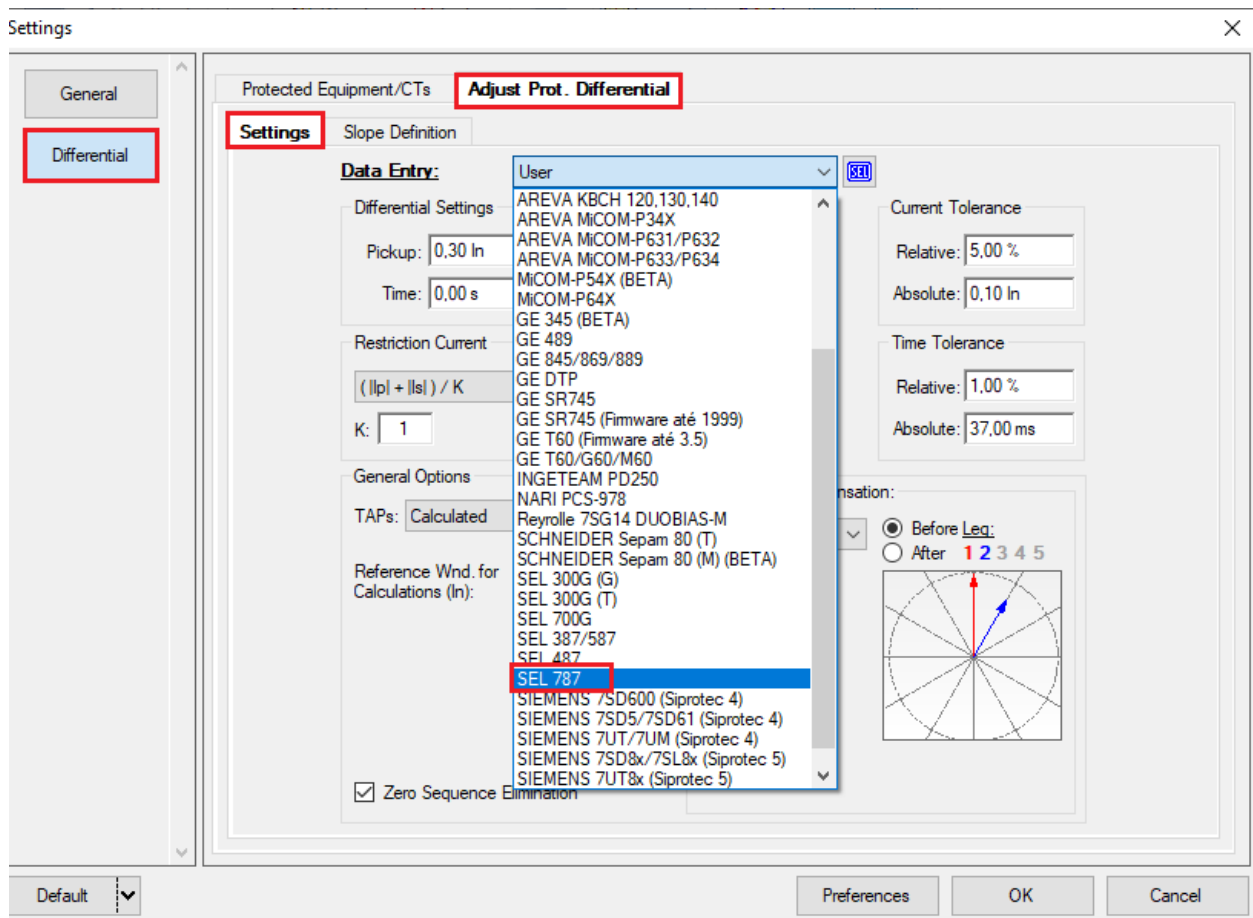


Figure 21

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Choosing the “SEL 787” template makes adjustments easier. Current and time tolerances are taken from Appendix A.

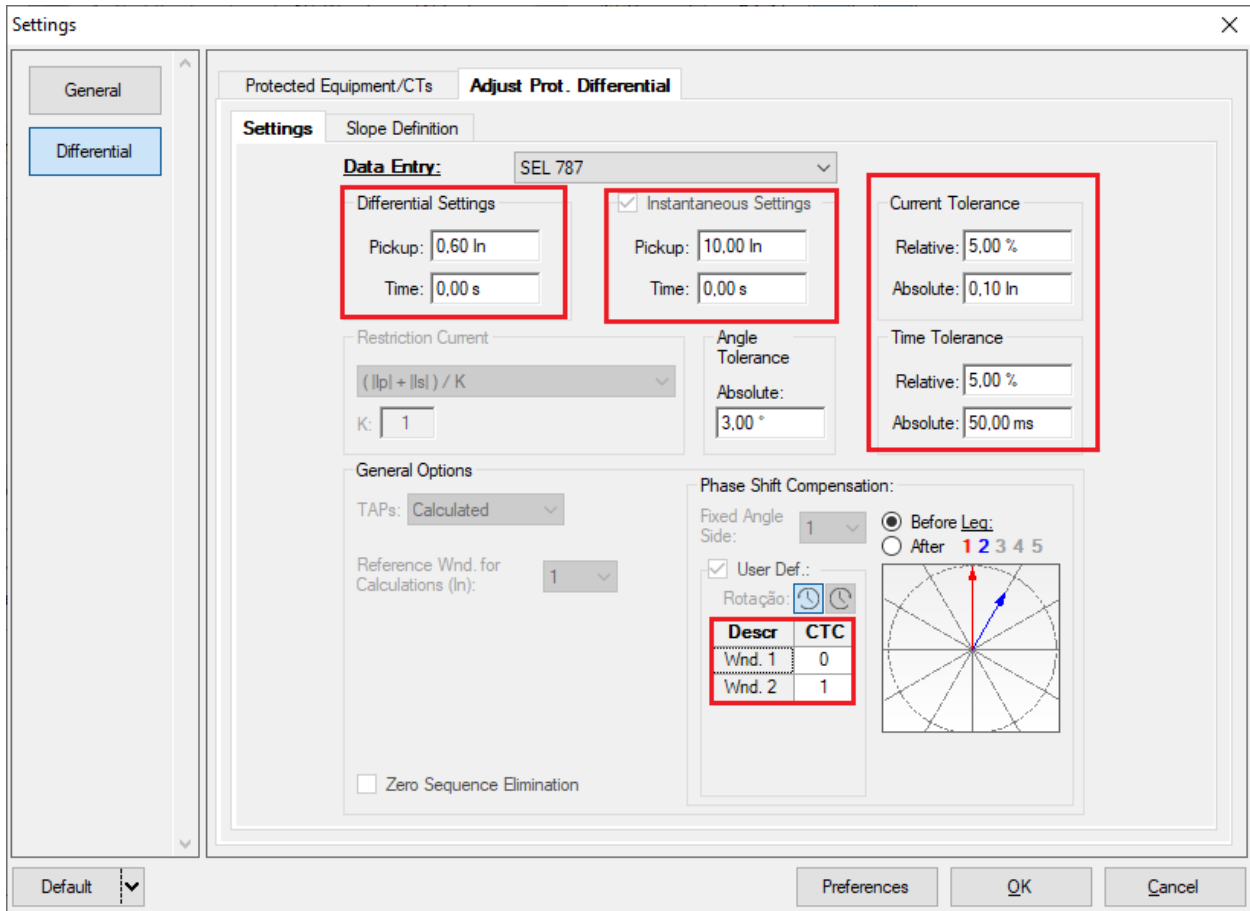


Figure 22

6.2. Differential screen > Adjust Prot. Differential > Slope Definition

In this screen the values of the slopes (“Slope 1” and “Slope 2”) and the “Knee Point” must be entered.

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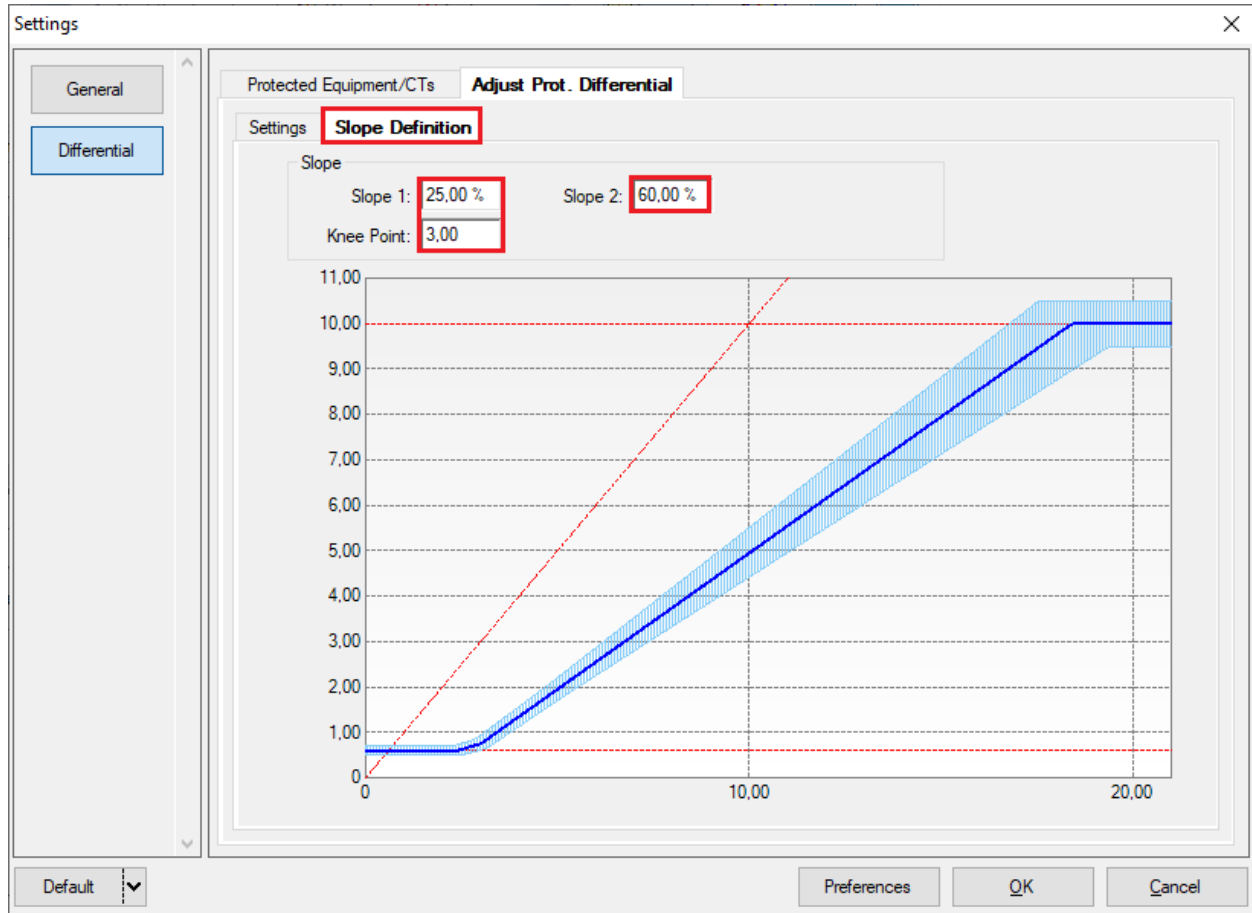


Figure 23

6.3. Differential screen > Protected Equipment / CT's

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 two-winding transformer. However, it is possible to test, in addition to the differential protection of transformers, the busbar, generator, motor and line protections. For transformer protection there is the possibility of testing up to four windings, using two test set simultaneously.

INSTRUMENTOS PARA TESTES ELÉTRICOS

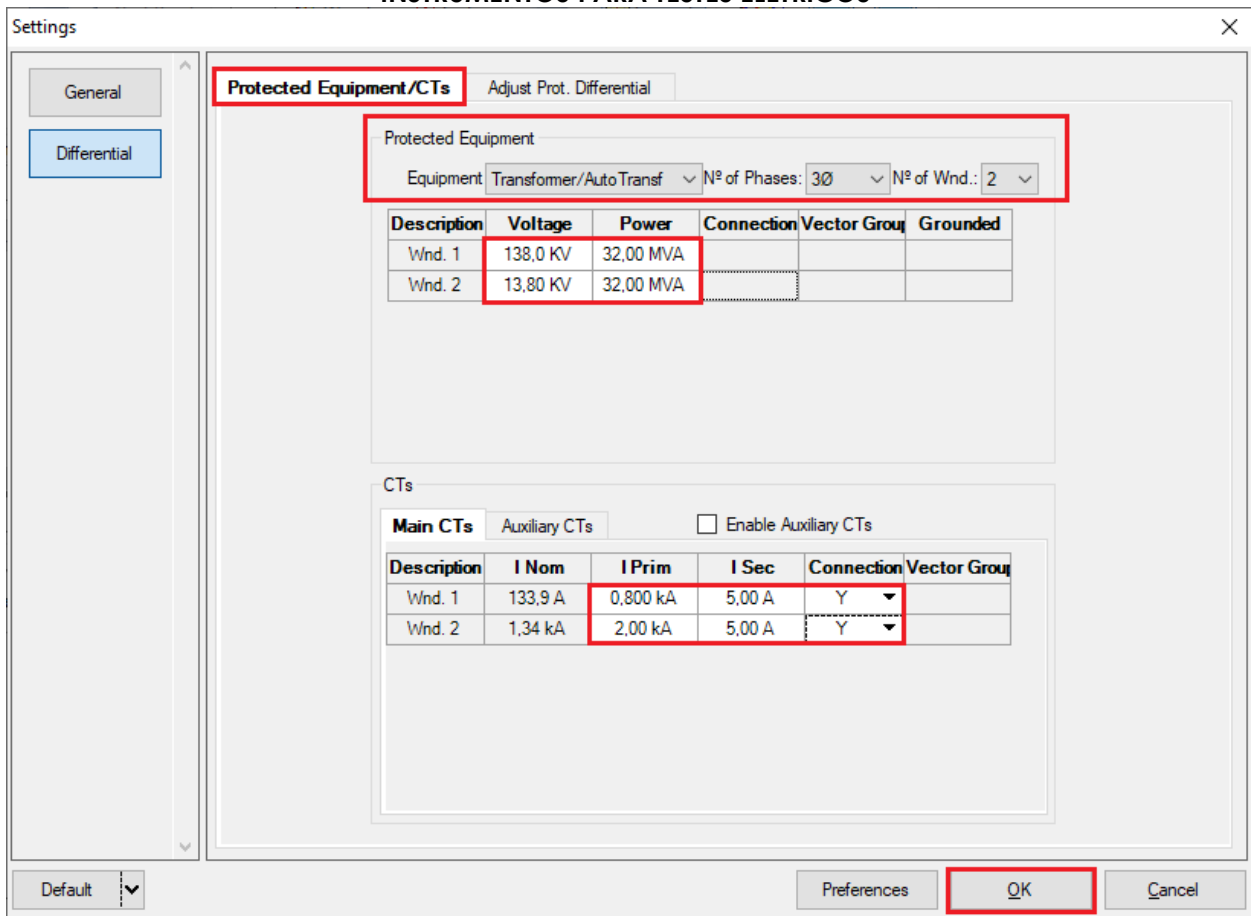


Figure 24

7. Channel Targeting and Hardware Configurations

Click on the icon illustrated below.

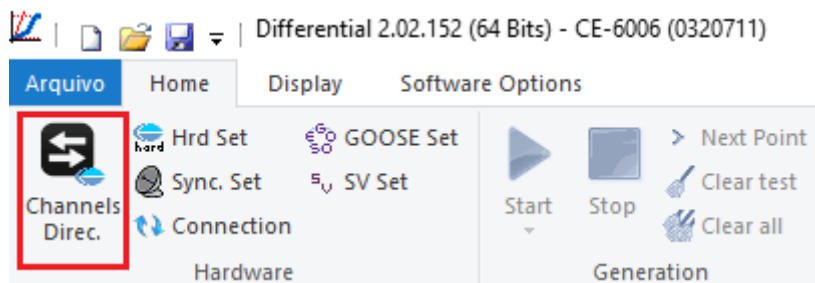


Figure 25

Then click on the highlighted icon to configure the hardware.

INSTRUMENTOS PARA TESTES ELÉTRICOS

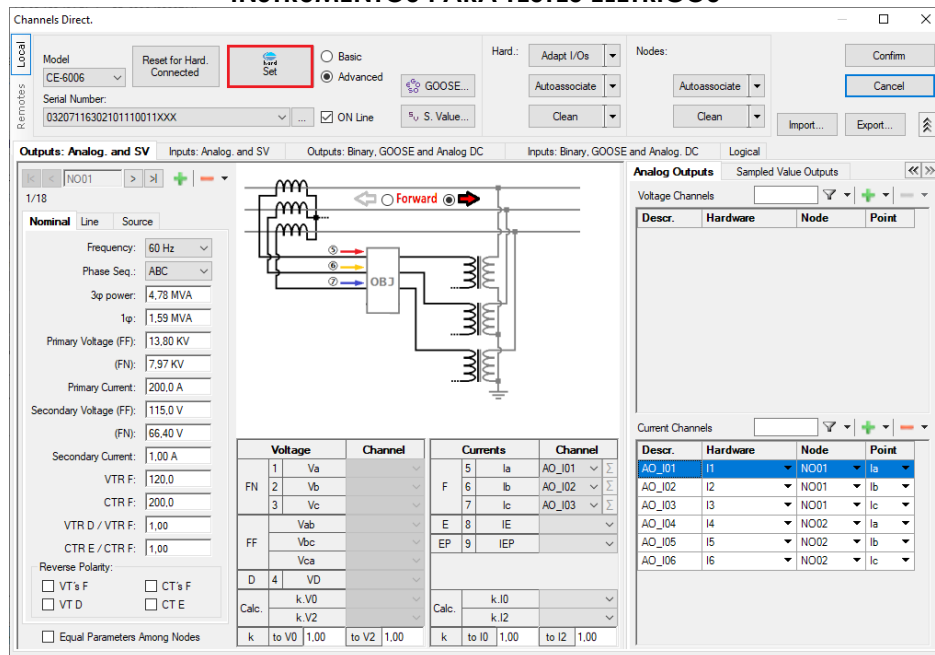


Figure 26

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

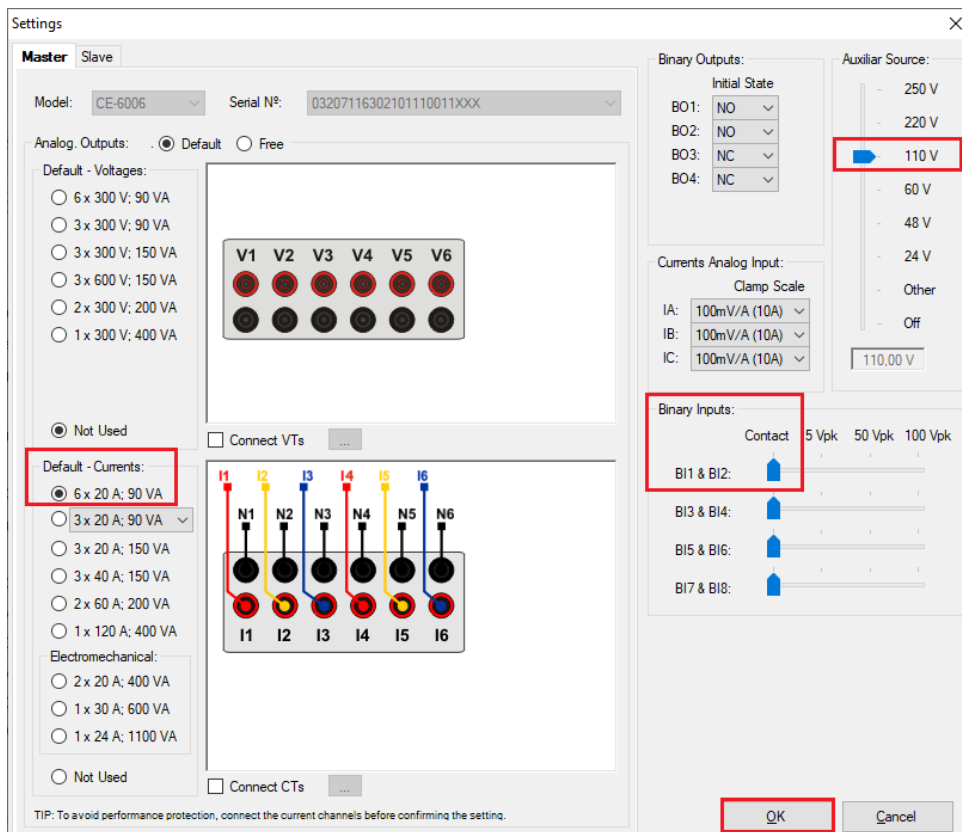


Figure 27

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

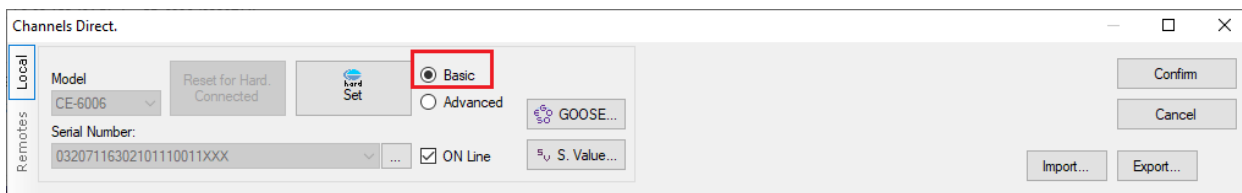


Figure 28

8. Test Settings

In the test settings tab, the important thing is the correct direction of the generation channels and the selection of the stopwatch interface for “BI01”. Enable a pre-fault with nominal values with a time of 500ms so that the “Point Test” is done properly.

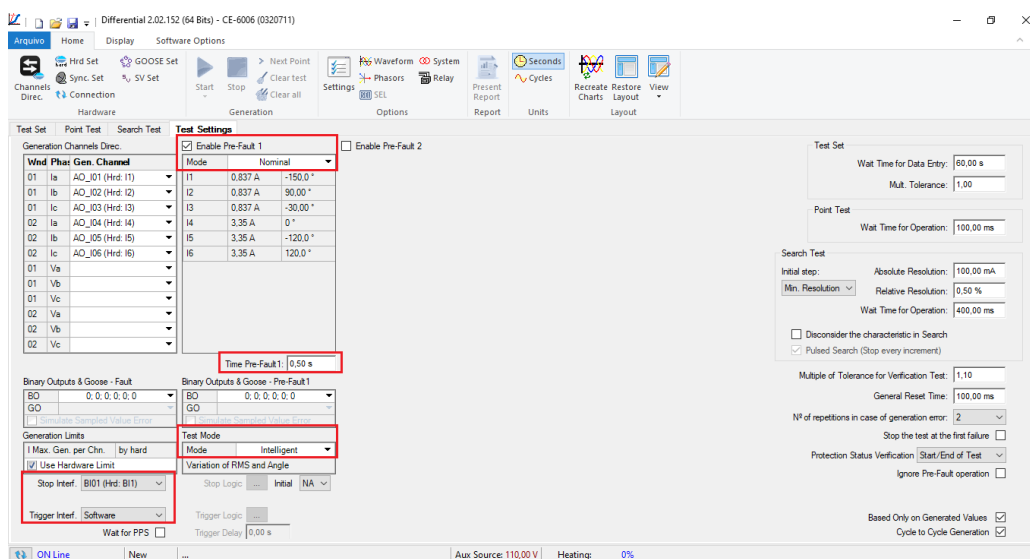


Figure 29

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 this, enter the new point according to the data below:

- **Data Entry:** IDiff e iRest
- **IDiff:** 1In
- **iRest:** 2In
- **Source Location:** Winding. 1
- **Fault Location:** Winding. 2
- **Fault Type:** ABC

INSTRUMENTOS PARA TESTES ELÉTRICOS

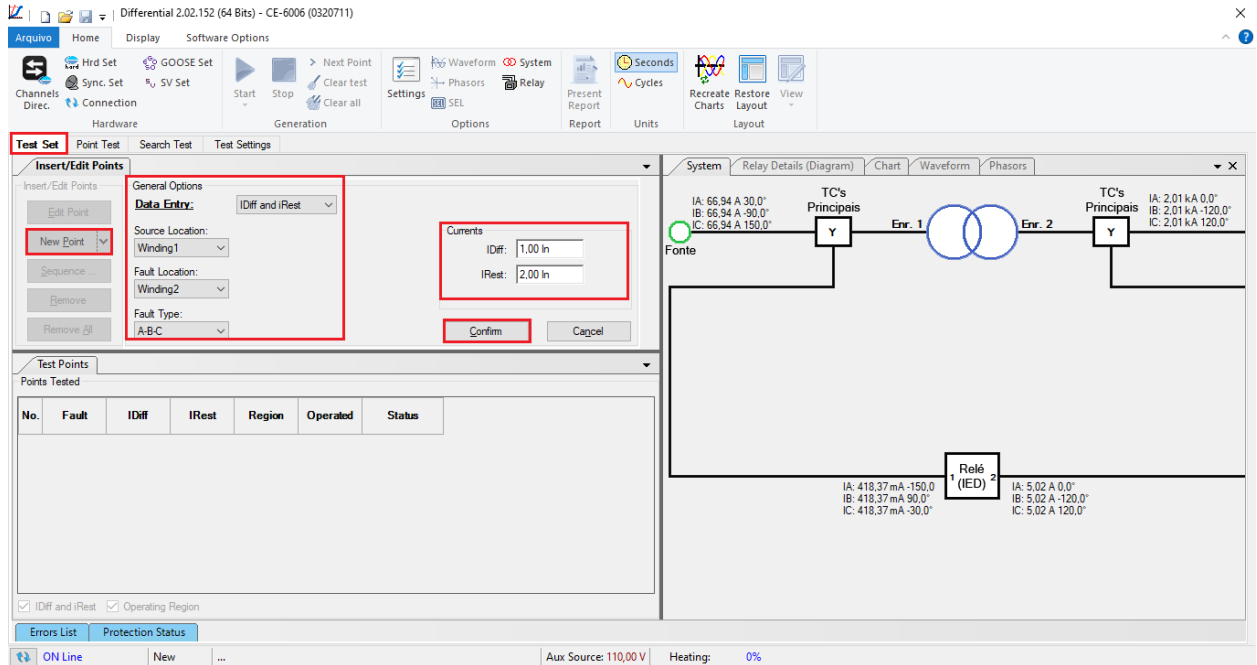


Figure 30

When starting the test, the user must enter the values of differential and restraint current read in the relay, which must be within the range of tolerance values given by the manufacturer in relation to the values calculated in the software. To view the values measured by the relay choose the “*Human Machine Interface*” and choose “*Differential*” in software “*AcSELERator*”.

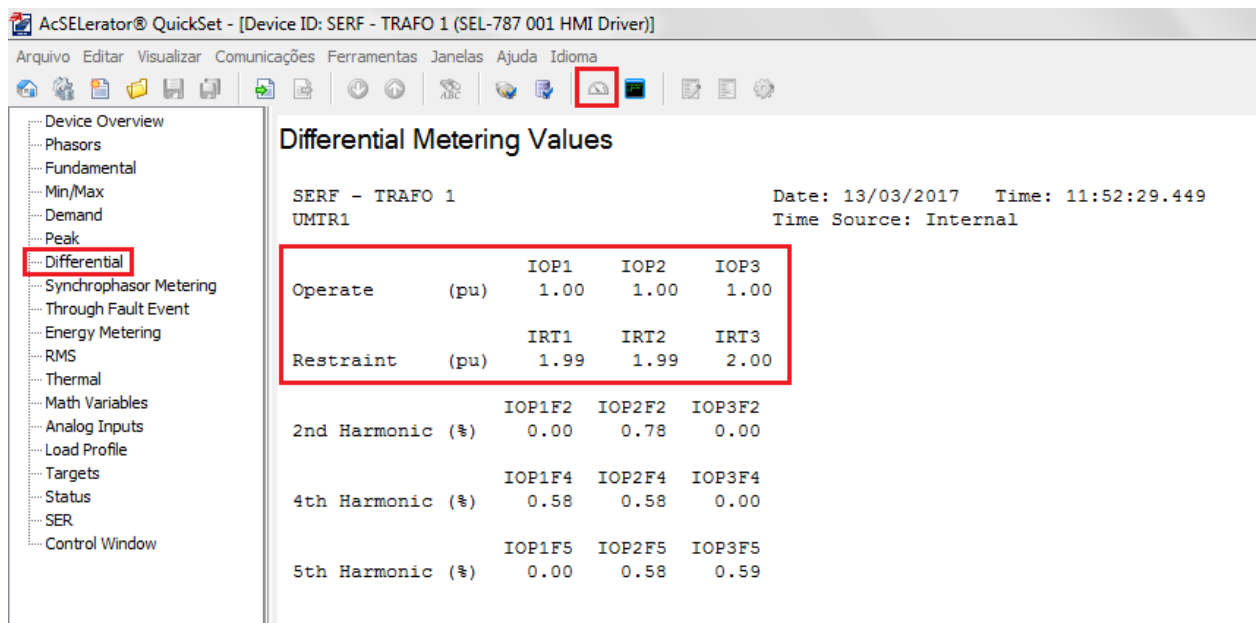


Figure 31

INSTRUMENTOS PARA TESTES ELÉTRICOS

When entering the data, the software will perform this automatic data comparison.

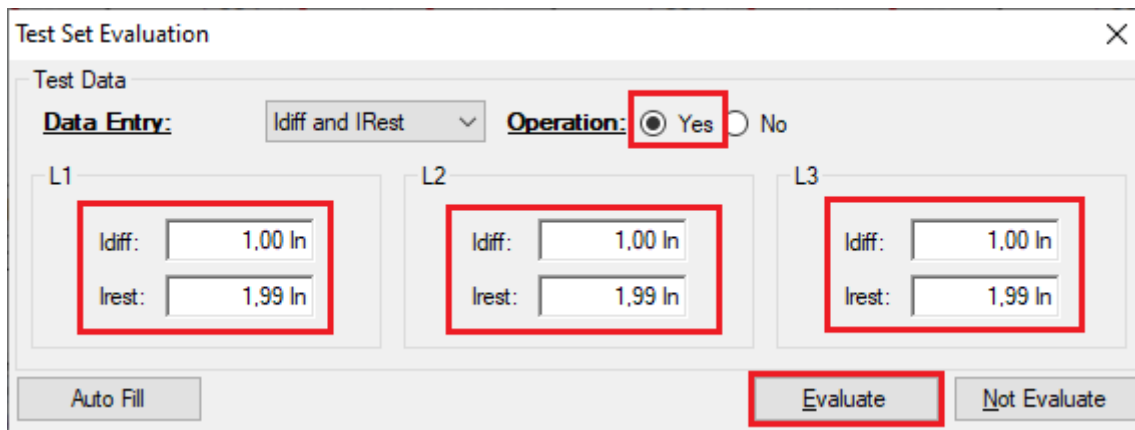


Figure 32

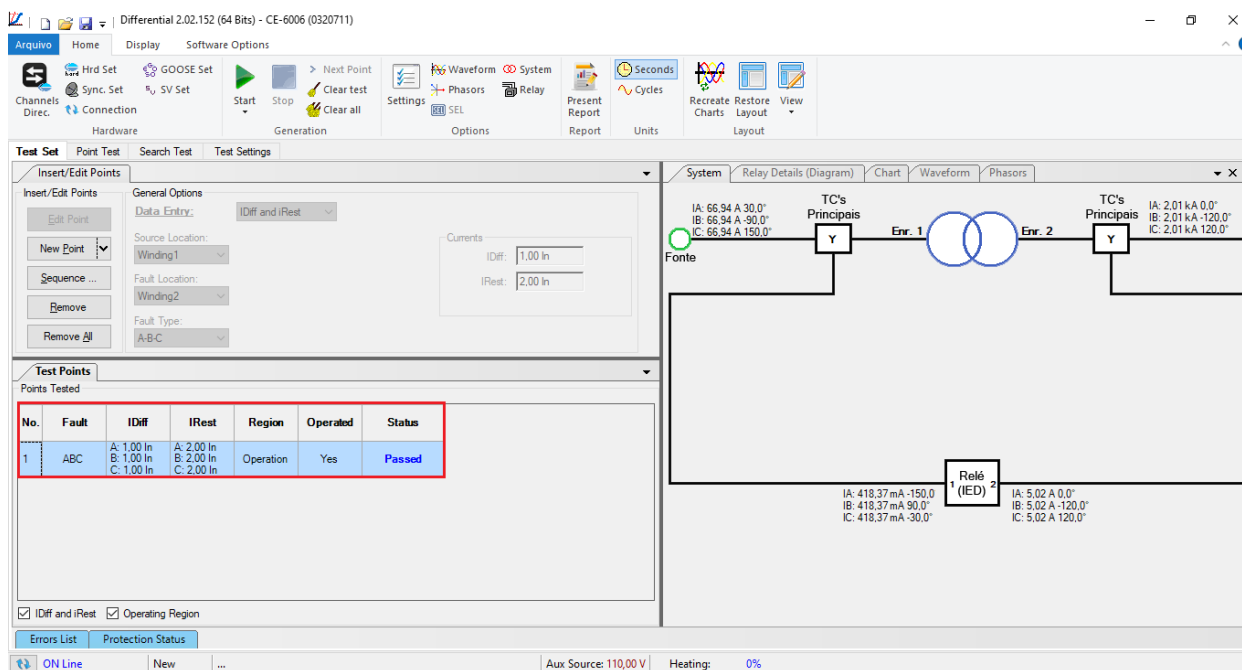


Figure 33

Passing the configuration test makes it possible for the other two tests to be carried out successfully. If the result is “Failed”, check all connections and adjustments between the test set and the relay.

10. Point Test

For the point test, click on the “Sequence” field and choose the type of fault, the initial and final value of the restraint current.

INSTRUMENTOS PARA TESTES ELÉTRICOS

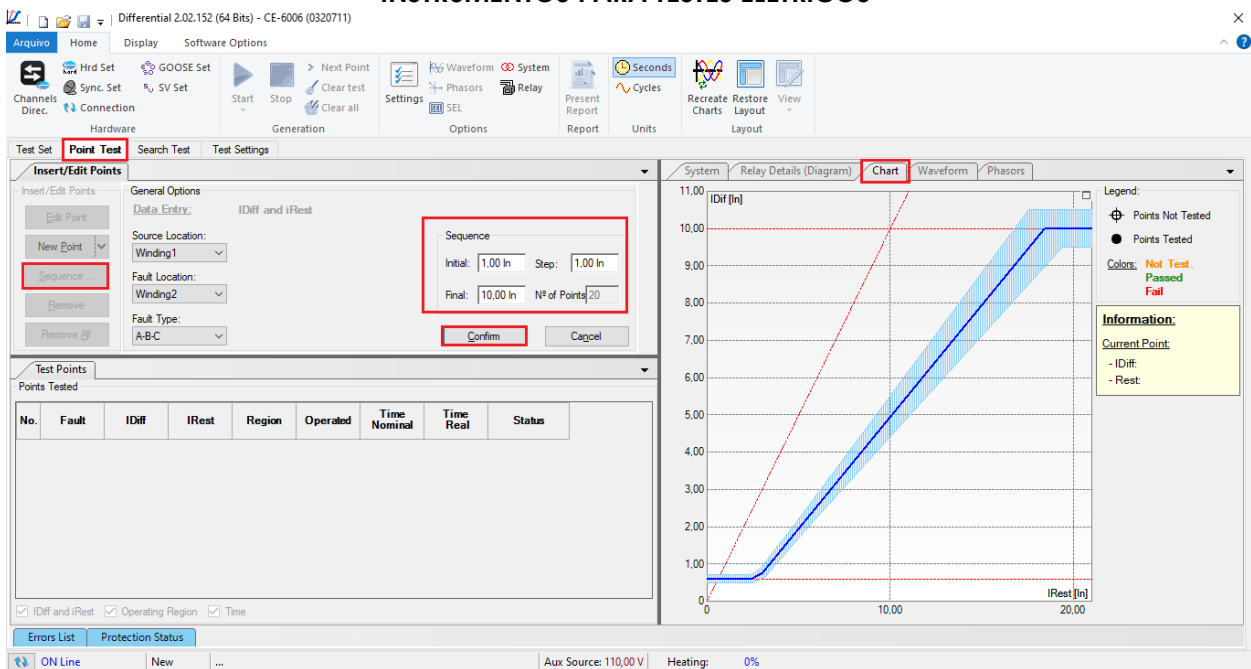


Figure 34

When starting the test all points will be tested sequentially and the status will update automatically. The following figure shows the result of a test where 8 points were tested. The detail to be observed is that the tested points must be within the generation limit of the current channels, otherwise the point will not be tested and a status informing that the point is outside the generation limit will be presented.

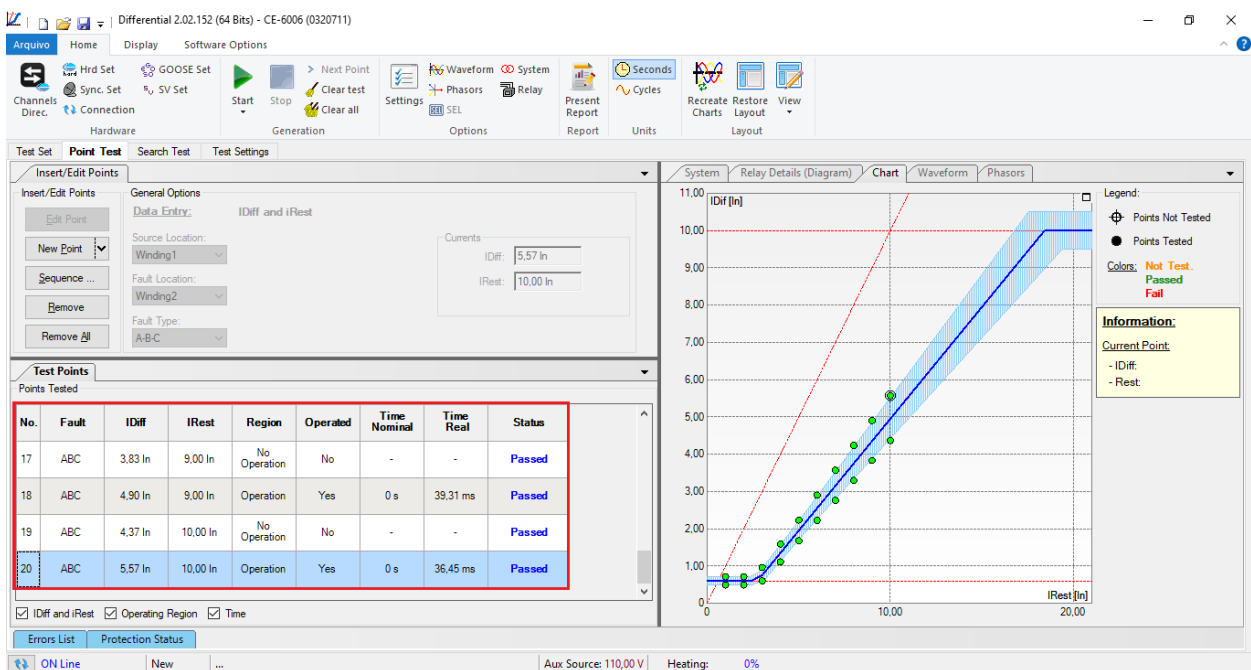


Figure 35

INSTRUMENTOS PARA TESTES ELÉTRICOS

It is verified that the points within the operating region acted within the expected time, whereas the points outside the operating region did not act.

11. Search Test

To perform the search test, click on the “*Sequence*” field, choose the type of fault, the source location, the location of the short and the initial, final and step restraint current values.

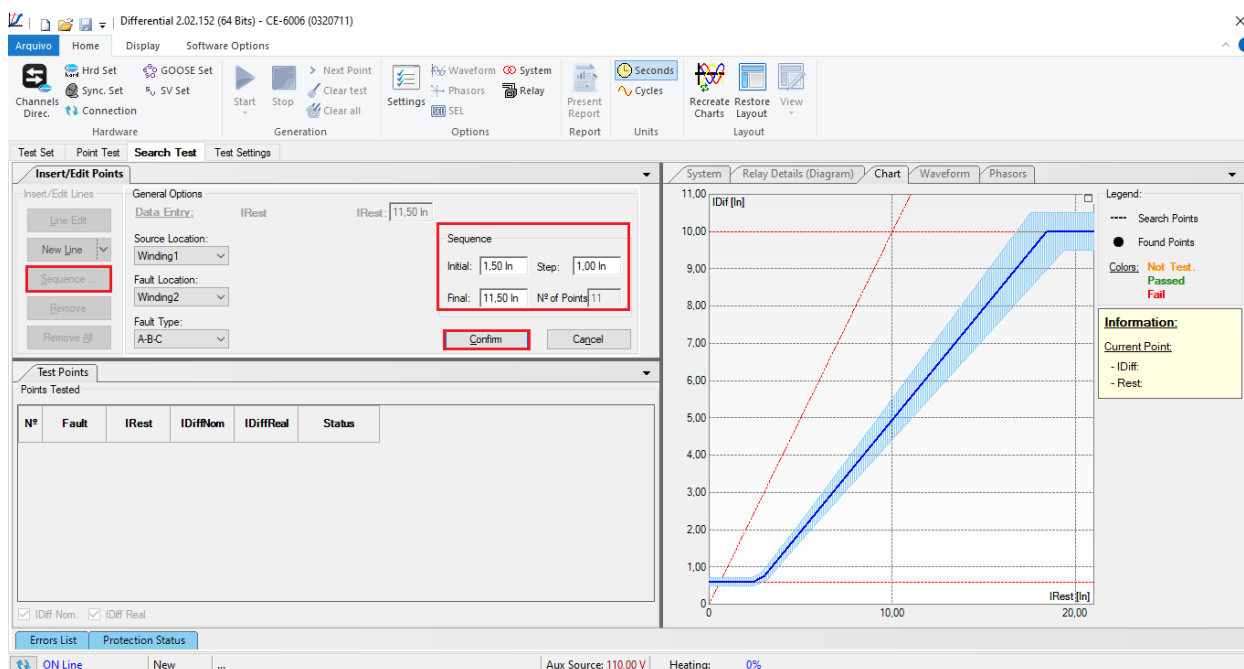


Figure 36

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

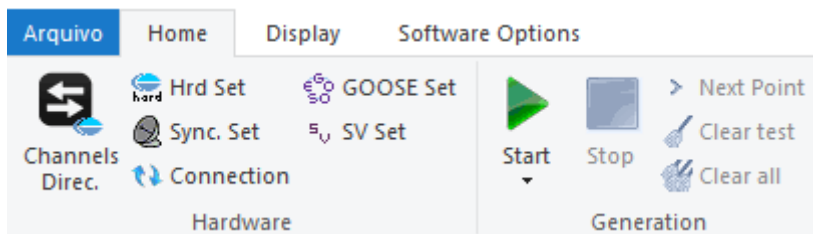


Figure 37

11.1. Final Search Test Result

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

INSTRUMENTOS PARA TESTES ELÉTRICOS

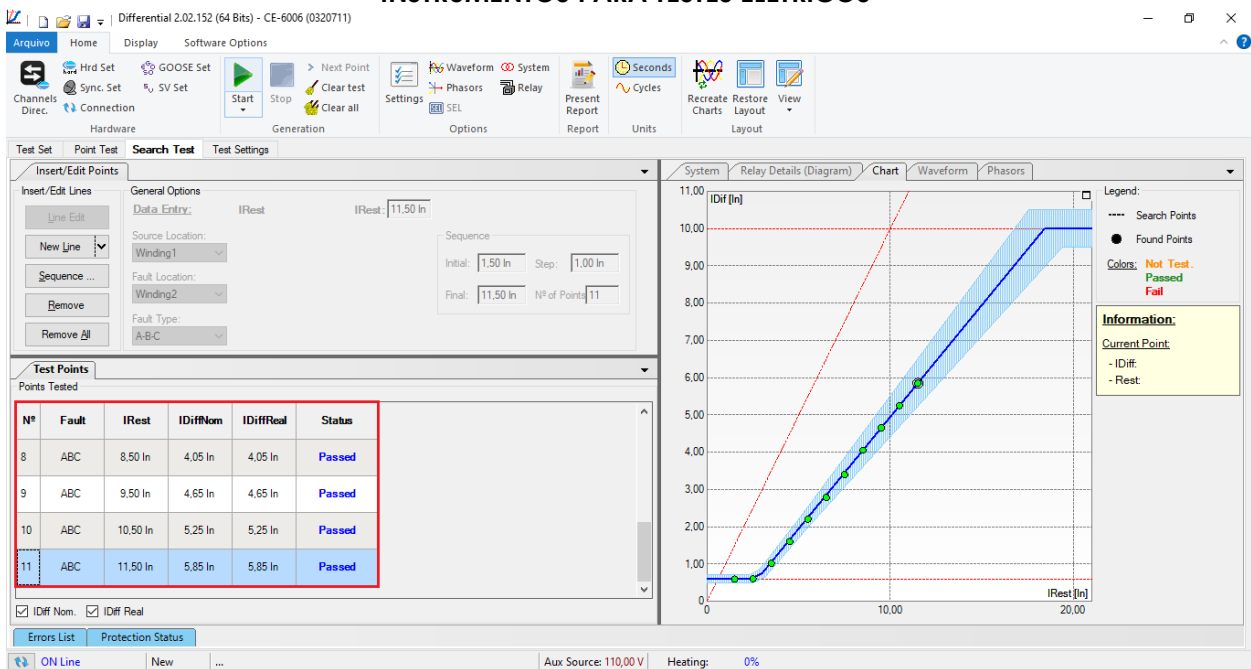


Figure 38

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.

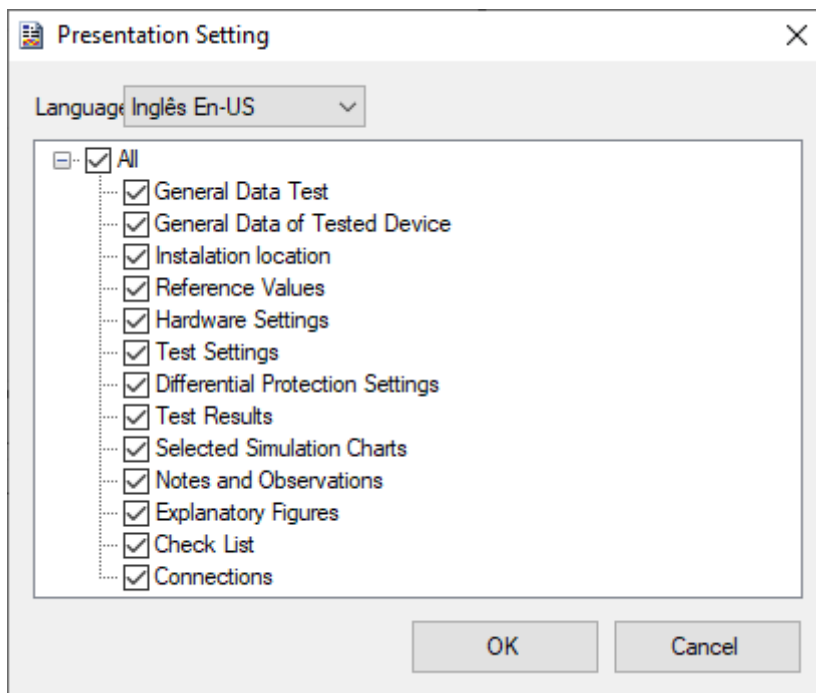


Figure 39

INSTRUMENTOS PARA TESTES ELÉTRICOS

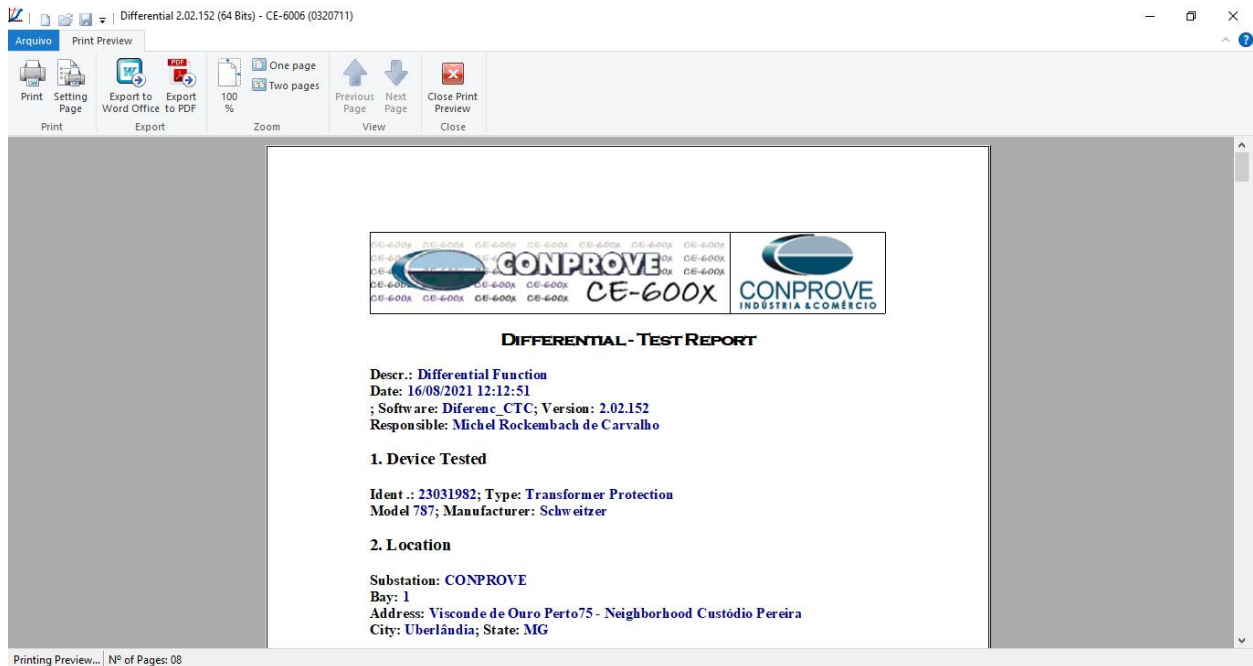


Figure 40

INSTRUMENTOS PARA TESTES ELÉTRICOS

APPENDIX A

A.1 Terminal Designations

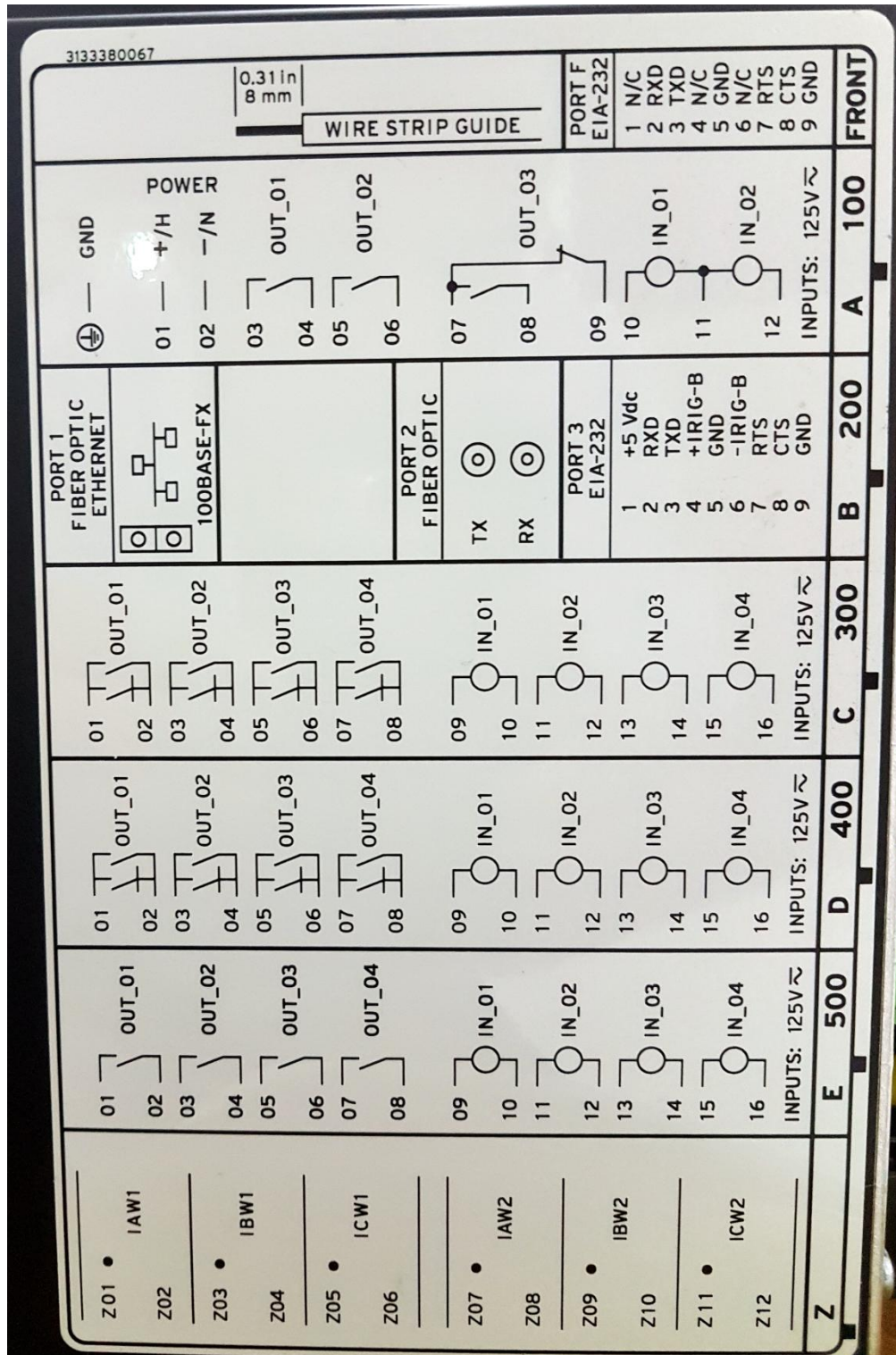


Figure 41

A.2 Technical Data

Differential (87)

Unrestrained Pickup Range: 1.0–20.0 in per unit of TAP

Restrained Pickup Range: 0.10–1.00 in per unit of TAP

Pickup Accuracy (A secondary):

5 A Model: $\pm 5\%$ plus ± 0.10 A

1 A Model: $\pm 5\%$ plus ± 0.02 A

Unrestrained Element

Pickup Time: 0.8/1.0/1.9 cycles (Min/Typ/Max)

Restrained Element (with harmonic blocking)

Pickup Time: 1.5/1.6/2.2 cycles (Min/Typ/Max)

Restrained Element (with harmonic restraint)

Pickup Time: 2.62/2.72/2.86 cycles (Min/Typ/Max)

APPENDIX B

Equivalence of software parameters and the relay under test.

Table 1

Differential Software		SEL 787 Relay	
Parameter	Figure	Parameter	Figure
Voltage (Wind. 1)	24	VWDG1 Winding 1 Line-to-Line Voltage	10
Voltage (Wind. 2)	24	VWDG2 Winding 2 Line-to-Line Voltage	10
Power (Wind. 1)	24	MVA Maximum Transformer Capacity	10
Power (Wind. 2)	24	MVA Maximum Transformer Capacity	10
I Prim (Wind. 1)	24	CTR1 Winding CT Ratio (*5,0A)	10
I Prim (Wind. 2)	24	CTR2 Winding CT Ratio(*5,0A)	10
Differential Settings (pickup)	22	O87P Restrained Element Operation Current PU	11
Differential Settings (time)	22	A.2 Technical Data	
Instantaneous Settings (pickup)	22	U87P Unrestrained Element Current PU	11
Instantaneous Settings (time)	22	A.2 Technical Data	
Enr.1 (CTC)	24	W1CTC Winding 1 CT Conn. Compensation	11
Enr.2 (CTC)	24	W2CTC Winding 2 CT Conn. Compensation	11
Slope 1	22	SLP1 Restraint Slope 1 Percentage	11
Slope 2	22	SLP2 Restraint Slope 2 Percentage	11
Knee Point	22	IRS1 Restraint Current Slope1 Limit	11