

Test Tutorial

Equipment Type: Protection Relay

Brand: Siemens

Model: 7UT86

Function: 32R or PDOP – Power Directional

Tool Used: CE-6006; CE-6707; CE-6710; CE-7012 or CE-7024

Objective: Perform tests on the reverse power function to verify its directionality

Version control:

Version	Descriptions	Date	Author	Reviewer
1.0	Initial release	24/05/2022	M.R.C.	G.C.D.P.

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INSTRUMENTOS PARA TESTES ELÉTRICOS

APPENDIX B37

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 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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1. Relay connection to CE-6710

Appendix A shows the relay terminal designations.

1.1 Auxiliary Source

Connect the positive (red terminal) of the Aux source. Vdc to pin B1 of slot 2B of the relay and the negative (black terminal) of the Aux Vdc supply to pin B2 of slot 2B.

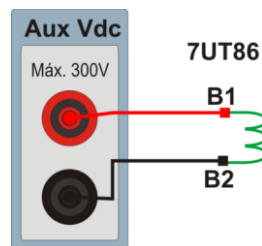


Figure 1

1.2 Current and Voltage Coils

To establish the connection of voltage coils, connect voltage channels V1, V2 and V3 to pins B1, B3 and B5 of relay slot 3B respectively, and their common to pins B2, B4 and B6 respectively. If the relay commons are short-circuited, just connect the three commons of the voltage channels to that point. To connect the current coils, connect channels I1, I2 and I3 with pins A1, A3 and A5 of slot 1A of the relay terminal and common to pins A2, A4 and A6. If these last three points are short-circuited, connect all commons to this point.

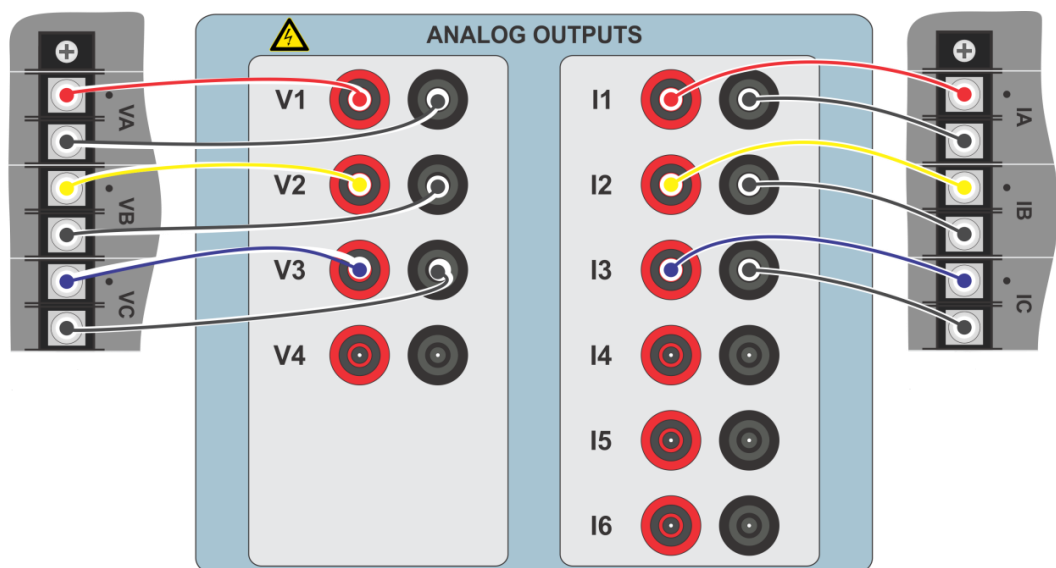


Figure 2

1.3 Binary Inputs

Connect the CE-6710 binary inputs to the relay binary outputs.

- BI1 to pin D1 and its common to pin D2;

The following figure shows the details of the connection.

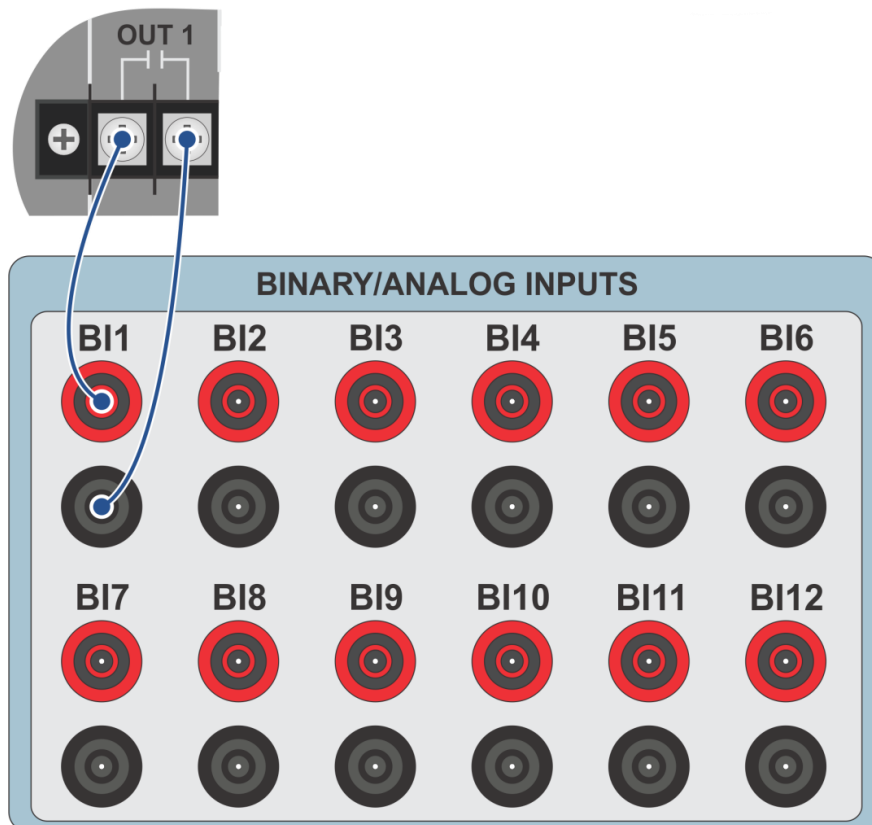


Figure 3

2. Communication with 7UT86 relay

First connect a USB cable from the notebook with the relay. Then double-click on the software icon and “DIGSI 5”.



Figure 4

When opening the program, click on the “Project” menu then choose the “New” option.

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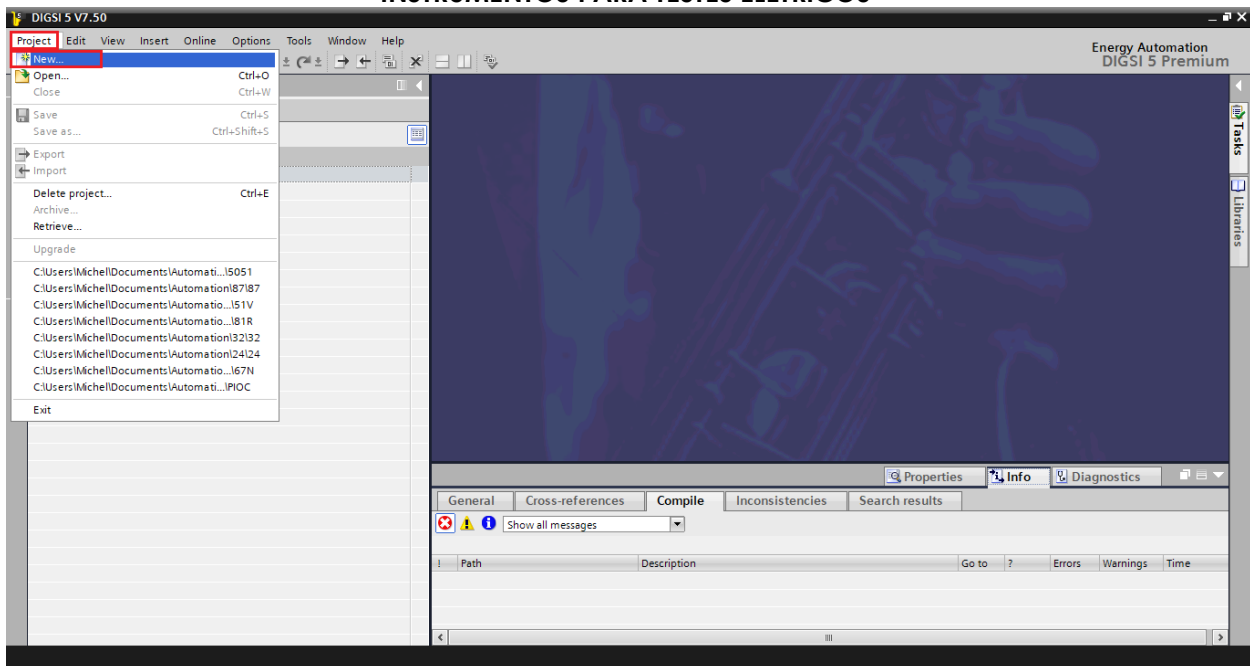


Figure 5

Enter a name for the project and then click “*Create*” as highlighted below.

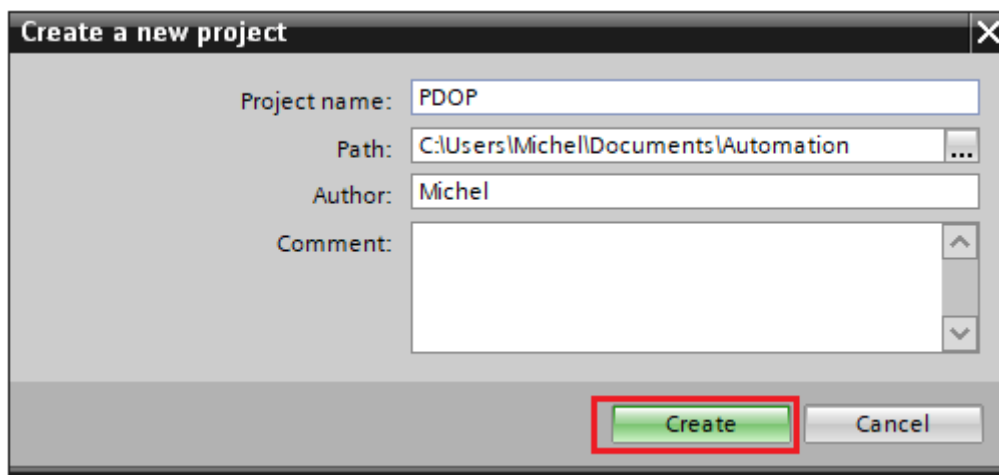


Figure 6

When creating the project, add the relay that will be tested, to do this double-click on “*Add New Device*” as highlighted below.

INSTRUMENTOS PARA TESTES ELÉTRICOS

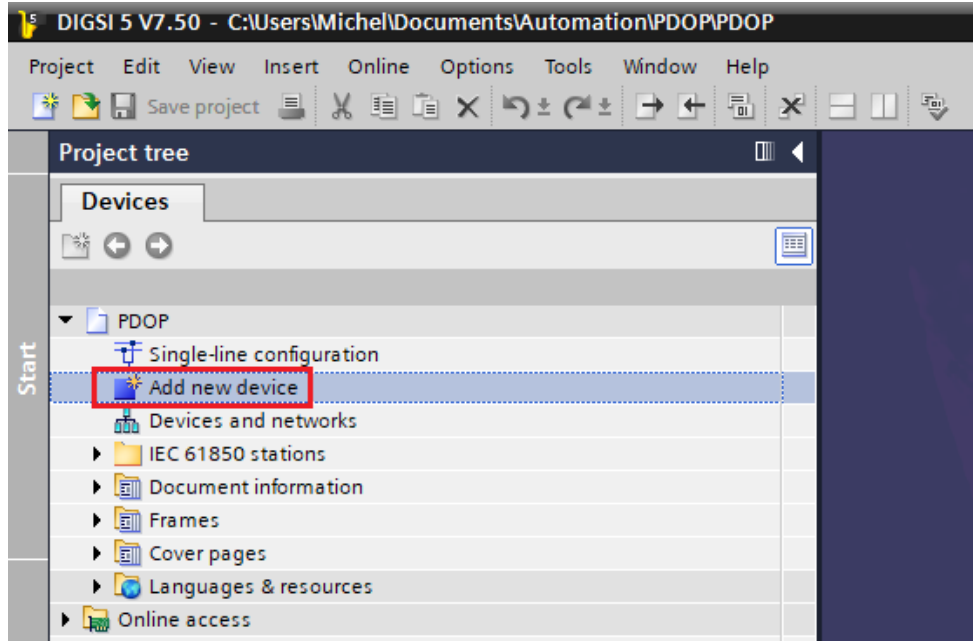


Figure 7

Enter the relay short code located on a “TAG” side of the relay, then click “Verify” as highlighted below.

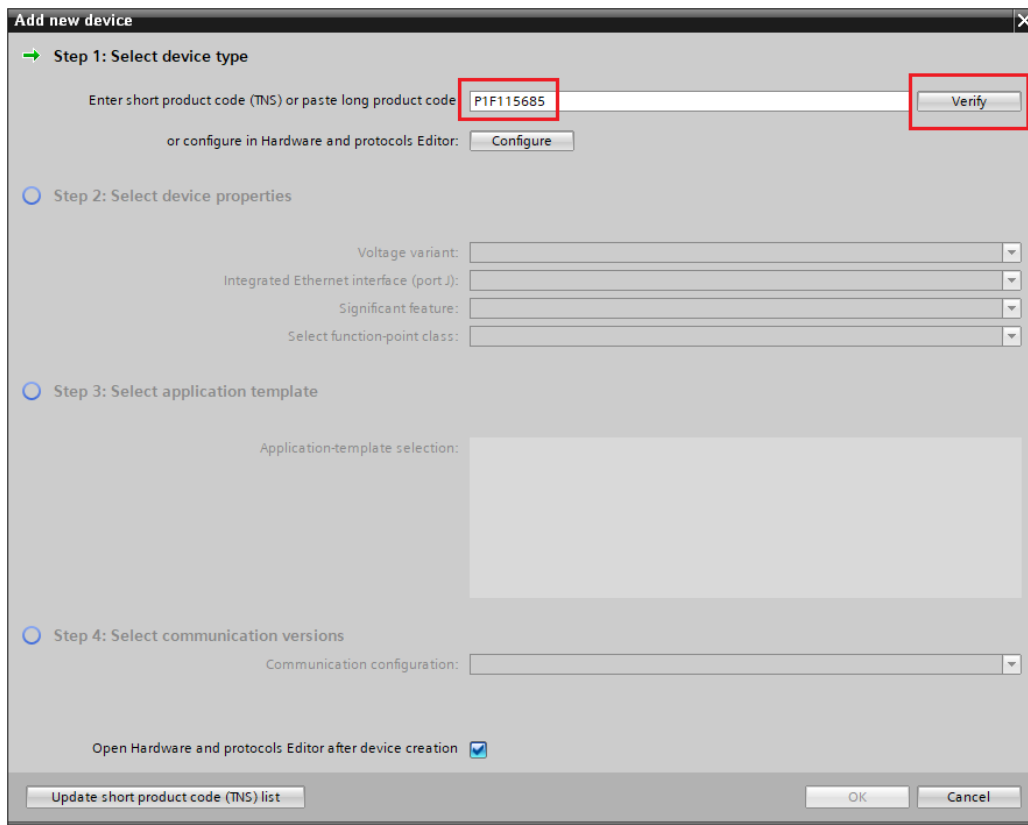


Figure 8

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Select the basic “*Template*” whose firmware version is consistent with that of the relay (To verify, just look at the relay HMI when it is turned on). Then click “*OK*”.

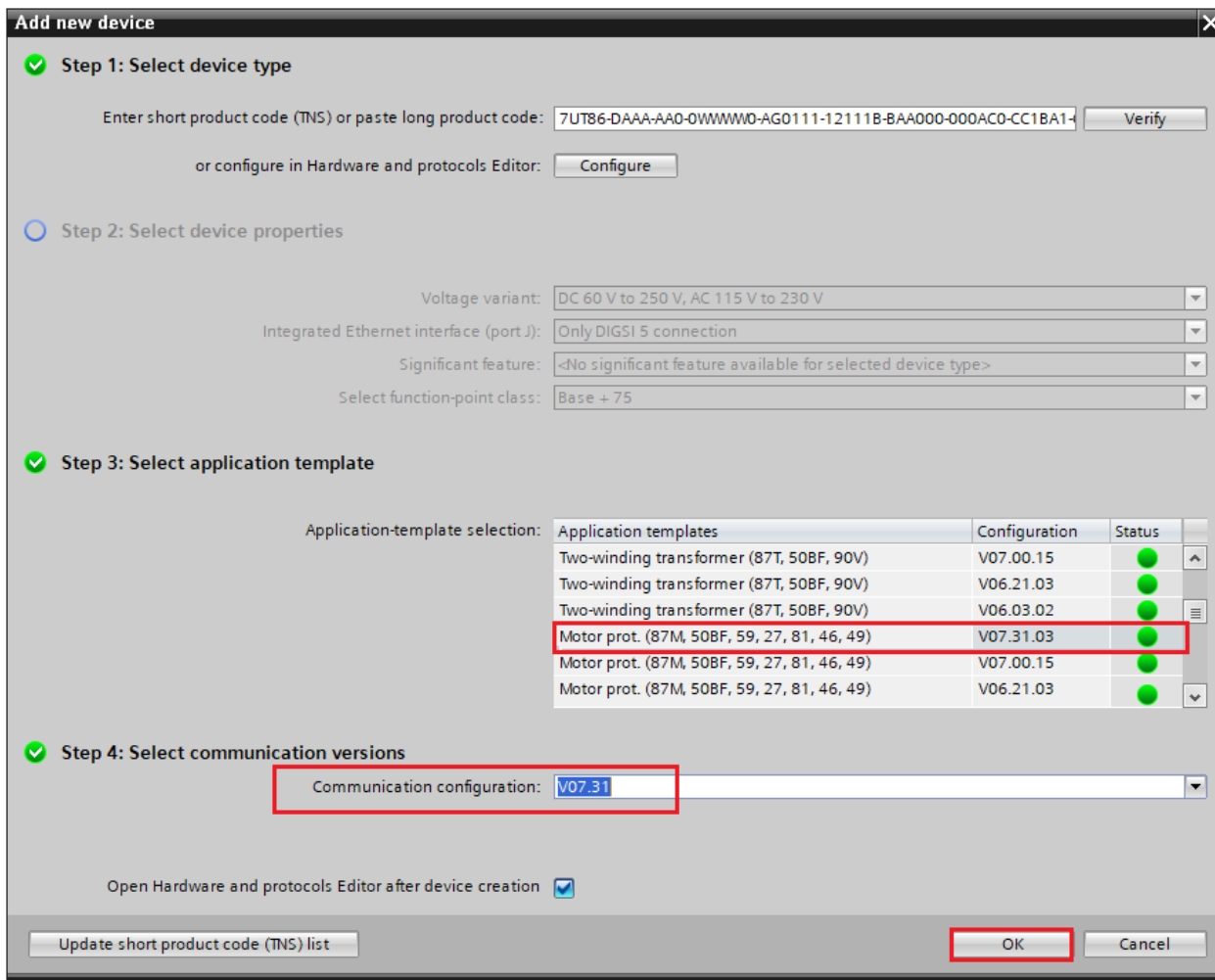


Figure 9

Note that a generic relay has been added (highlighted in green below). The next step is to establish communication with the equipment, for that go to the “*Online*” menu and choose the option “*Connect to device and retrieve data*”.

INSTRUMENTOS PARA TESTES ELÉTRICOS

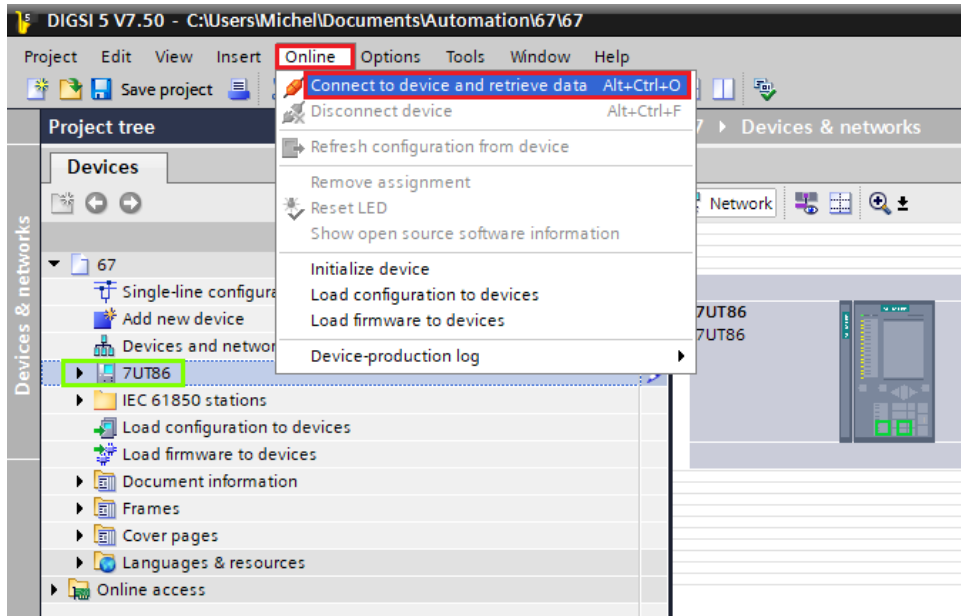


Figure 10

After establishing communication with the relay, it is necessary to read the parameterized settings. Right-click on the target relay (highlighted in green above) and choose the option “Update configuration from target device”.

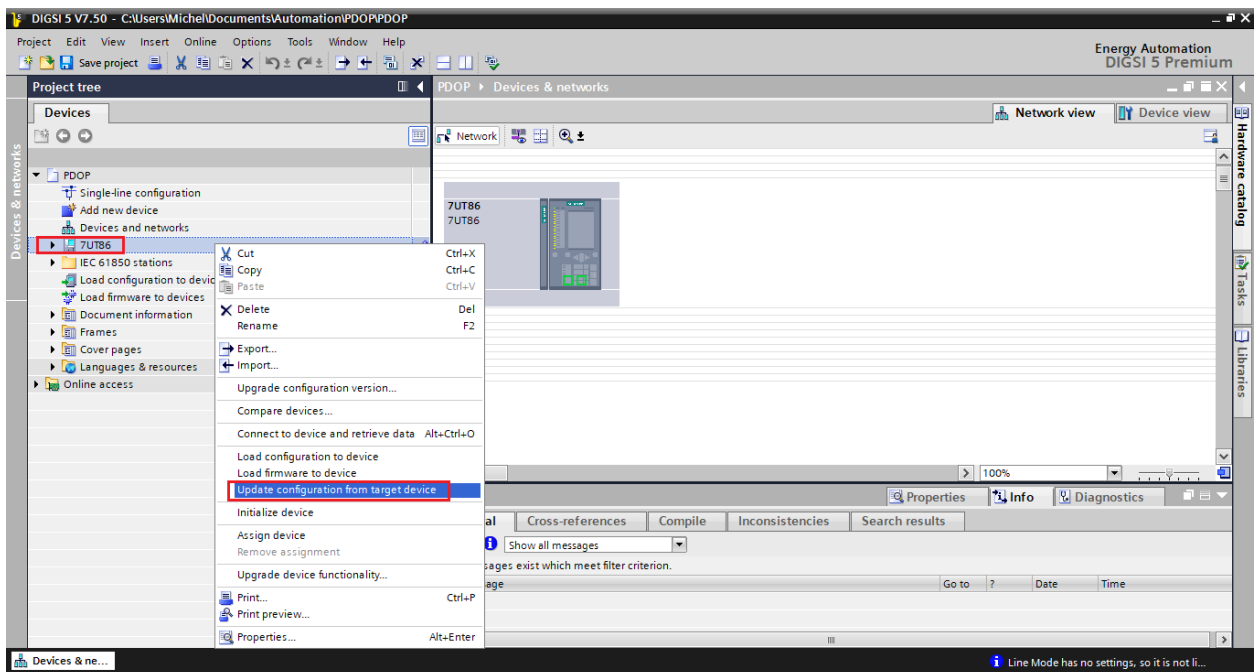


Figure 11

Click “Yes” to the following message:

INSTRUMENTOS PARA TESTES ELÉTRICOS

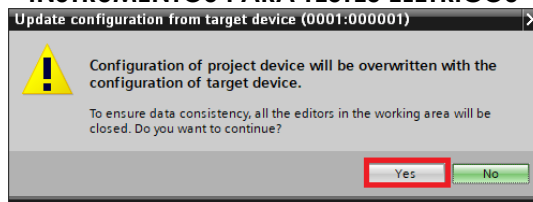


Figure 12

There were other warning messages (not shown), click “Yes” on all. If the procedure works, the following screen will appear.

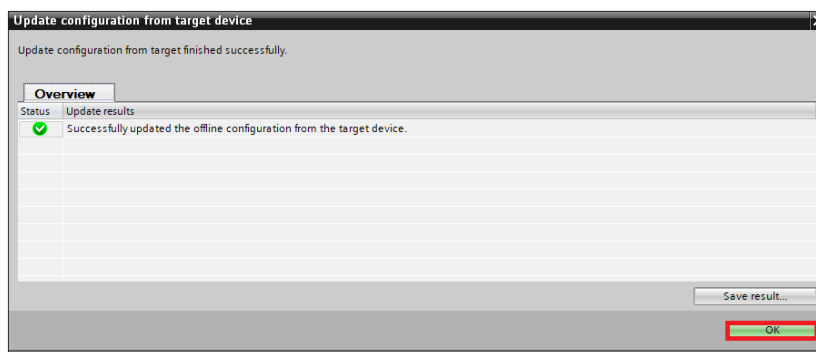


Figure 13

Export the created file in “.dex5” format in order to have a backup of the settings.

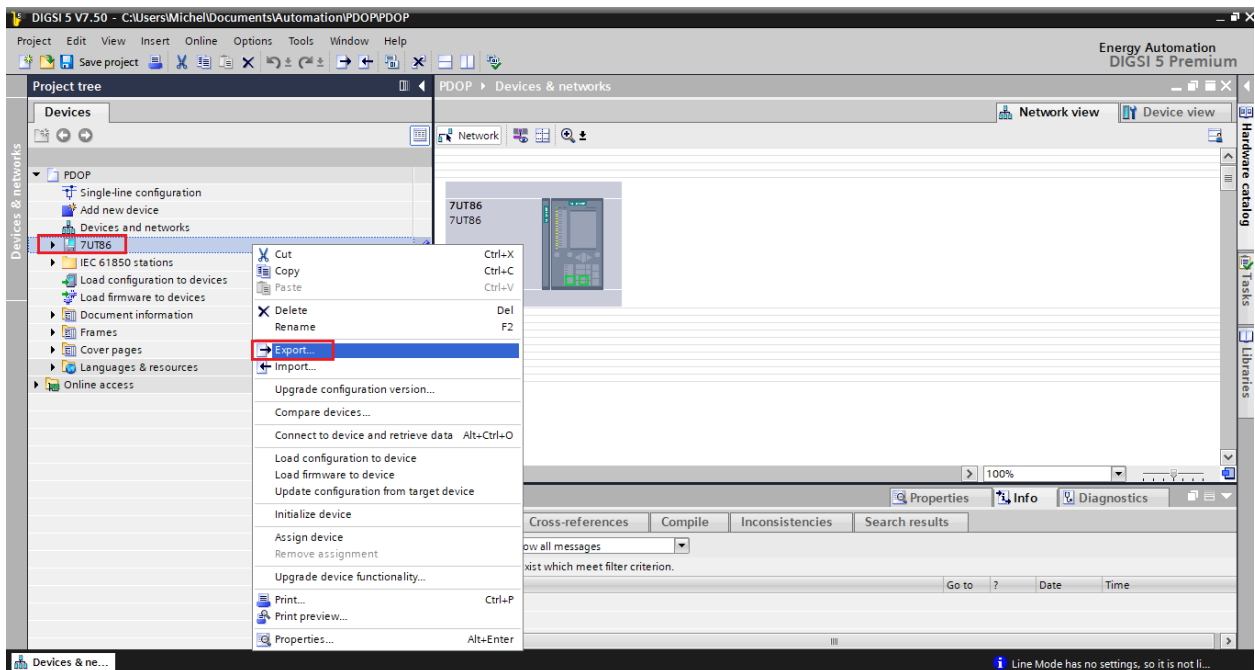


Figure 14

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There are other ways to extract information from Siemens Siprotec 5 relays, but the mode shown here is the most efficient way for those who will commission a relay already parameterized and installed in a panel.

3. Parameterization of the 7UT86 relay

3.1 Device Settings

After the connection has been established, open the “7UT86” device section. Then open the “Settings” section, finally choose the “Device Settings” option. Check that group 1 is active, the rated frequency is 60Hz and the minimum operating time is zero seconds.

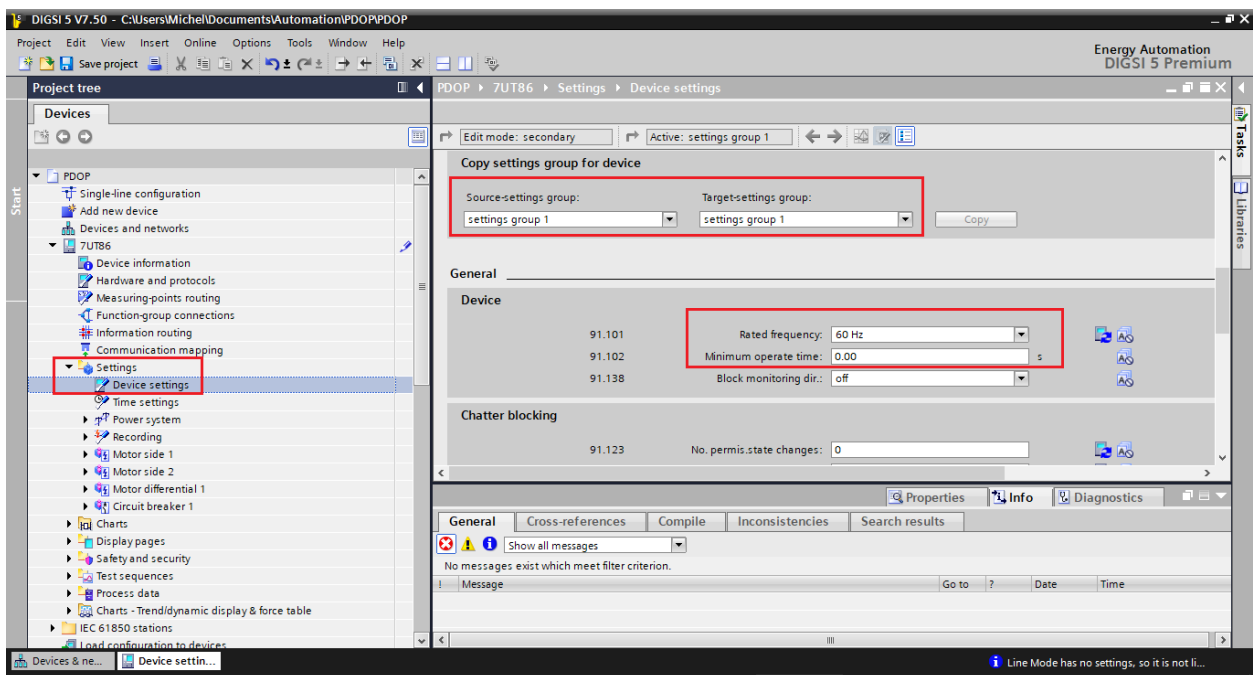


Figure 15

3.2 General

Open the “Power System” section and select the “General” option. Check the parameterized phase sequence.

INSTRUMENTOS PARA TESTES ELÉTRICOS

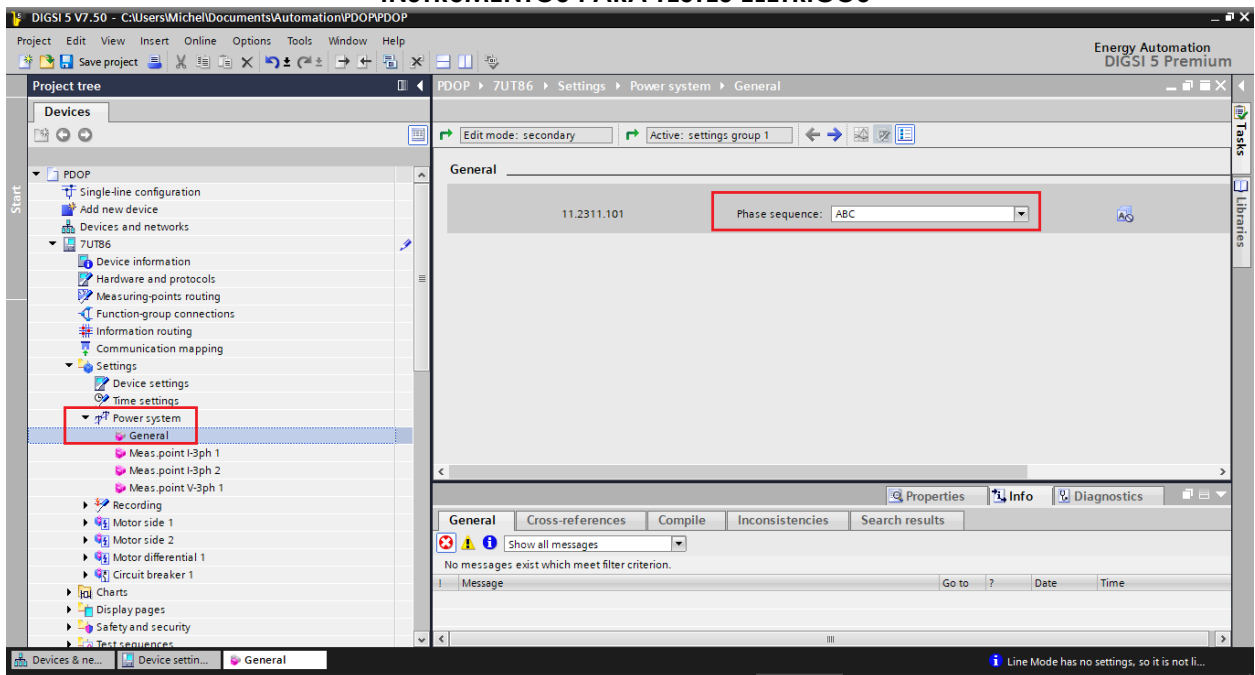


Figure 16

3.3 Meas. Point I-3ph 1

Select the option “Meas. Point I-3ph 1”. Adjust primary and secondary current values, magnitude compensation factors and **disable supervision functions**.

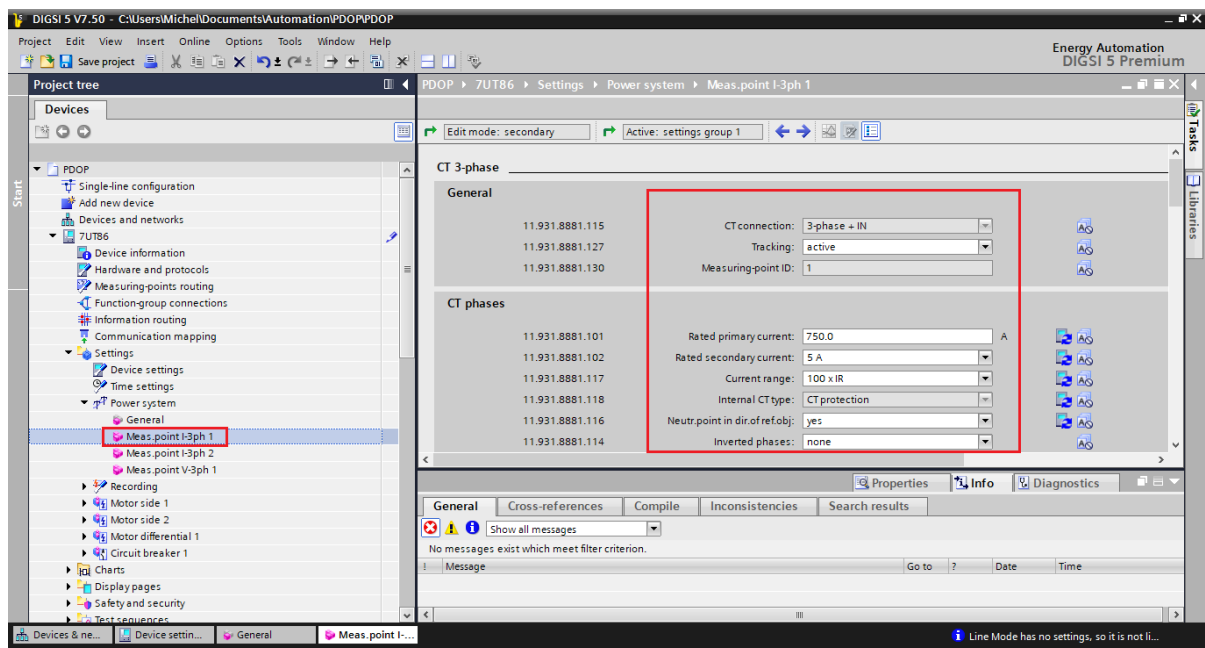


Figure 17

Click on the “Info” tab to hide it and enlarge the settings window.

INSTRUMENTOS PARA TESTES ELÉTRICOS

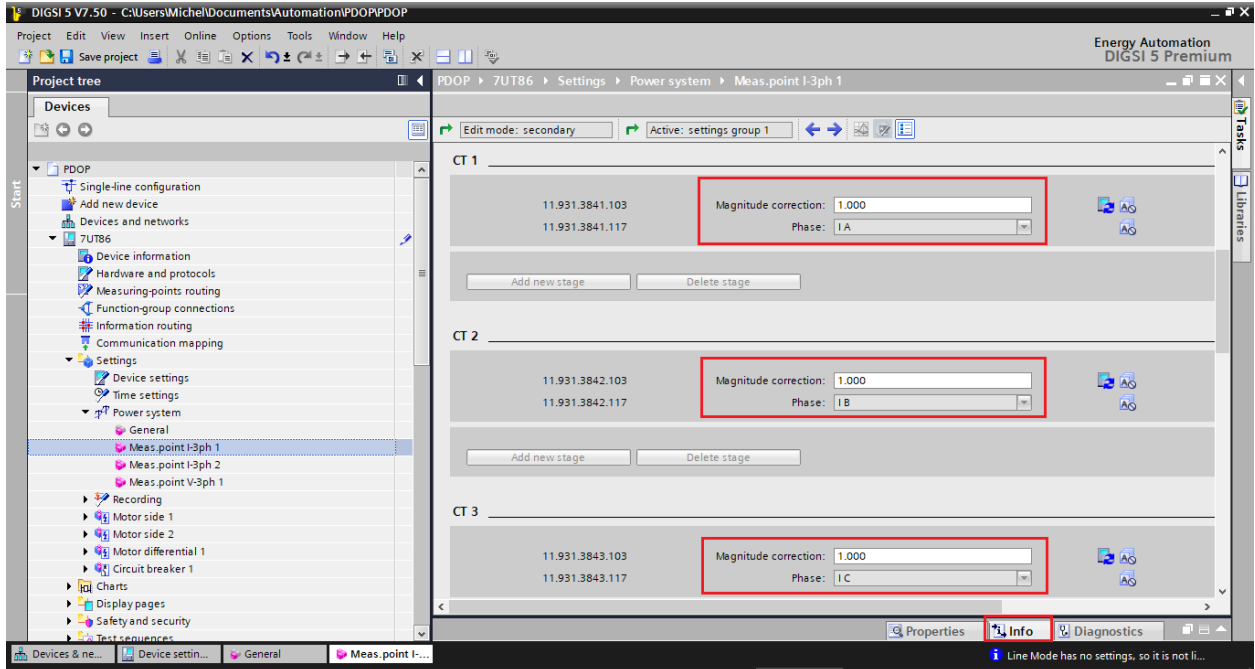


Figure 18

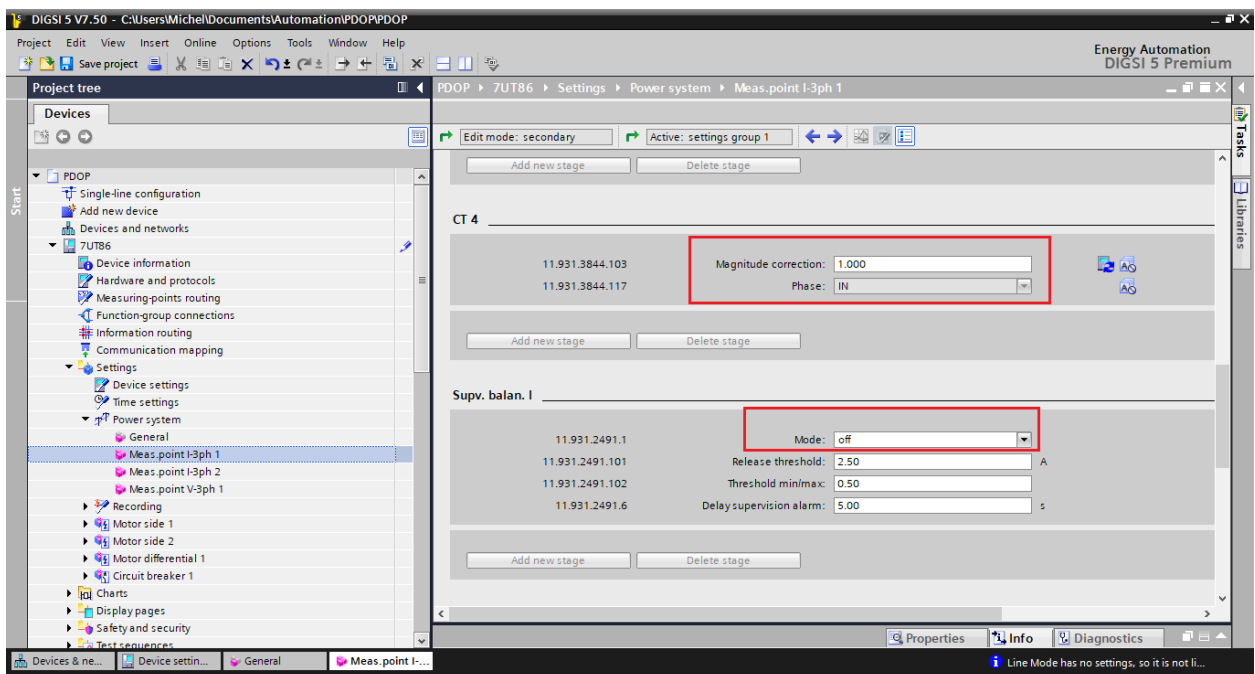


Figure 19

INSTRUMENTOS PARA TESTES ELÉTRICOS

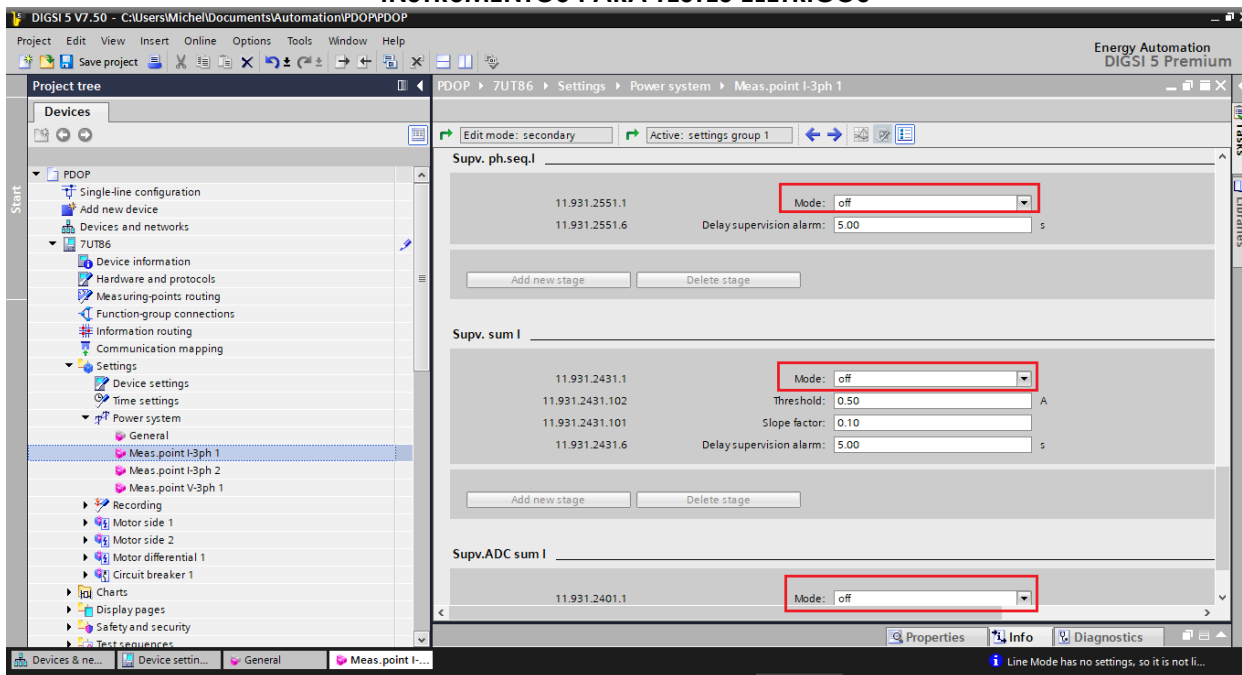


Figure 20

3.4 Meas. Point V-3ph 1

Select the option “*Meas. Point V-3ph 1*”. Set the values of primary, secondary voltages and magnitude compensation factor for the first winding and **disable supervision functions**.

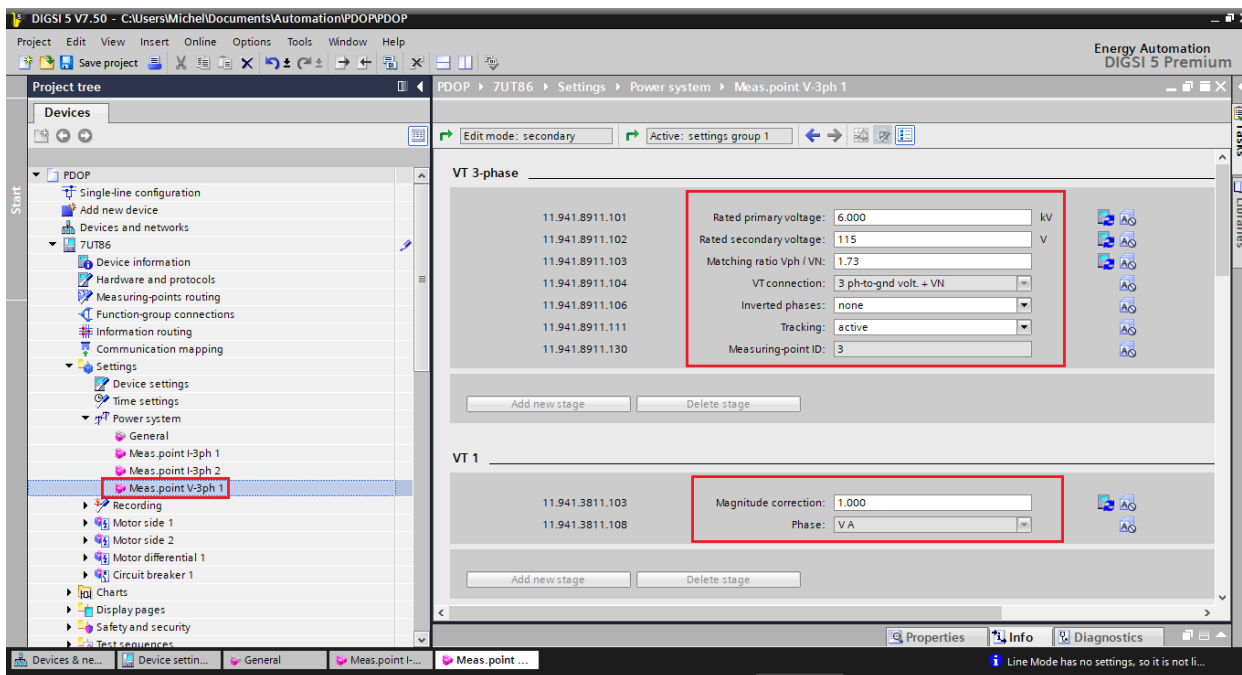


Figure 21

INSTRUMENTOS PARA TESTES ELÉTRICOS

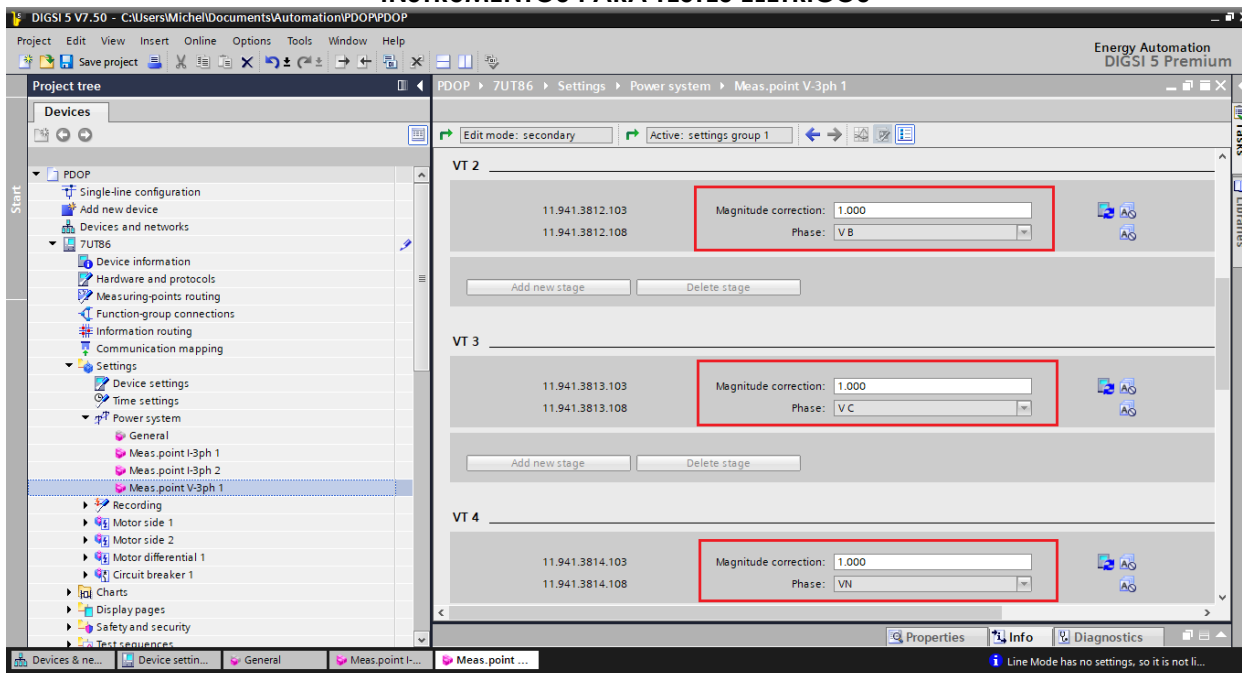


Figure 22

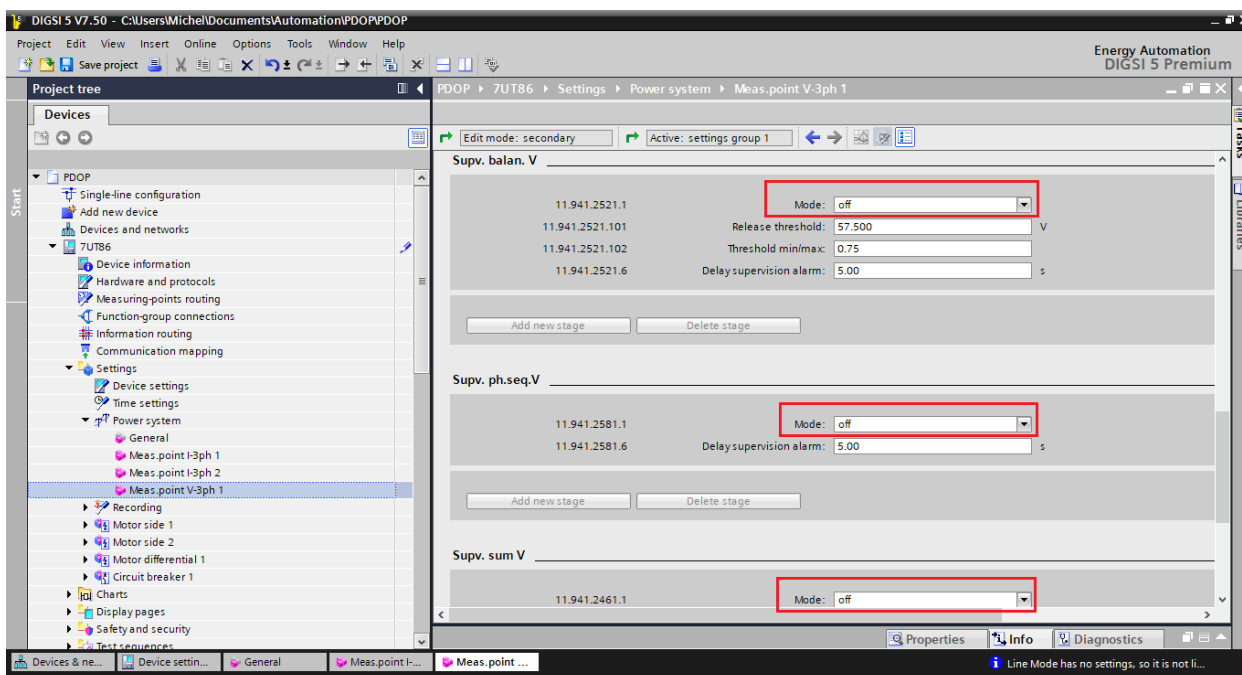


Figure 23

3.5 General

Open the “Motor side 1” option and double-click on the “General” option to make the voltage and power adjustments.

INSTRUMENTOS PARA TESTES ELÉTRICOS

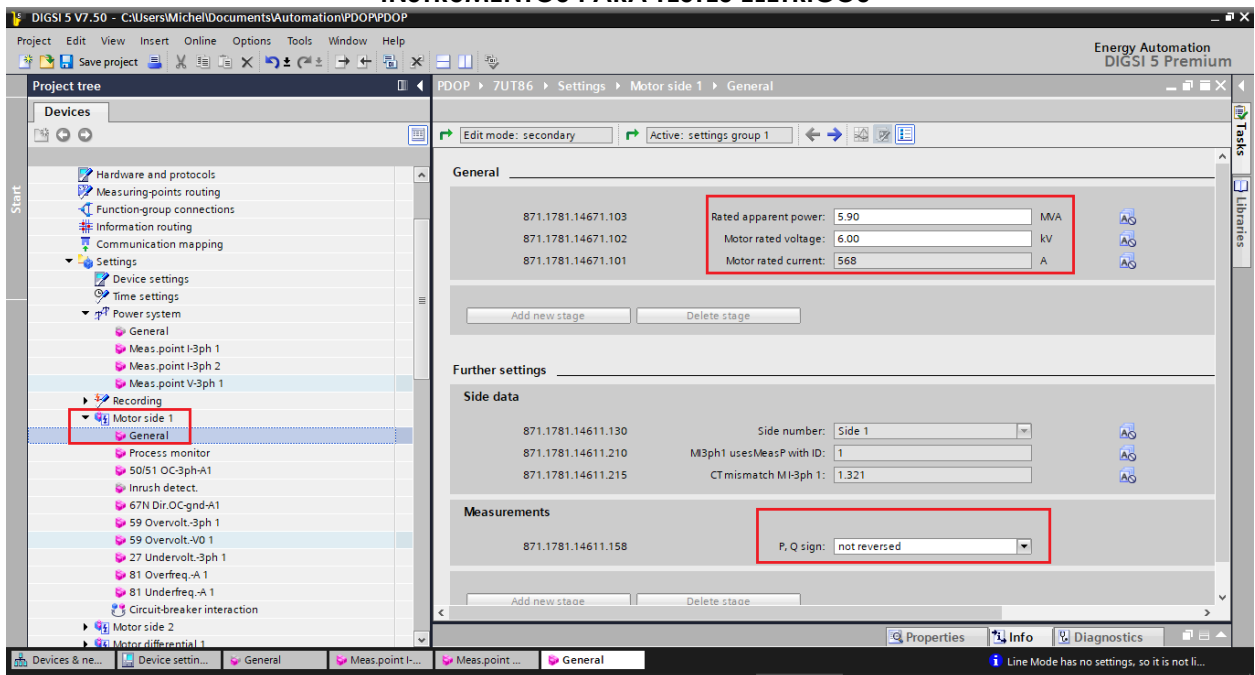


Figure 24

3.6 Inserting function 32

Click on the “Libraries” option and follow the path “Global DIGSI 5 Library > Types > Transformer differential protection > 7UT86 Transformer, 3 sides > FG Motor diff > Power protection > 32R Revers. pow.”. Drag the “32R Revers. pow.” above the “Motor side 1” icon and release.

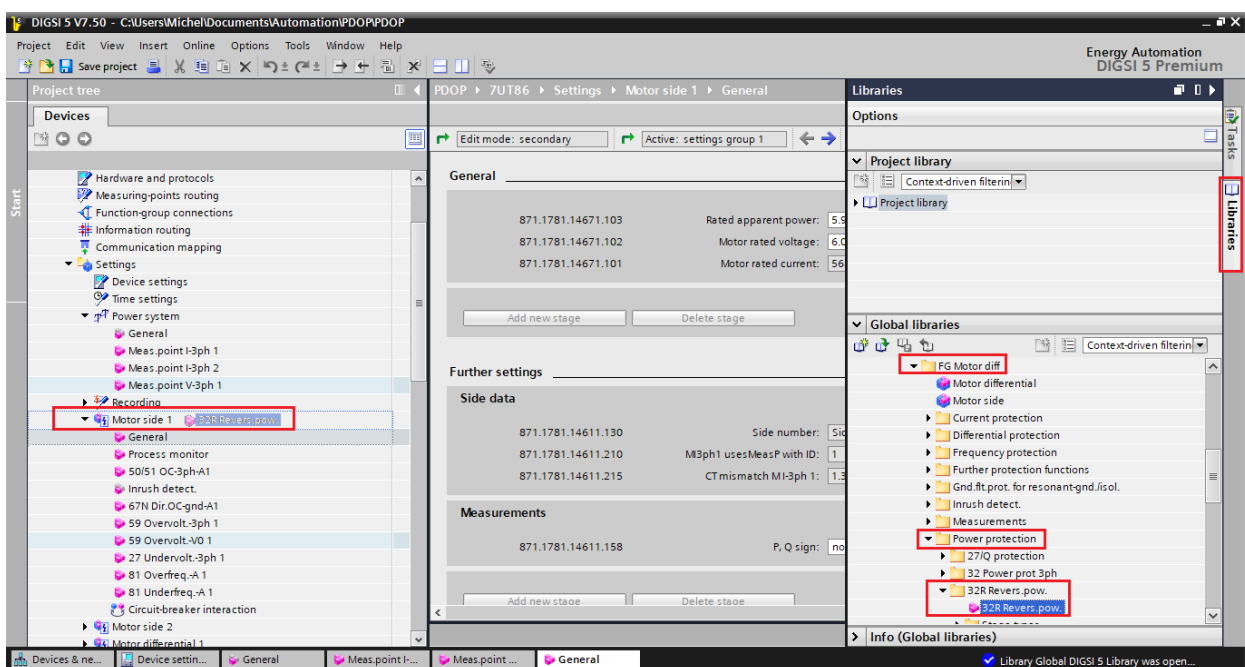


Figure 25

INSTRUMENTOS PARA TESTES ELÉTRICOS

3.7 32R Revers. pow.

Double click on “32R Revers. pow.” to perform reverse power directional function adjustments.

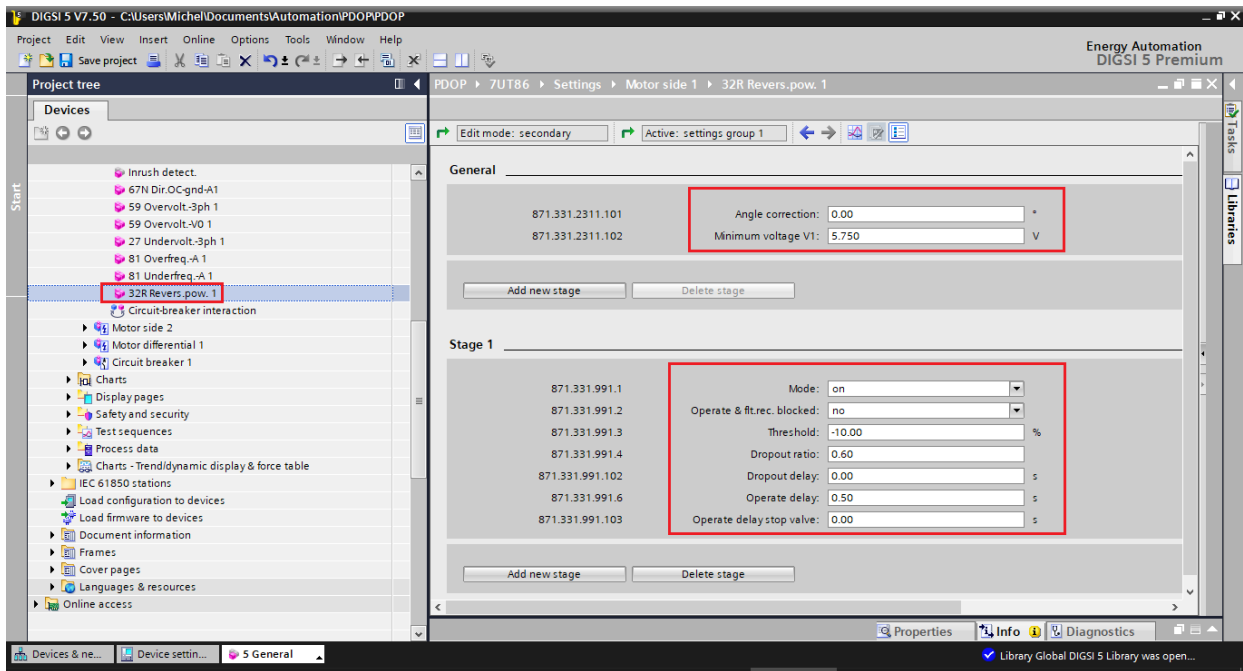


Figure 26

3.8 Information Routing

In the “Information Routing” option, the trip signal of function 32 must be associated with the physical output. For easier viewing, maximize the window.

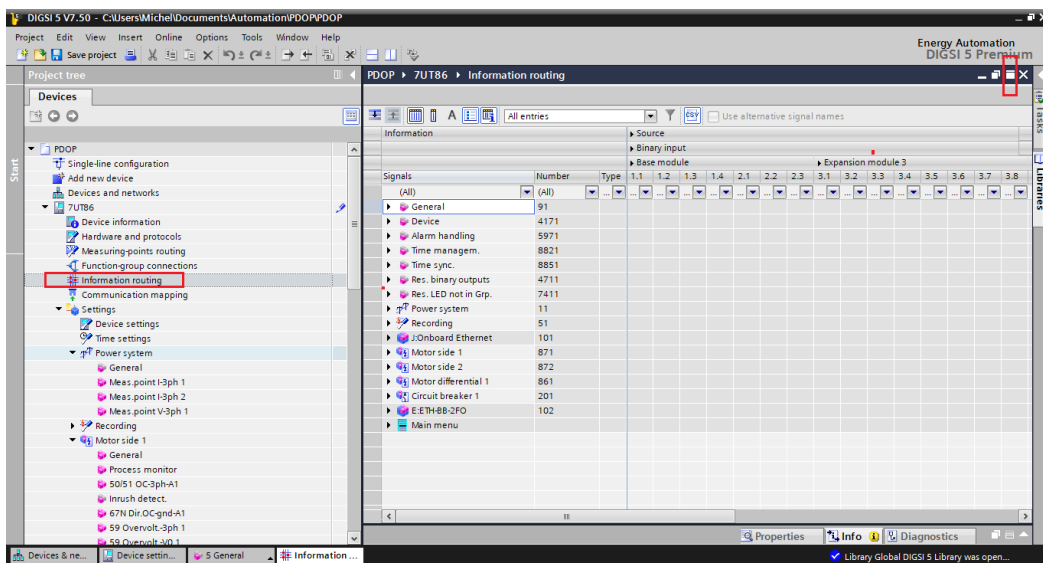


Figure 27

INSTRUMENTOS PARA TESTES ELÉTRICOS

The first columns are associated with the binary inputs of the relay. In that case they will not be used. Double-click the “Source” option to hide these settings.

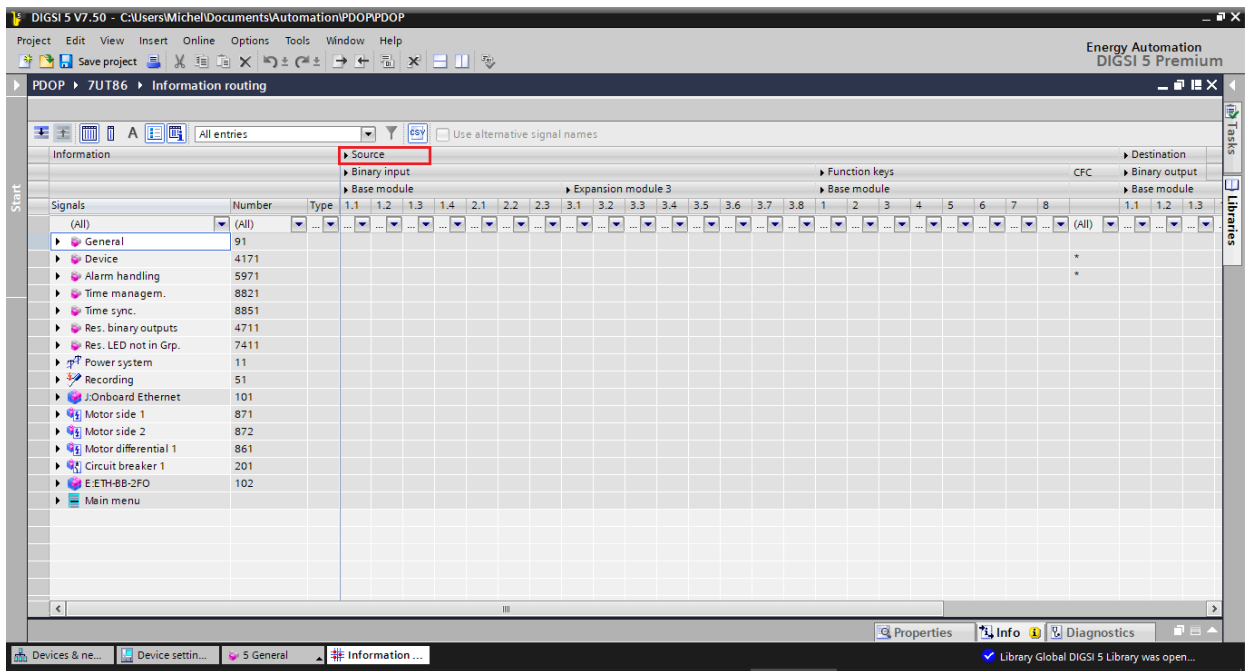


Figure 28

Enter the options “Motor side 1 > 32R Revers. wow. 1 > Stage 1”.

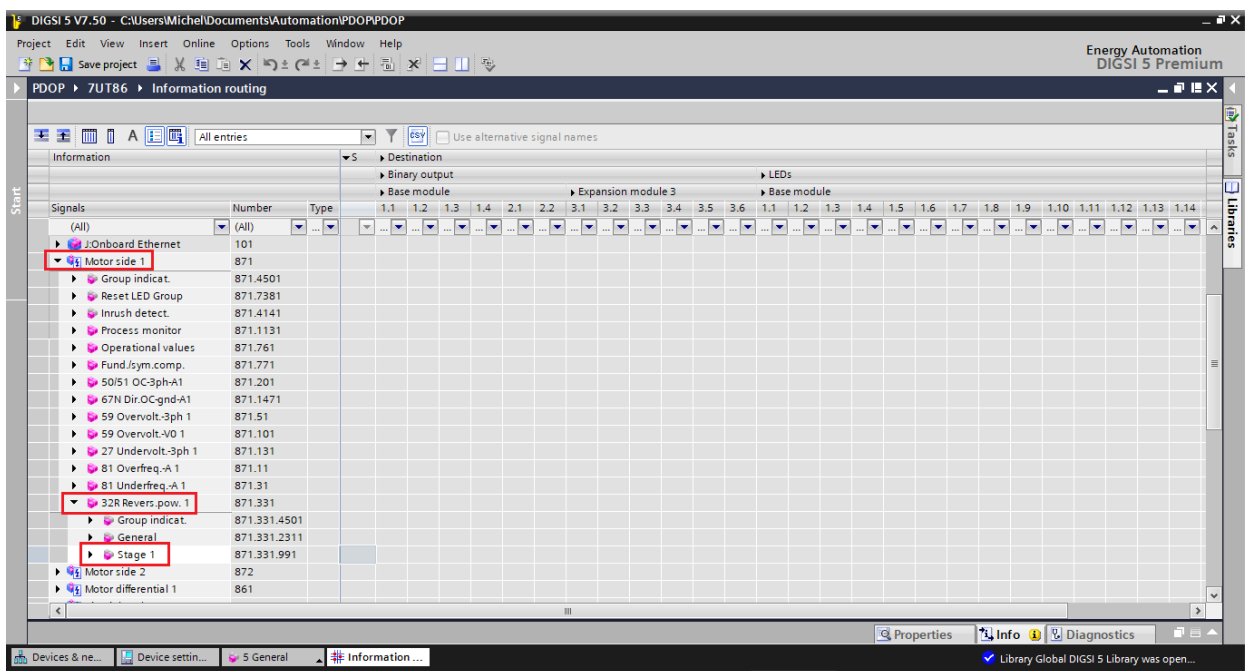


Figure 29

INSTRUMENTOS PARA TESTES ELÉTRICOS

Assign the “*general*” signal within the “*Operate delay expired*” to the 1.1 output. Look at the columns for that signal “*Destination > Binary output > Base module*”.

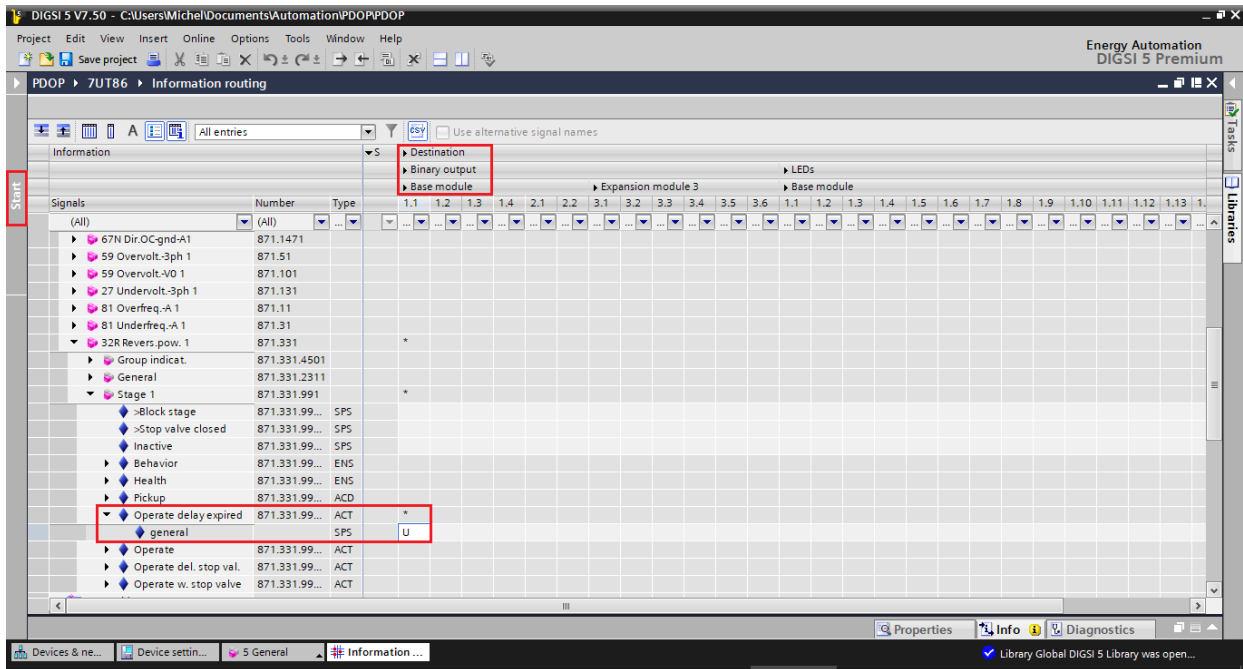


Figure 30

The option “*U*” must be used, which means “*Unlatched*”, that is, the relay activates and when the fault ceases, it automatically returns to the initial state of the binary. If the user chooses the “*L*” or “*Latched*” option, the relay activates and remains activated even if the fault has been extinguished. (This option is not indicated for the test).

Click on the “*Start*” option so that the main window is shown again.

3.9 Sending adjustments

To send the changes in the parameterization right-click on the relay icon “*7UT86*” and choose the option “*Load configuration to device*”.

INSTRUMENTOS PARA TESTES ELÉTRICOS

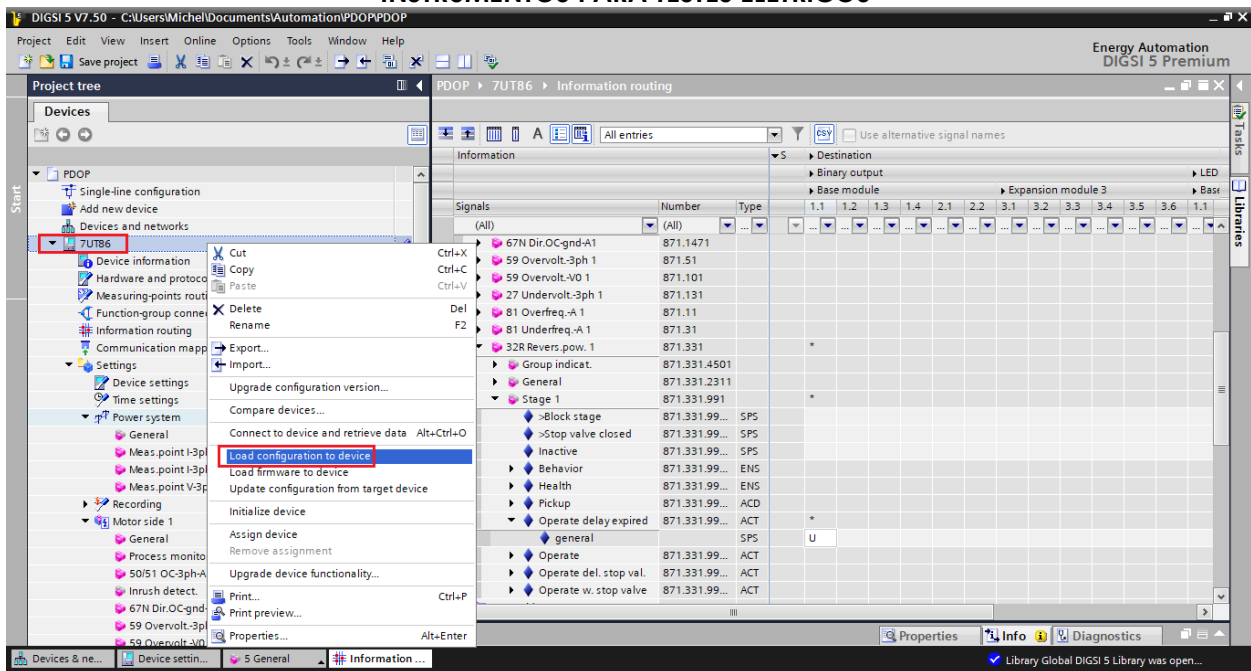


Figure 31

Reminding that the default password for Siemens SIPROTEC 5 is: “222222”.

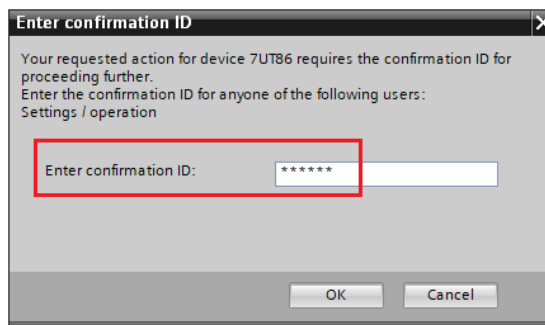


Figure 32

In the next two windows not shown, choose the “Yes” option.

4. Power Directional software adjustments

4.1 Opening the Power Directional

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

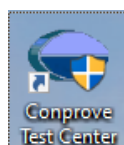


Figure 33

INSTRUMENTOS PARA TESTES ELÉTRICOS

Click on the Power Directional software icon.



Figure 34

INSTRUMENTOS PARA TESTES ELÉTRICOS

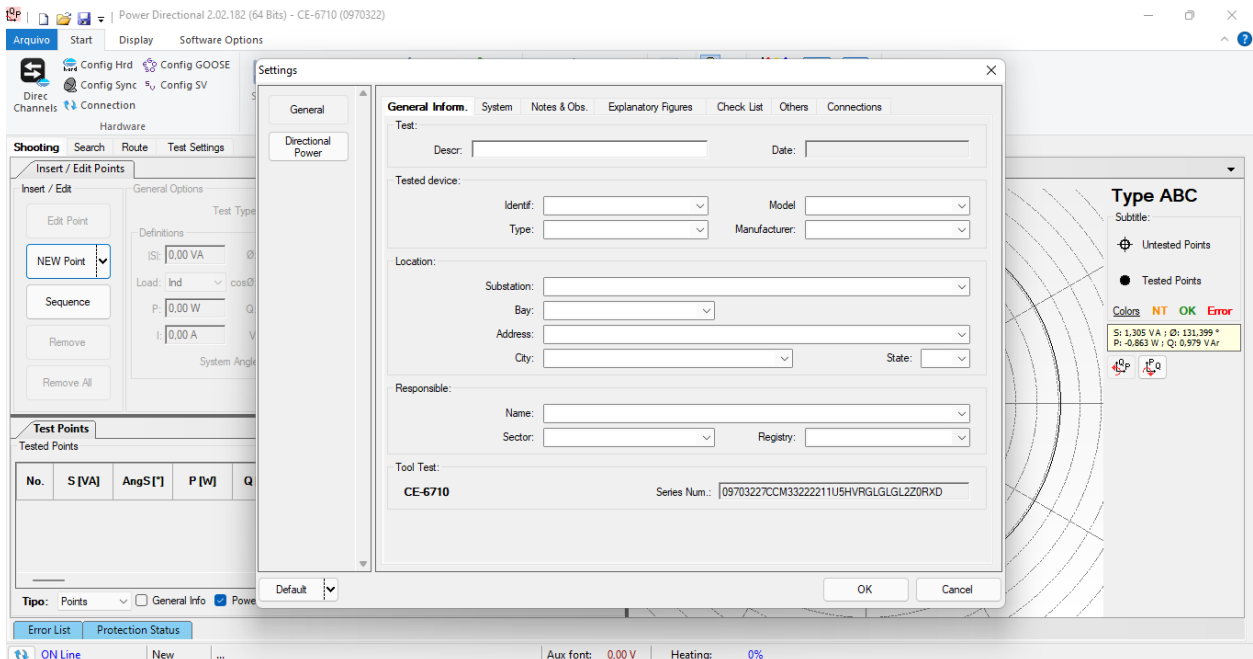


Figure 35

4.2 Configuring the Settings

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

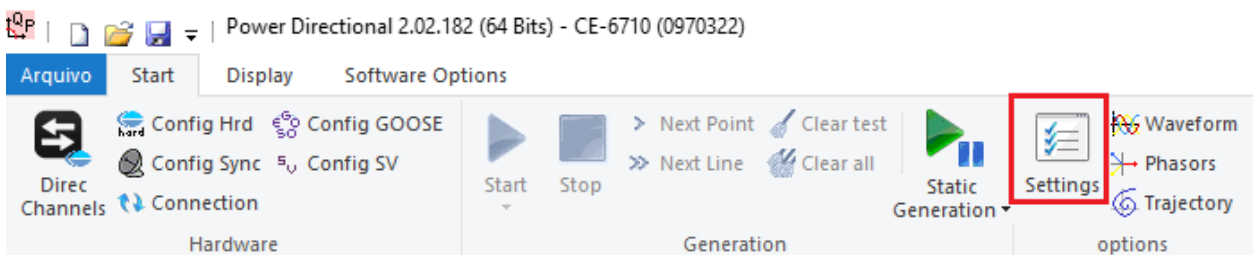


Figure 36

Inside the “Settings” screen, fill in the “General Inform.” with details of the tested device, installation location and the person responsible. This makes reporting easier, as this tab will be the first to be shown.

INSTRUMENTOS PARA TESTES ELÉTRICOS

Settings

General

Directional Power

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

Test:
 Descr: Reverse Power Directional Date:

Tested device:
 Identif: 23031982 Model: 7UT86
 Type: Transformer Protection Manufacturer: Siemens

Location:
 Substation: Conprove
 Bay: 1
 Address: Visconde de Ouro Preto 75, Custódio Pereira
 City: Uberlândia State: MG

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

Tool Test:
CE-6710 Series Num.: 09703227CCM33222211U5HVRGLGLGL2Z0RXD

Default Preferences OK Cancel

Figure 37

4.3 System

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

INSTRUMENTOS PARA TESTES ELÉTRICOS

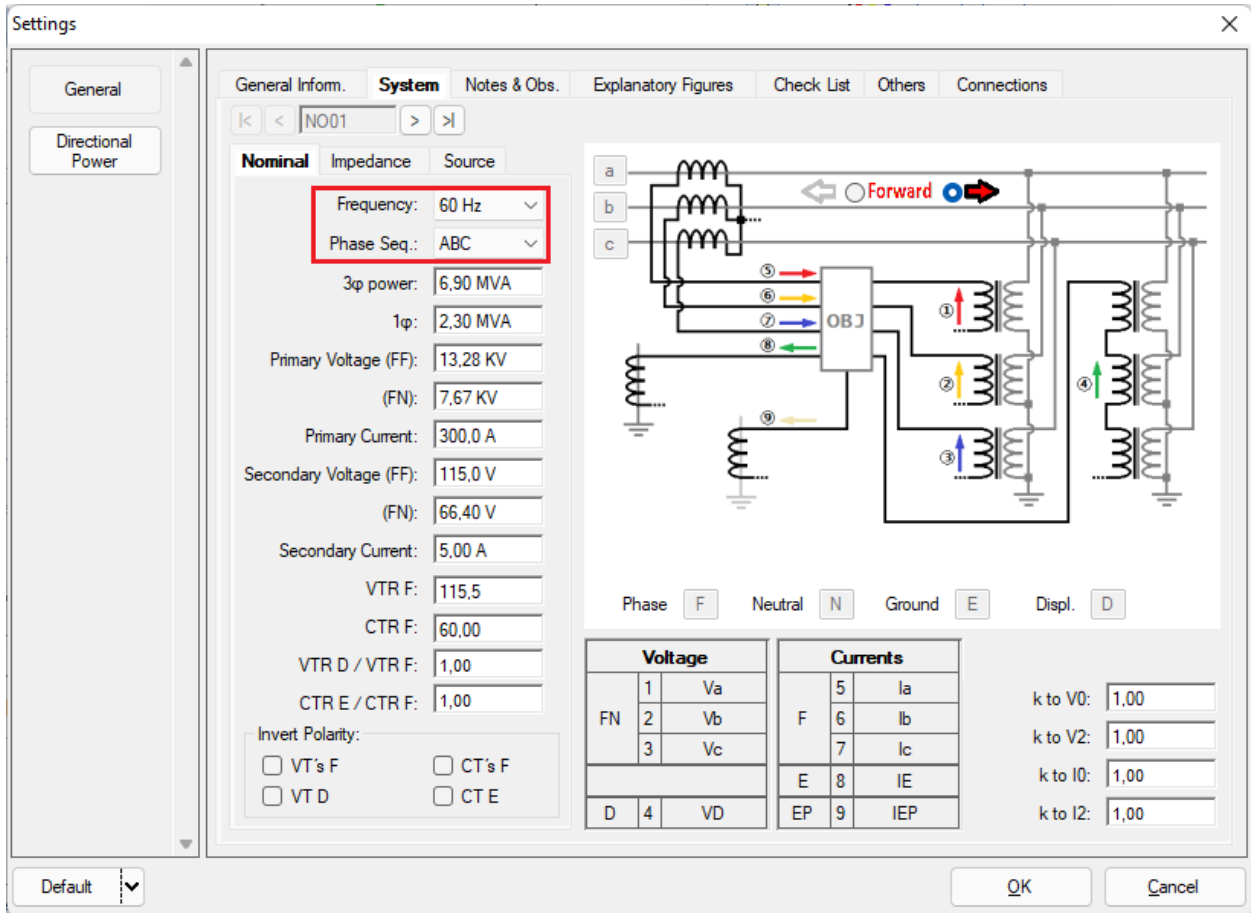


Figure 38

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

5. Channel Direction and Hardware Configurations

Click on the icon illustrated below.

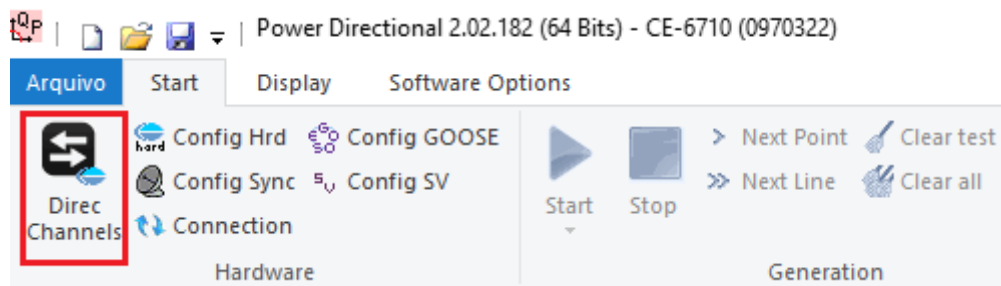


Figure 39

INSTRUMENTOS PARA TESTES ELÉTRICOS

Then click on the highlighted icon to configure the hardware.

Channels Direct.

Local: Model: CE-6710, Serial Number: 09703227CCM3322211U5HVRGLGL2Z0RXD, ON Line checked, Basic/Advanced radio buttons, Hard.: Adapt I/Os, Nodes: Autoassociate, Confirm/Cancel buttons.

Remotes: [Hard Set icon highlighted]

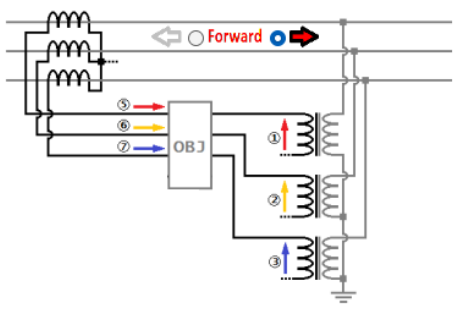
Outputs: Analog. and SV | Inputs: Analog. and SV | Outputs: Binary, GOOSE and Analog DC | Inputs: Binary, GOOSE and Analog. DC | Logical

1/1

Nominal Line Source

Frequency: 60 Hz
Phase Seq.: ABC
3 ϕ power: 47,80 MVA
1 ϕ : 15,93 MVA
Primary Voltage (FF): 13,80 KV
(FN): 7,97 KV
Primary Current: 2,00 kA
Secondary Voltage (FF): 115,0 V
(FN): 66,40 V
Secondary Current: 5,00 A
VTR F: 120,0
CTR F: 400,0
VTR D / VTR F: 1,00
CTR E / CTR F: 1,00

Reverse Polarity:
 VT's F CT's F
 VT D CT E
 Equal Parameters Among Nodes



Forward

Voltage		Channel	Currents		Channel
1	Va	AO_V01	5	Ia	AO_I01
2	Vb	AO_V02	6	Ib	AO_I02
3	Vc	AO_V03	7	Ic	AO_I03
	Vab		8	IE	
	Vbc		9	IEP	
	Vca				
4	VD				
	k.V0			k.I0	
	k.V2			k.I2	
k	to V0	1,00	to I0	1,00	
			to I2	1,00	

Analog Outputs | Sampled Value Outputs

Descr.	Hardware	Node	Point
AO_V01	V1	NO01	Va
AO_V02	V2	NO01	Vb
AO_V03	V3	NO01	Vc
AO_V04	V4	NO01	UD

Descr.	Hardware	Node	Point
AO_I01	I1	NO01	Ia
AO_I02	I2	NO01	Ib
AO_I03	I3	NO01	Ic
AO_I04	I4	NO01	UD
AO_I05	I5	NO01	UD
AO_I06	I6	NO01	UD

Figure 40

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

INSTRUMENTOS PARA TESTES ELÉTRICOS

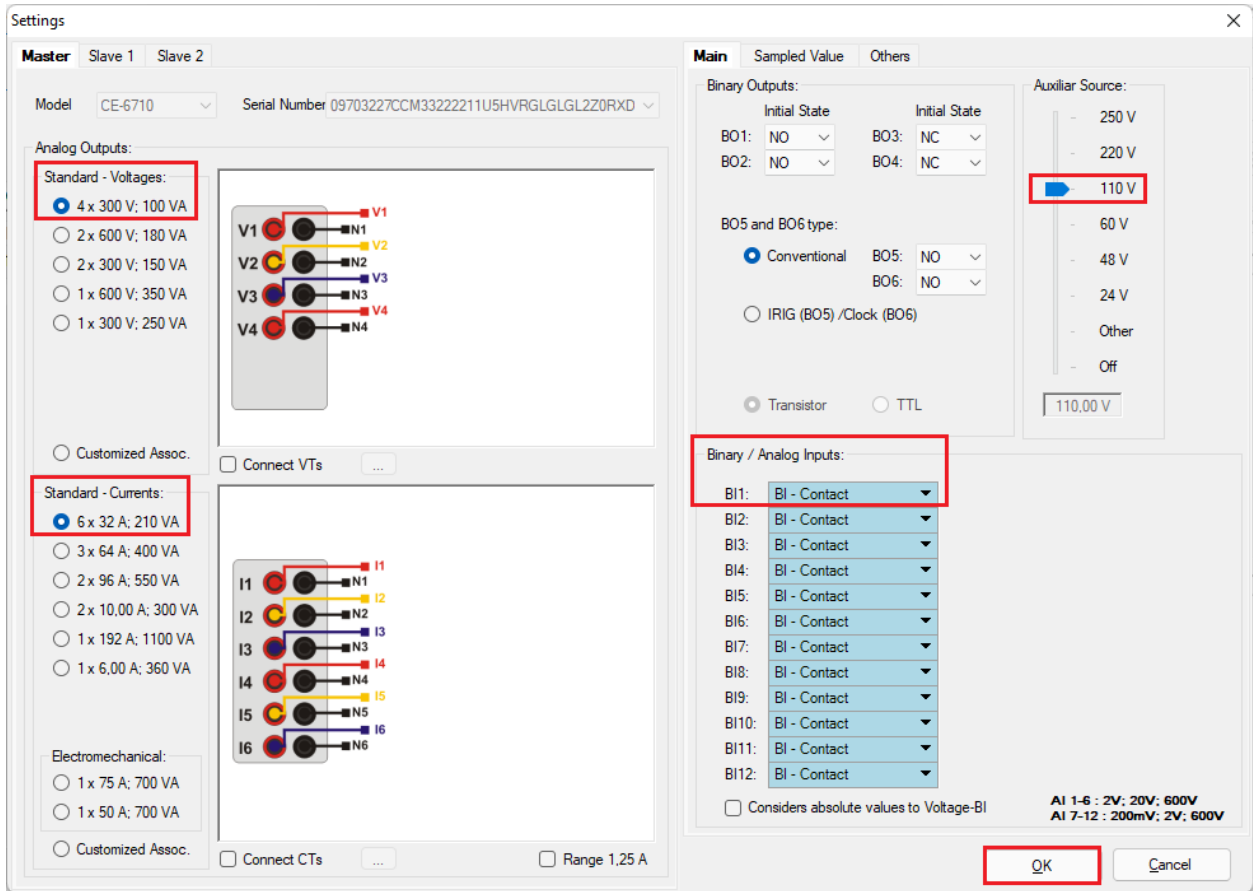


Figure 41

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

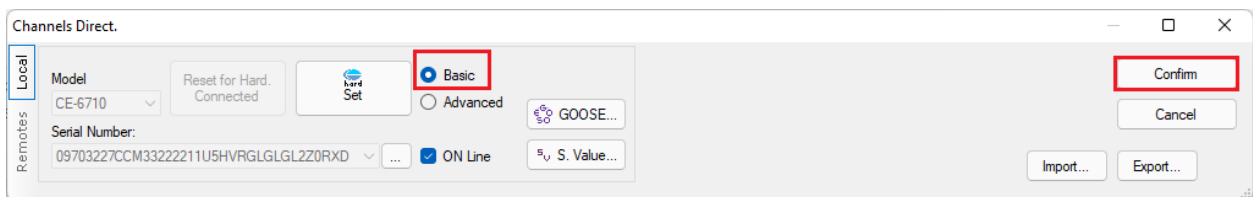


Figure 42

6. Power Directional Adjustment

6.1 Directional Power Screen > Definitions

In this tab you can adjust the pickup definition, power, time and angle tolerances. These tolerances should be consulted in the relay manufacturer's manual (available in Appendix A). There is also the option of limiting a maximum value for both voltage and current.

INSTRUMENTOS PARA TESTES ELÉTRICOS

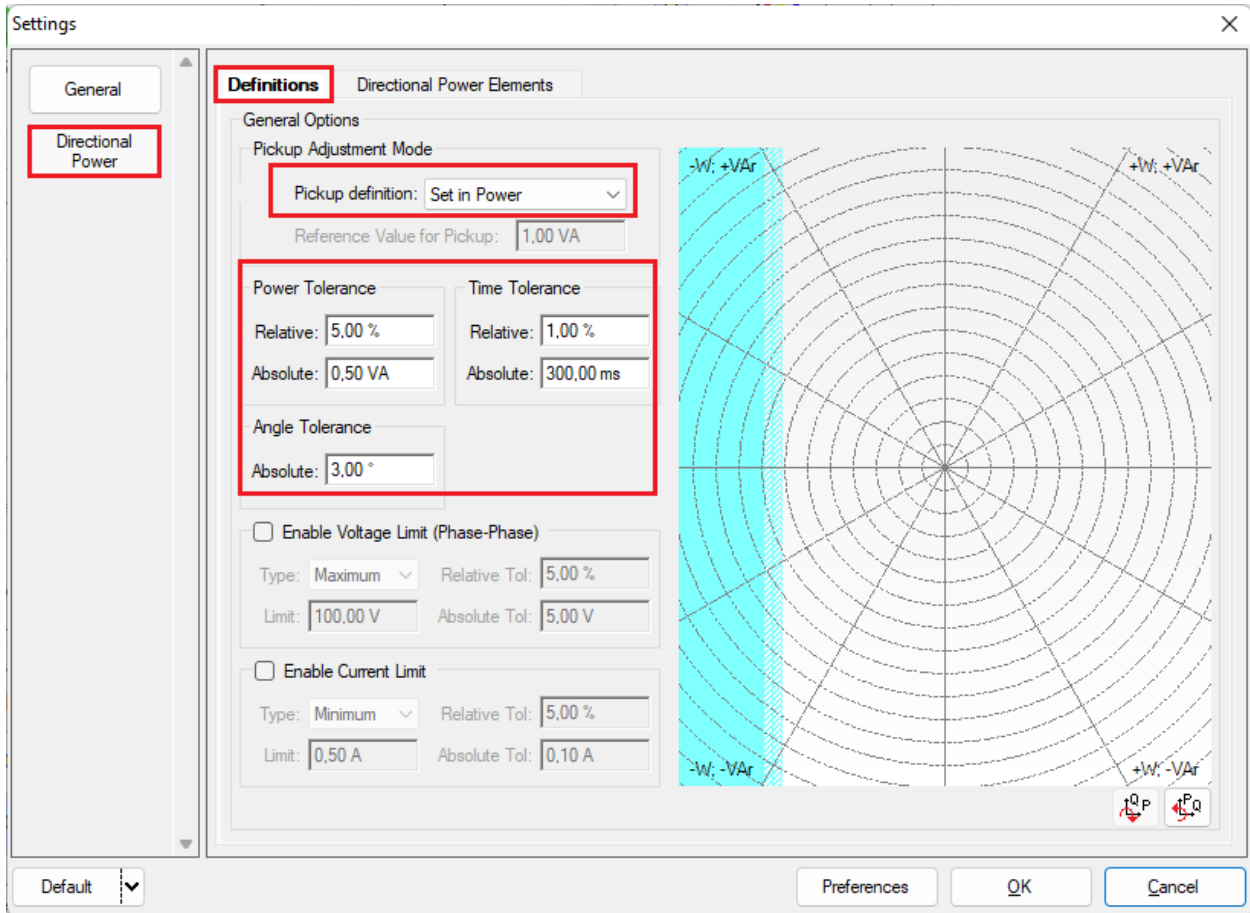


Figure 43

6.2 Directional Power Screen > Directional Power Elements > Active

Here the reverse power directional element is configured. To do this, click once on the highlighted “+” icon.

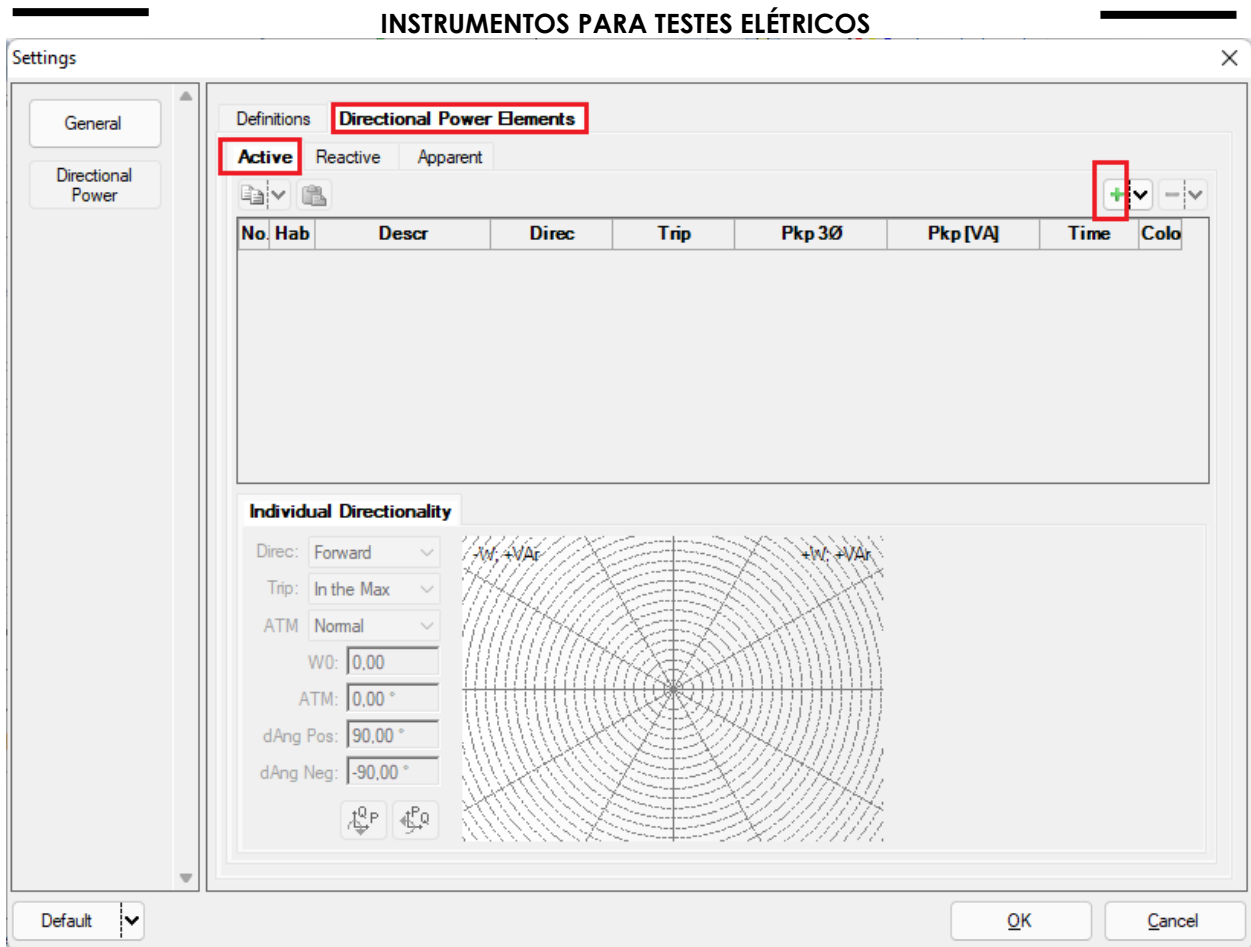


Figure 44

For the first element change the name to 32R, choose the directionality as reverse, set the pickup value and the run time. Remembering that the pickup value must be referenced to the secondary according to the following formula:

$$P_{secondary} = \frac{P_{primary}}{VTR * CTR}$$

$$P_{secondary} = \frac{5,9M}{\left(\frac{6,0K}{115}\right) * \left(\frac{750}{5}\right)}$$

$$P_{secondary} = 753,88W$$

$$P_{secondary} = 0,1 * 753,88 \approx 75,39W$$

In the “*Individual Directionality*” tab set the “*Reverse*” option, the maximum torque angle “*ATM*” should be set “*Normal*” and the positive and negative angular offset as 90° and -90°.

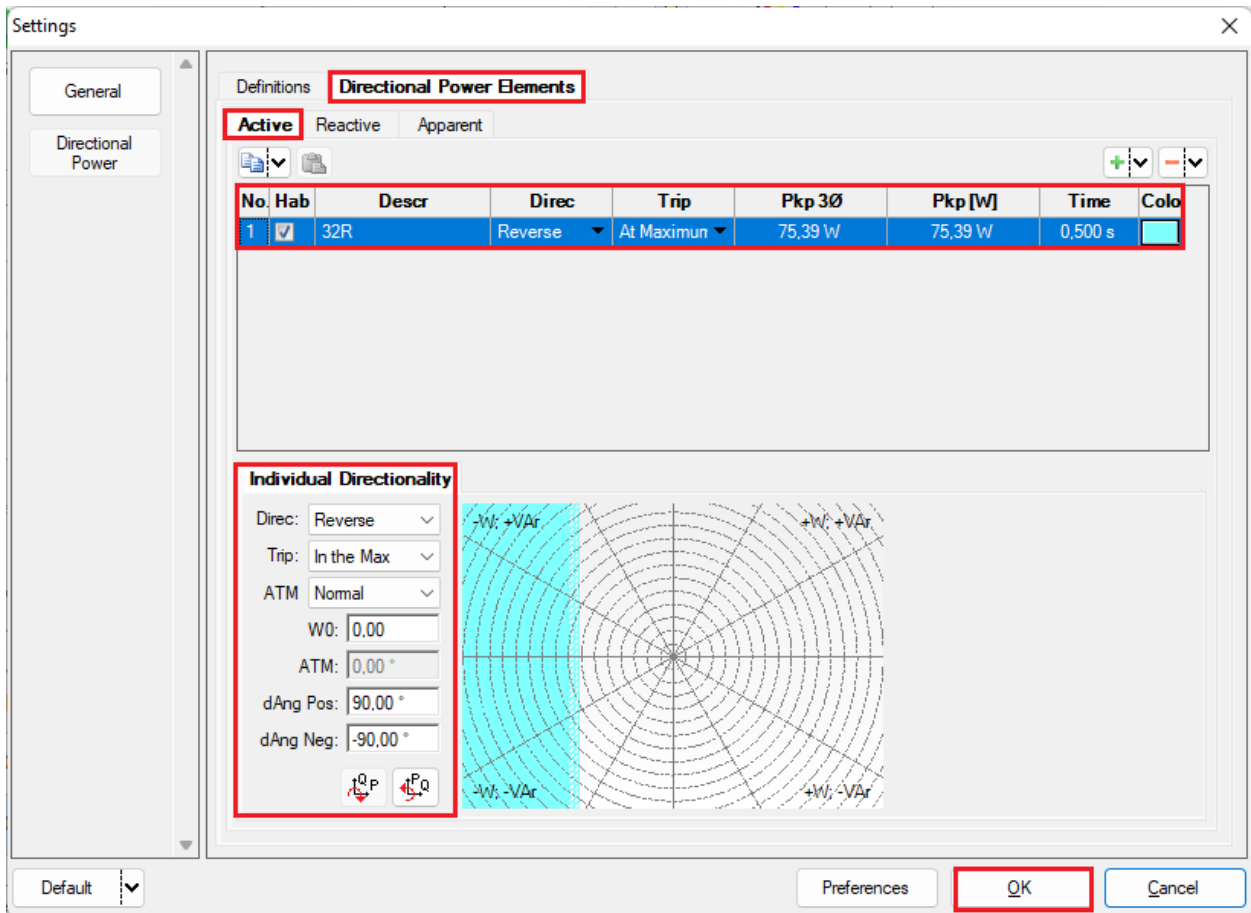


Figure 45

7. Test Structure for function 32

7.1 Test Settings

In this tab, you must configure the trip signal direction with the binary input, in addition to configuring the generation channels. Enter a pre-fault with rated voltage and current with a time of 100ms.

INSTRUMENTOS PARA TESTES ELÉTRICOS

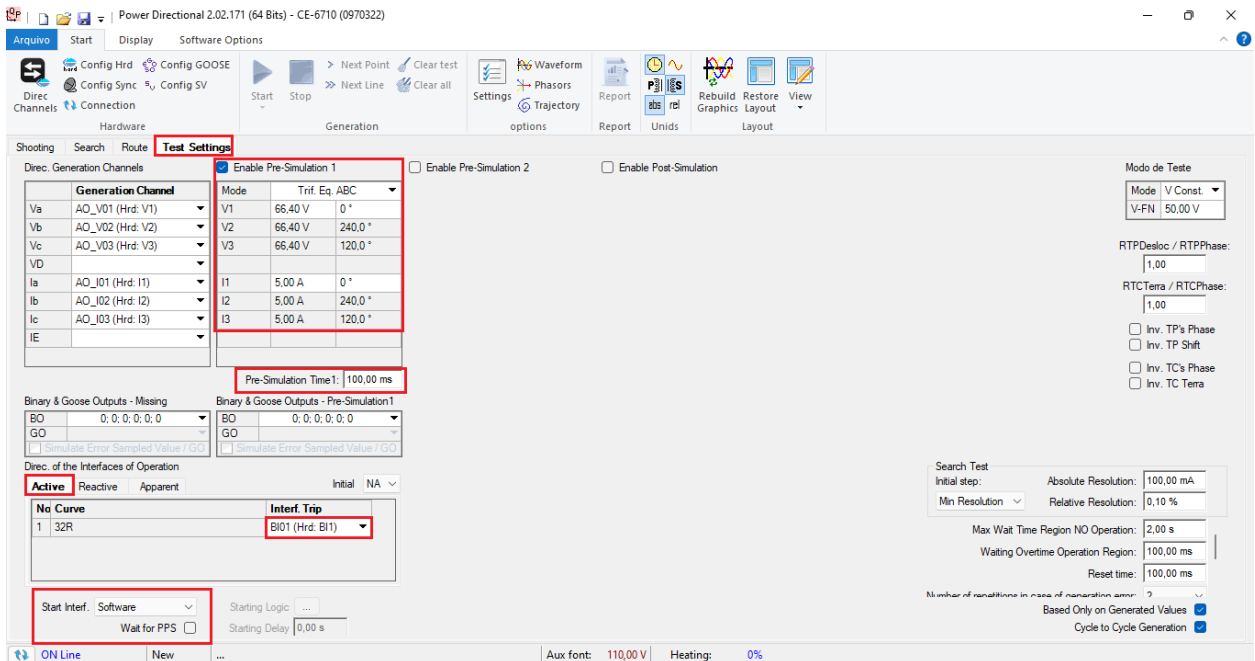


Figure 46

7.2 Shooting Screen

In this tab click on “Sequence” and choose the value of the initial and final power and the step. Repeat the process for the angles as shown in the following figure.

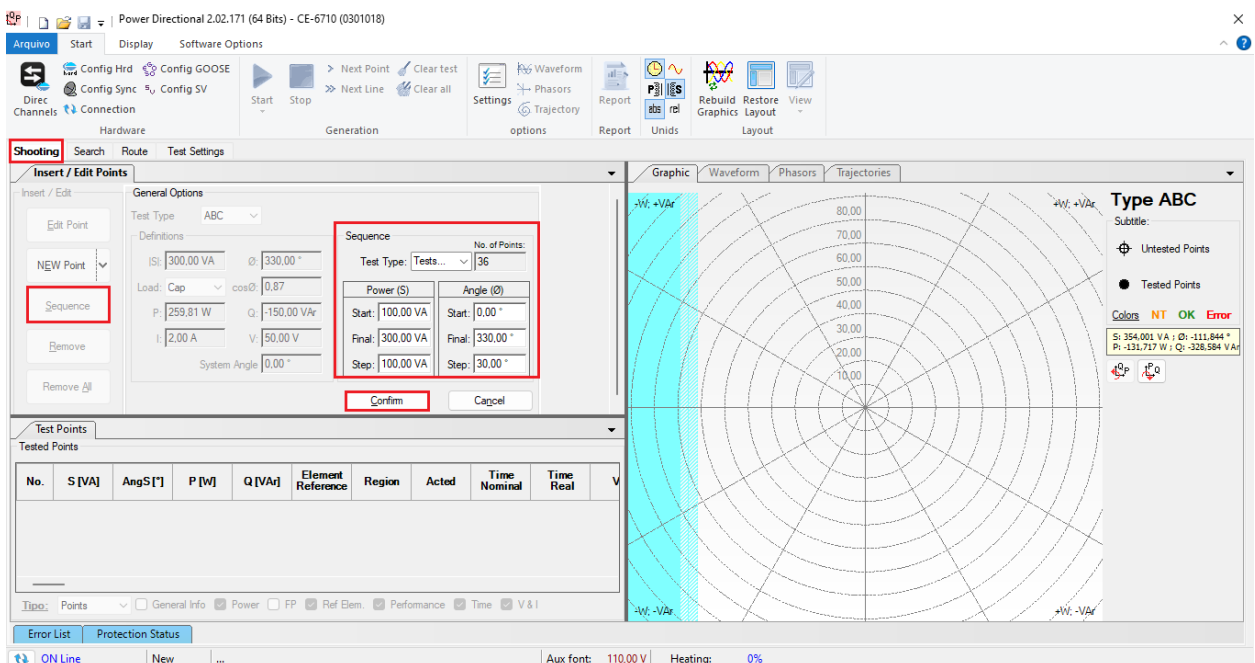


Figure 47

INSTRUMENTOS PARA TESTES ELÉTRICOS

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

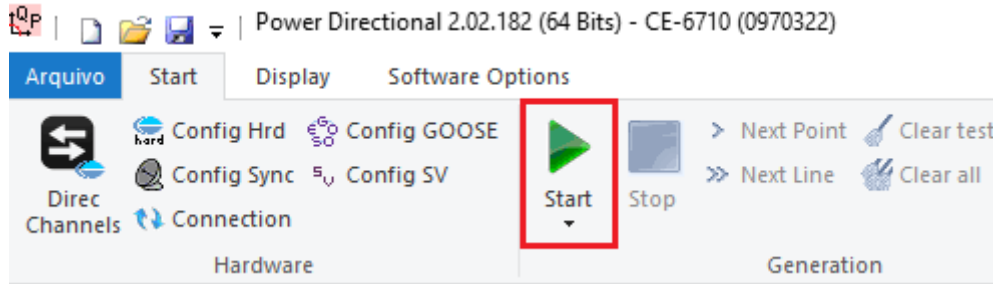


Figure 48

7.3 Final Result of the Shooting Test

In this test, it can be verified that within the operating region the relay operates within the predicted time plus its tolerance. In the case of the non-operation region, the relay does not act, proving the correct functioning of the function.

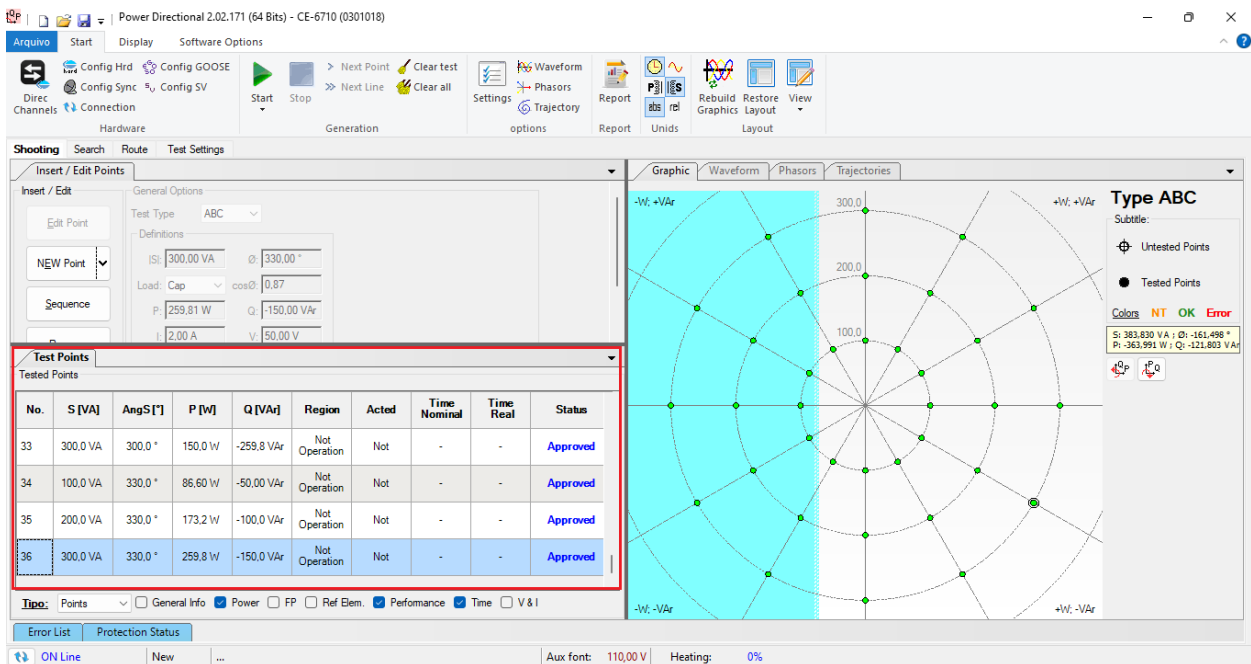


Figure 49

7.4 Search screen

In this tab, the power value that starts the relay is evaluated. For convenience, a sequence of values will be inserted, set the “Test Type” field to “ABC”. The field “Line Definition” was defined as “P”, with an initial value of -50.0W and a final value of -100.0W. In the “Variable (Q)” field, the initial value was 100.0VAr, the final value was -100.0VAr and with a step of -50.0VAr.

INSTRUMENTOS PARA TESTES ELÉTRICOS

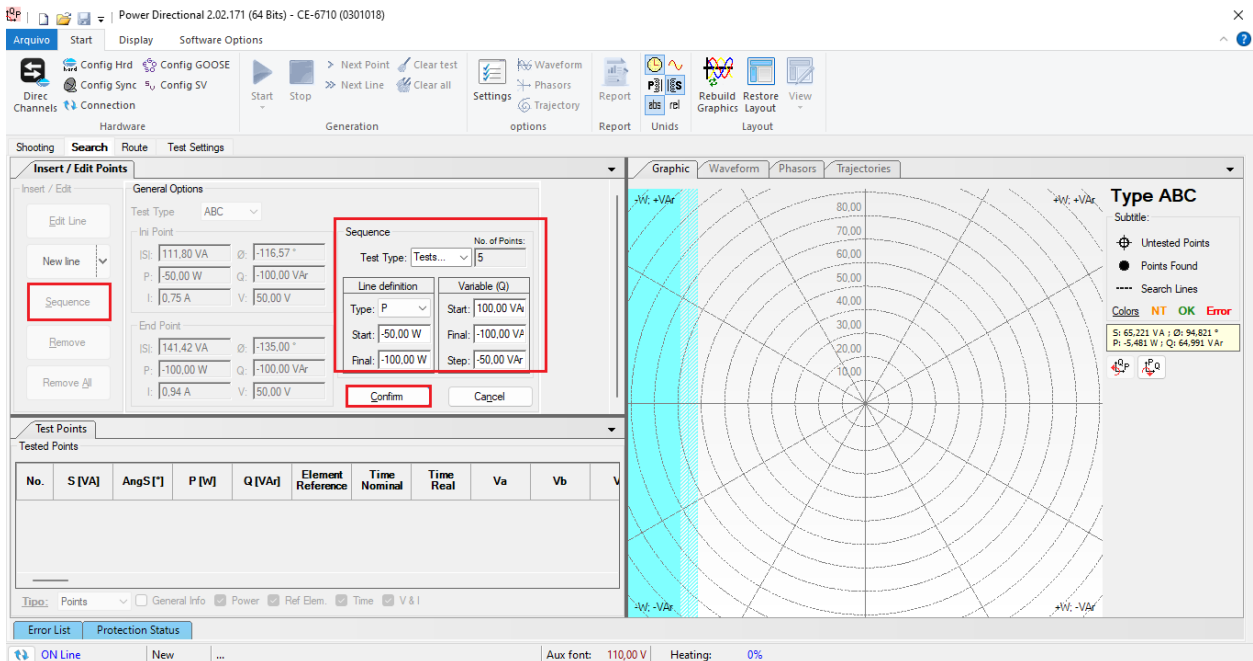


Figure 50

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

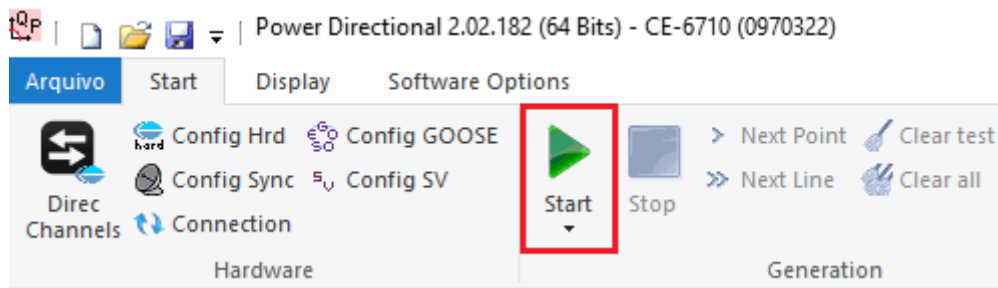


Figure 51

7.5 Final search test result

INSTRUMENTOS PARA TESTES ELÉTRICOS

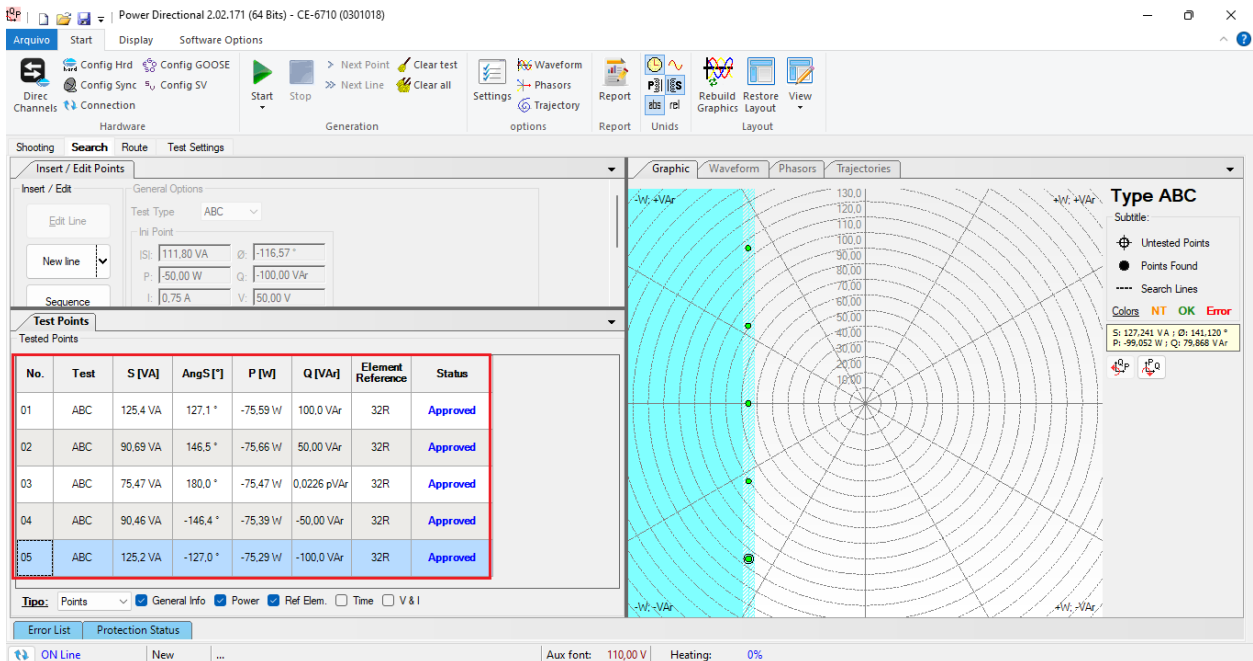


Figure 52

It is verified that all active power values are then within the tolerance region provided by the manufacturer

8. Report

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

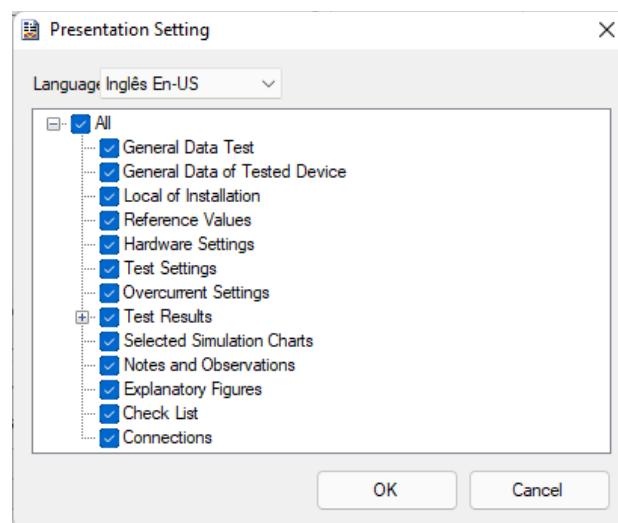



Figure 53

INSTRUMENTOS PARA TESTES ELÉTRICOS

Power Directional 2.02.171 (64 Bits) - CE-6710 (0301018)

Arquivo Print preview

Print Page setup Export to Office Word Export to PDF 100 % One page Two pages Previous page Next page Close Print Preview Close



POWER DIRECTIONAL - TEST REPORT

Descr.: Reverse Power Directional
Date: 23/05/2022 14:59:11
Software: DirecPot_CTC; Version: 2.02.171
Responsible: Michel Rockenbach de Carvalho

1. Device Tested

Ident.: 23031982; **Type:** Transformer Protection
Model: 7UT86; **Manufacturer:** Siemens

2. Location

Substation: Conprove
Bay: 1
Address: Visconde de Ouro Preto 75, Custódio Pereira
City: Uberlândia; **State:** MG

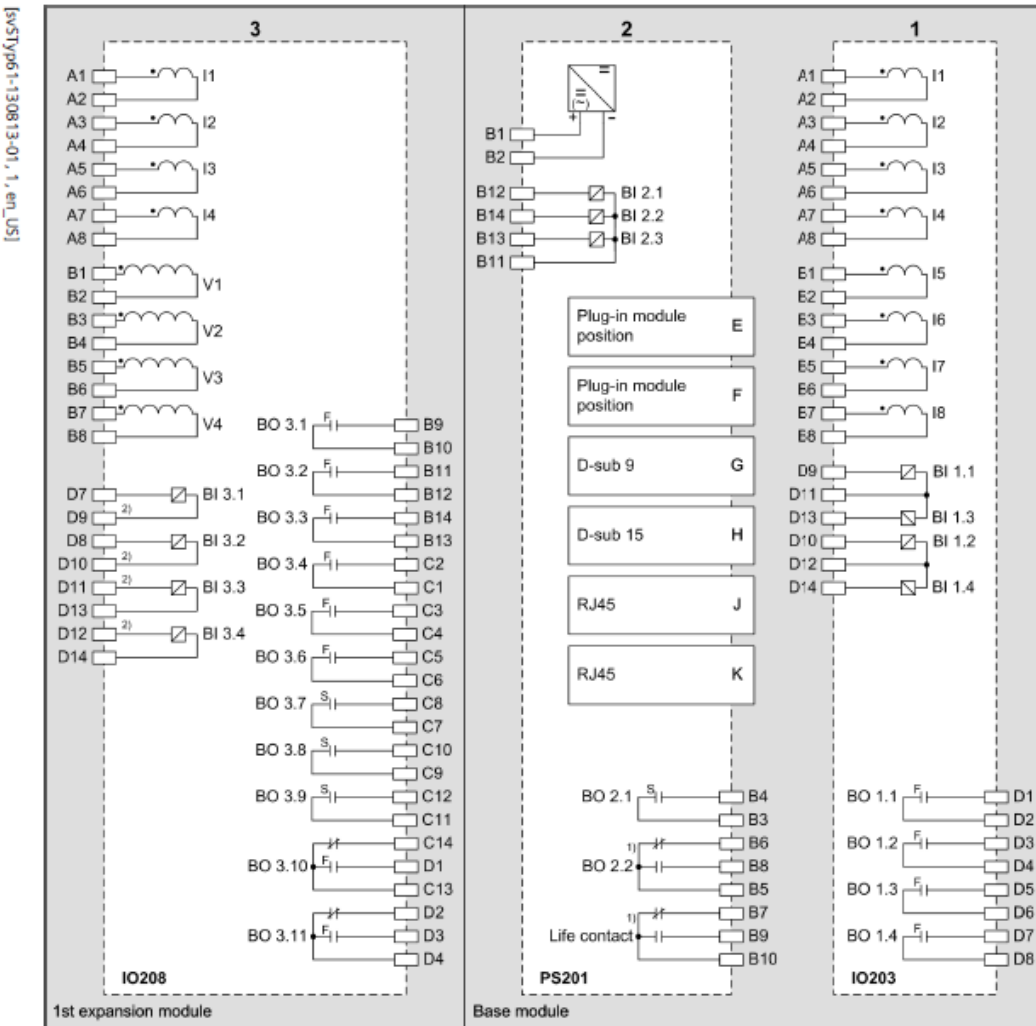
Printing Preview... | Nº of Pages: 11

Figure 54

APPENDIX A

A.1 Terminal Designations

Figure A-5 Standard Variant Type 1



¹⁾ Technical data like type F, but switching time 10 ms
²⁾ Use these terminals to root the binary inputs.

Positions for printed circuit board assemblies on the rear side

Figure 55

Standard Variants for 7UT86

A.2 Technical Data

Times

Pickup times	Approx. 360 ms at f = 50 Hz Approx. 300 ms at f = 60 Hz
Dropout times	Approx. 360 ms at f = 50 Hz Approx. 300 ms at f = 60 Hz

Tolerances

Reverse power	0.15 % S_{rated} or 5 % of the setting value when $Q < 0.5 S_{rated}$
Time delays	1 % or 10 ms

APPENDIX B

Equivalence of software parameters and the relay under test.

Table 1

Power Directional Software		7UT86 Relay	
Parameter	Figure	Parameter	Figure
Pkp 3Φ	45	Threshold	26
Time	45	Operate delay	26