



INSTRUMENTOS PARA TESTES ELÉTRICOS

Test Tutorial

Equipment Type: Protection Relay

Brand: SIEMENS

Model: 7SA611

Function: 25 or RSYN – Synchronism Check

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

Objective: Test when two systems can connect, respecting voltage, frequency and angle limits, that is, if they are in synchronism.

Version control:

Version	Descriptions	Date	Author	Reviewer
1.0	Initial Version	21/12/2021	M.R.C.	M.P.S



INSTRUMENTOS PARA TESTES ELÉTRICOS

Summary

1. Relay connection to CE-6006	5
1.1 <i>Auxiliary Source</i>	5
1.2 <i>Voltage Coils</i>	5
1.3 <i>Binary Inputs</i>	6
1.4 <i>Binary Outputs</i>	6
2. Communication with the 7SA6 relay	7
3. Parameterization of the 7SA6 relay	8
3.1 <i>Device Configurations</i>	8
3.2 <i>Masking I/O</i>	10
3.3 <i>Tested System Configuration</i>	11
3.4 <i>Power System Data 1</i>	11
3.5 <i>Power System</i>	13
3.6 <i>Breaker</i>	13
3.7 <i>Setting Group A</i>	13
3.8 <i>Power System</i>	14
3.9 <i>Trip 1-/3 pole</i>	15
3.10 <i>25 Synchronism and Voltage Check</i>	16
3.11 <i>General</i>	16
3.12 <i>Man. Close +CNTRL</i>	17
4. Synchronism software adjustment	18
4.1 <i>Opening the software</i>	19
4.2 <i>Configuring the Settings</i>	20
4.3 <i>System</i>	21
5. Channel Targeting and Hardware Configurations	22
6. Synchronism Adjustments	23
6.1 <i>Synchronism > Systems Screen</i>	23
6.2 <i>Synchronism > Sync. Settings</i>	24
7. Test Settings	25
8. Trigger Test	26
9. Search Test	28
10. Trajectory Test	30
11. Report	31
APPENDIX A	33



INSTRUMENTOS PARA TESTES ELÉTRICOS	
A.1 Terminal Designations	33
A.2 Technical Data.....	34
APPENDIX B	35

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 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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Sequence for testing the Siemens 7SA6 relay in the Synchronism software

1. Relay connection to CE-6006

Appendix A-1 shows the relay terminal designations

1.1 Auxiliary Source

Connect the positive (red terminal) of the Vdc Aux. Source to pin F1 of the relay and the negative (black terminal) of the Vdc Aux. Source to pin F2 of the relay.

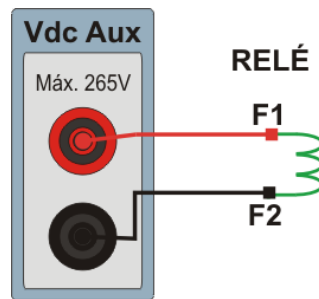


Figure 1

1.2 Voltage Coils

Connect the voltage channels V1, V2 and V3 of the CE-6006 to pins R15, R17 and R18 of the relay respectively, connect the three common ones of the CE-6006 to pin R16 of the relay, thus forming the connection for the voltage coils for the system 1. For system 2 connect channel V4 to pin R14 and common to pin 13.

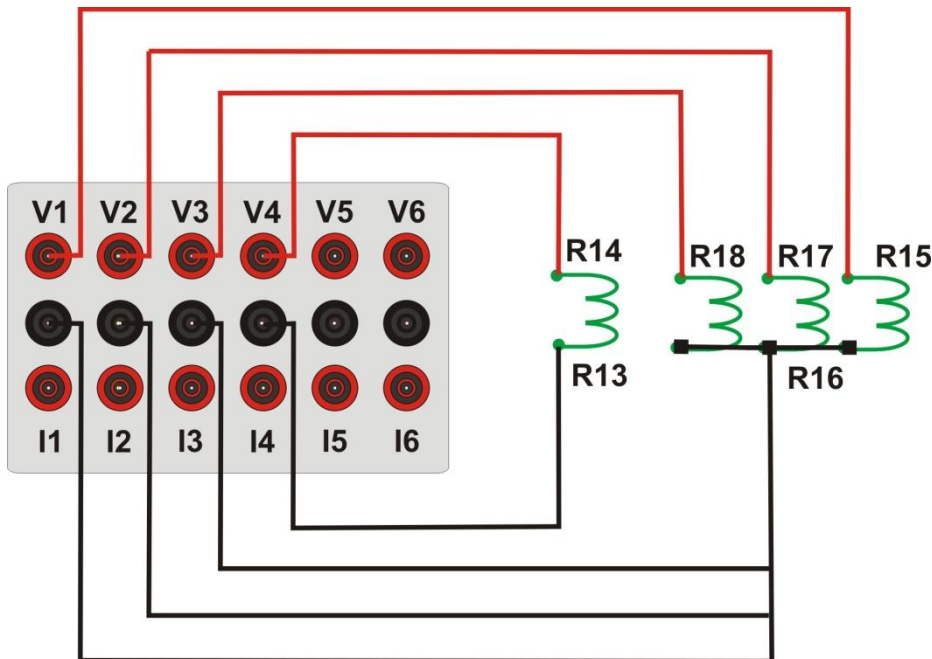


Figure 2

1.3 Binary Inputs

Connect the CE-6006 binary inputs to the relay binary outputs:

- BI1 to pin R1 and its common to pin R4.
- BI2 to pin R2 and its common to pin R4.
- BI3 to pin R3 and its common to pin R4.
- BI4 to pin R5 and its common to pin R6.
- BI5 to pin R7 and its common to pin R8.

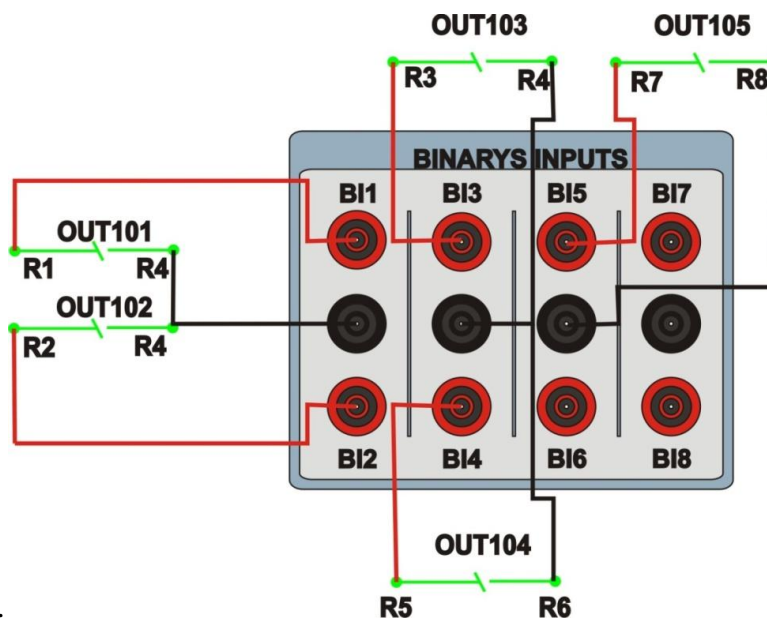


Figure 3

1.4 Binary Outputs

Connect the CE-6006 binary output to the auxiliary power supply red terminal. Connect auxiliary source common to relay pin F10. Finally connect the binary output common to relay pin F5.

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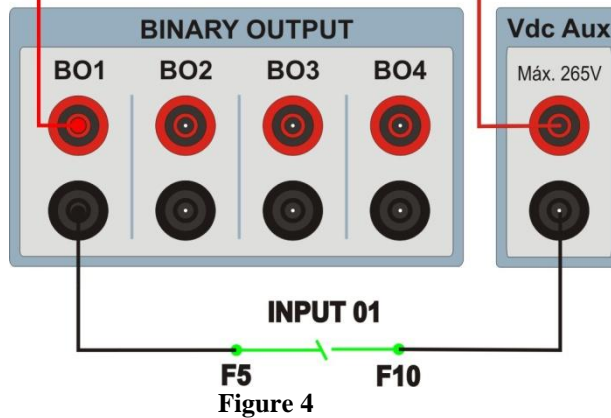


Figure 4

2. Communication with the 7SA6 relay

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



Figure 5

When opening the program, the substation that contains the relay in question (7SA6) is selected. After selecting the relay, right-click and select the “Open Object” option and then select the connection mode, as shown in the following figures.

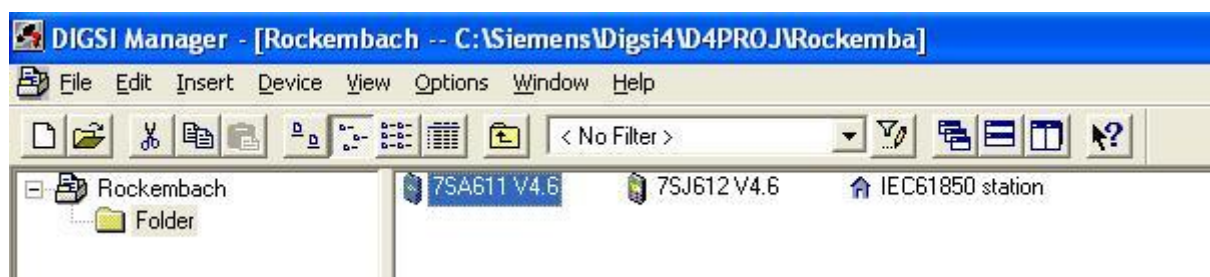


Figure 6

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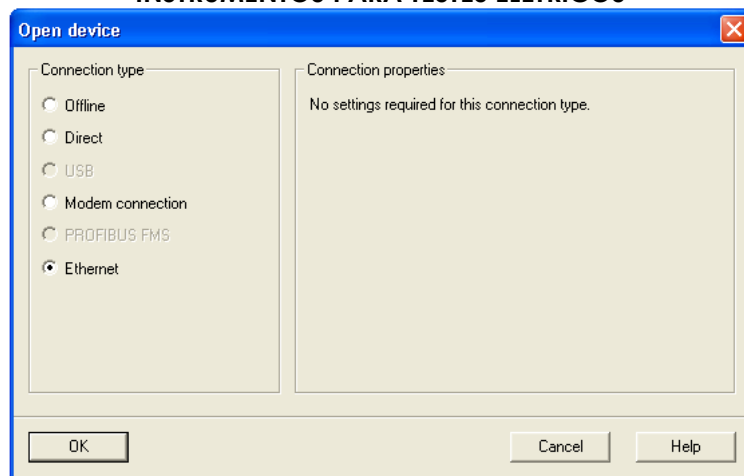


Figure 7

3. Parameterization of the 7SA6 relay

3.1 Device Configurations

After the connection has been established, access the general relay settings by double left-clicking on “Settings” and repeat the operation for “Device Configurations”.

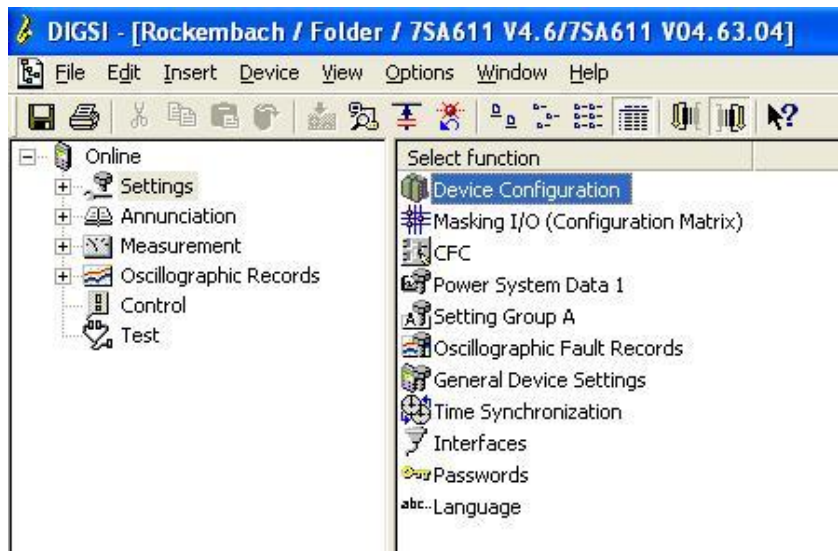


Figure 8

In the “Functional Scope” screen, disable all functions leaving only the “25 Synchronism and Voltage Check” function enabled. This facilitates testing in order to prevent the possibility of using trips from other functions. After the adjustments click “OK”.

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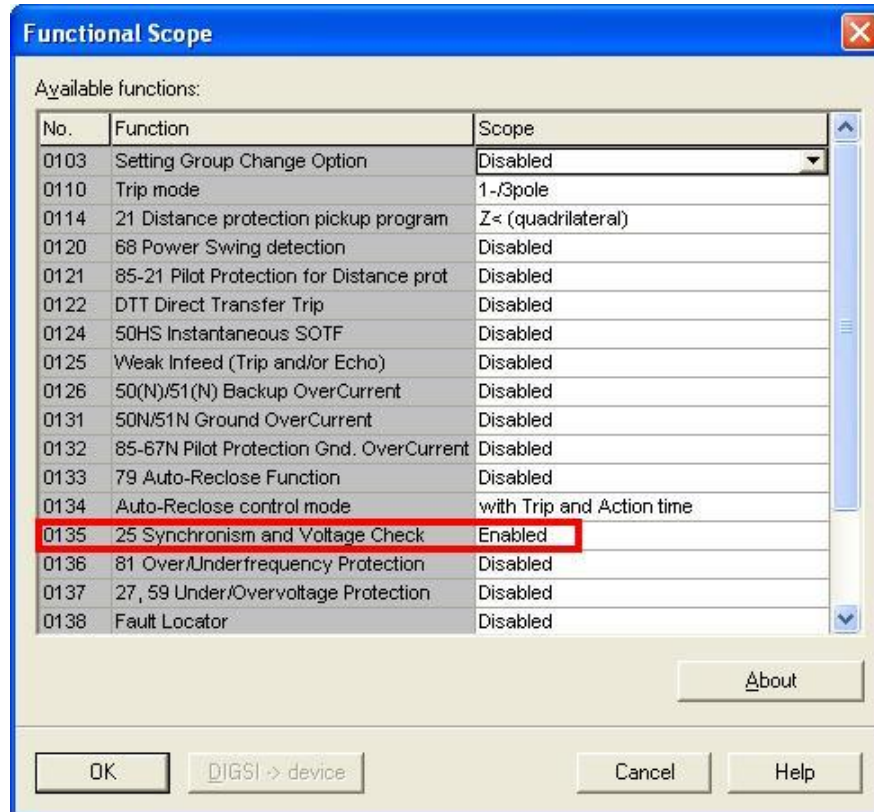


Figure 9

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3.2 Masking I/O

The next step is to adjust the binary inputs and 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.

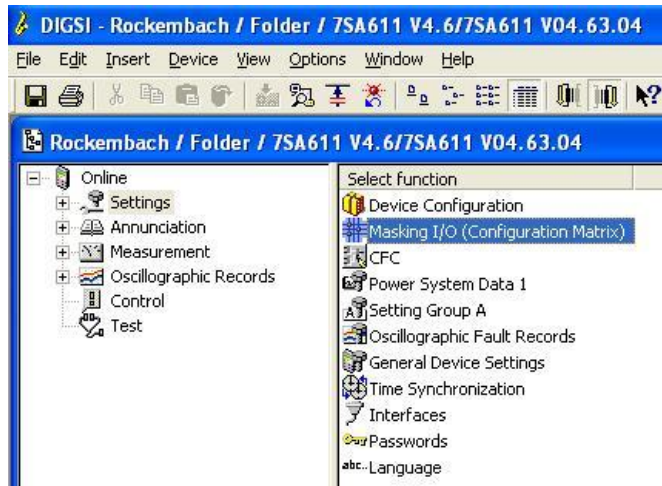


Figure 10

In order for the relay to understand that a manual close command has been issued, the binary output “25 SynStart MC” is enabled so that it operates with a high level “H”, whose signal will be issued when BI1 closes. Another important setting is the “25 Sy. ClosedCmd” which is the synchronism trip signal whose binary output is BO1. For V >, V <, f > and f <, outputs BO2, BO3, BO4 and BO5 are used respectively. To easily find a mistake in the settings of both the test box and the relay, some leds were designed to monitor the main trip signals. Finally send the changes to 7SA6.

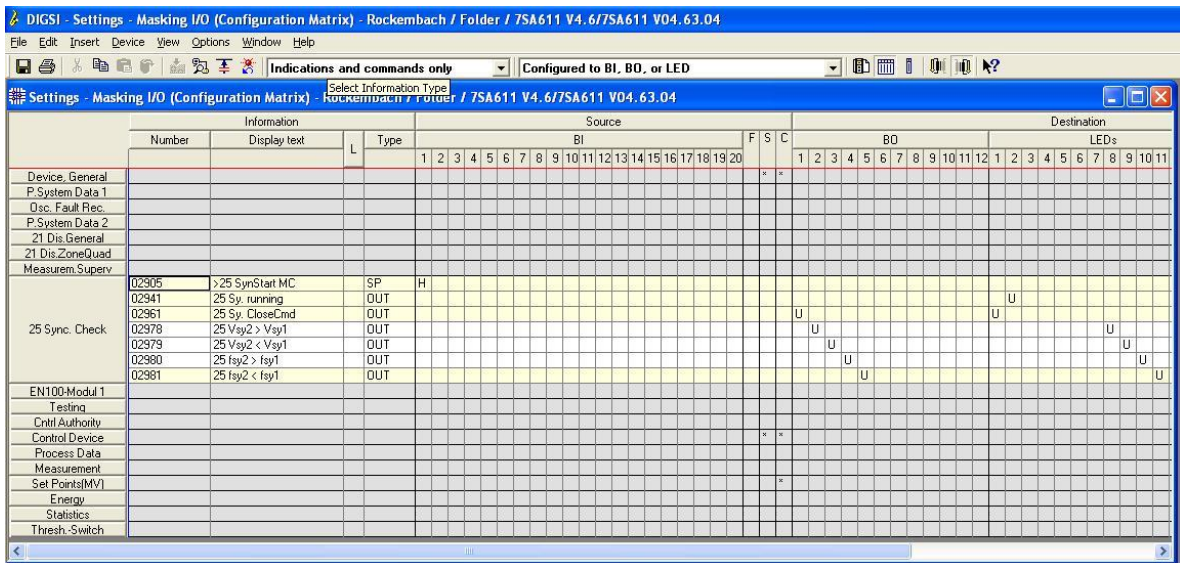


Figure 11

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3.3 Tested System Configuration

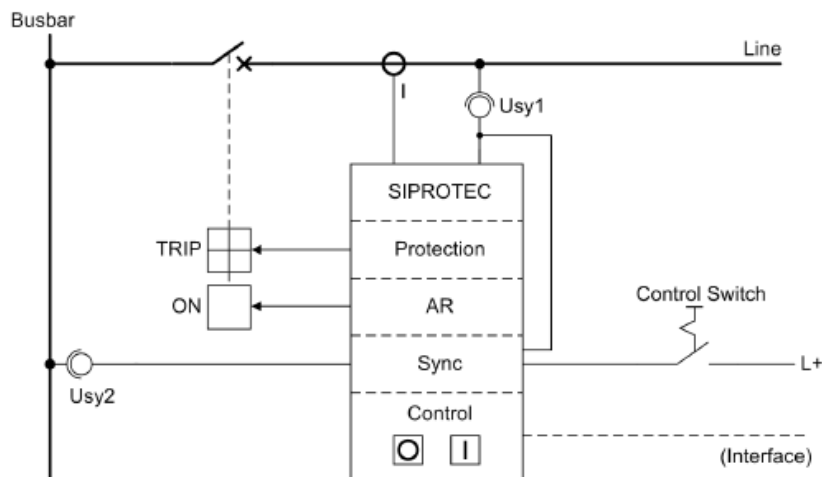


Figure 12

To complete the tutorial, a case is simulated where system 1 (line) has 116 volts of nominal secondary voltage and is 30° ahead of system 2 (collector bar) which in turn has 100 volts of nominal secondary voltage. In this case, the time for closing the circuit breaker is 60ms.

The synchronism check function in the 7SA6 usually works in conjunction with the integrated automatic reclosure, manual close and relay control functions. This tutorial deals with the option where the substation operator performs a manual command.

3.4 Power System Data 1

Returning to the settings, double-click on “Power System Data 1” to access the system settings 1.

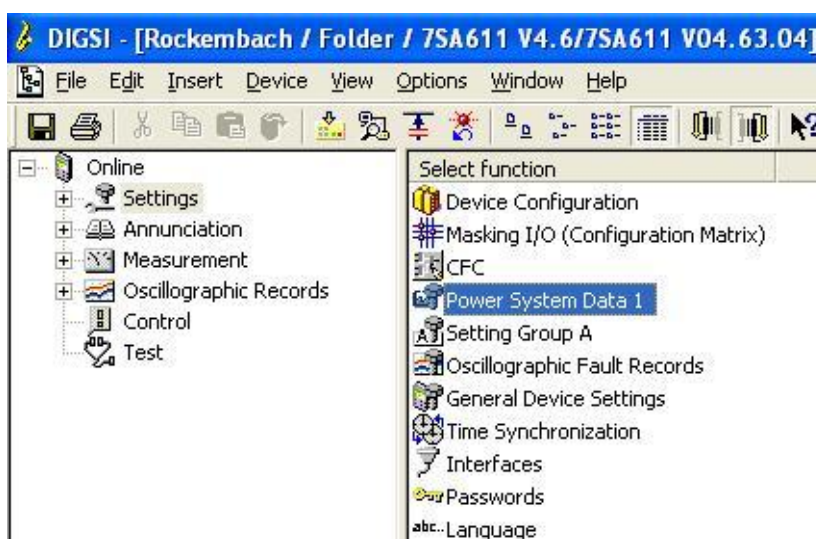


Figure 13

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Those settings highlighted in red need special attention. At address 0210 it is important to enable the option that a fourth voltage is being monitored. At address 0212 it is configured which voltage will be used as a reference, which can be phase or neutral. As there is an angular difference between the two systems due to the transformer, address 0214A must be set in order to compensate for this offset. At address 0215 the relationship between the voltages between the two systems is entered ($116/110 = 1.16$).

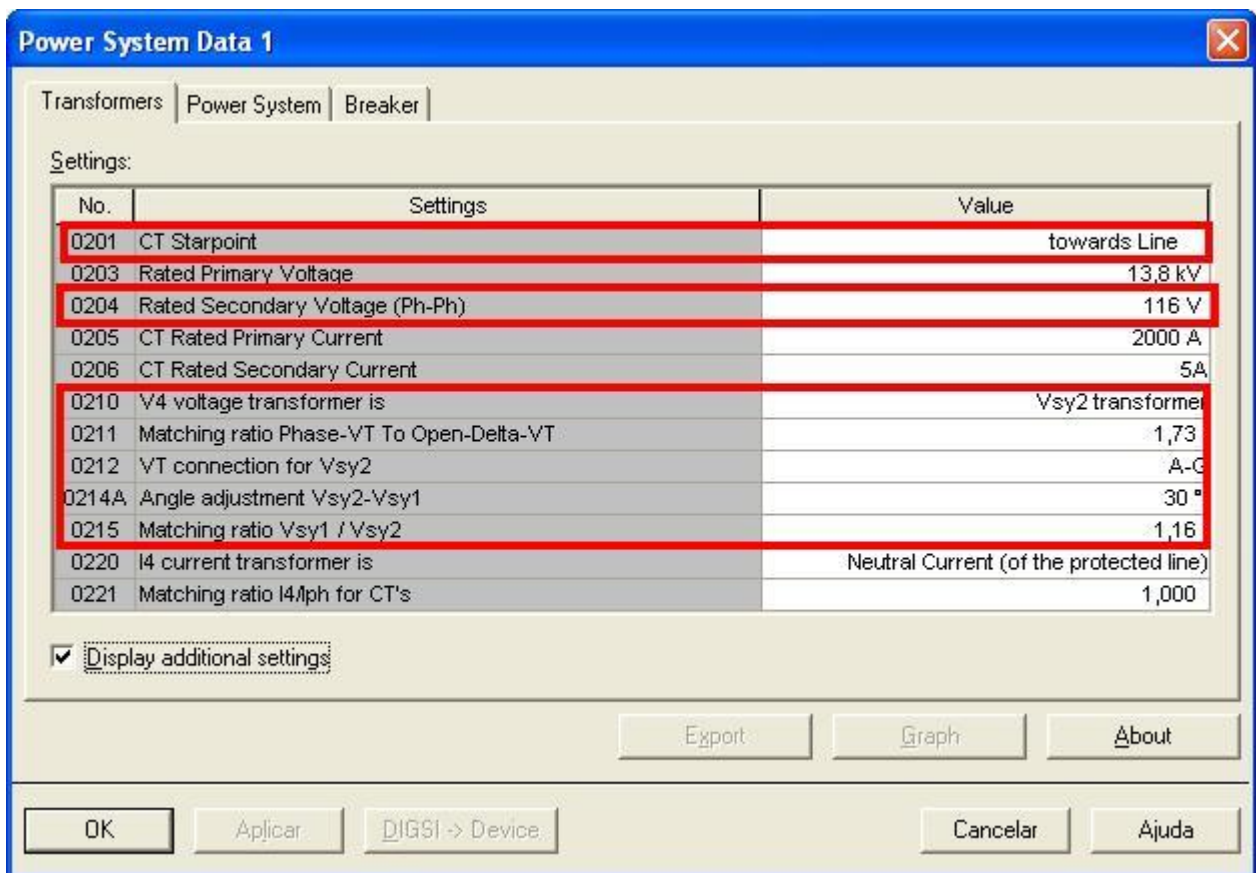


Figure 14

3.5 Power System

On the Power System tab you configure the voltage and phase sequence.

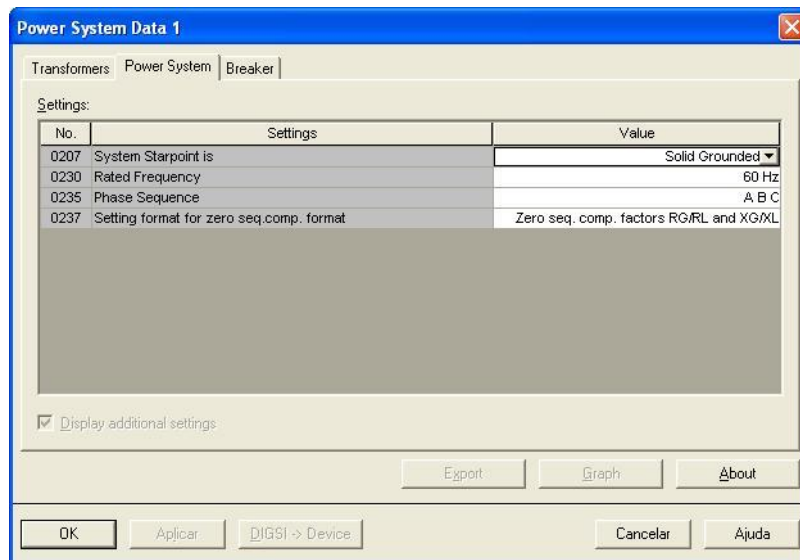


Figure 15

3.6 Breaker

In the “Breaker” tab and at address 0239 the time for the effective closing of the circuit breaker is inserted, in this tutorial 60ms is used.

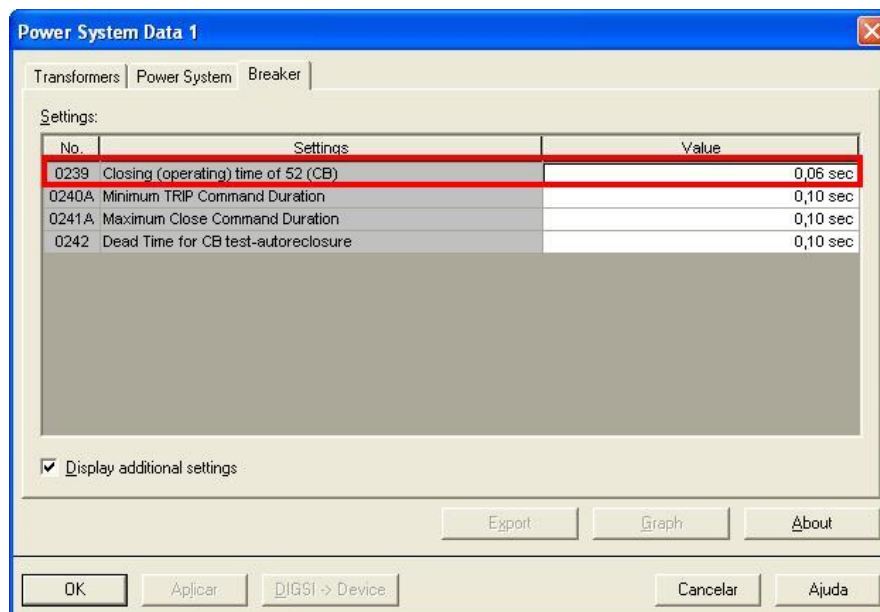


Figure 16

3.7 Setting Group A

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In this option are the settings of system two and the synchronism function.

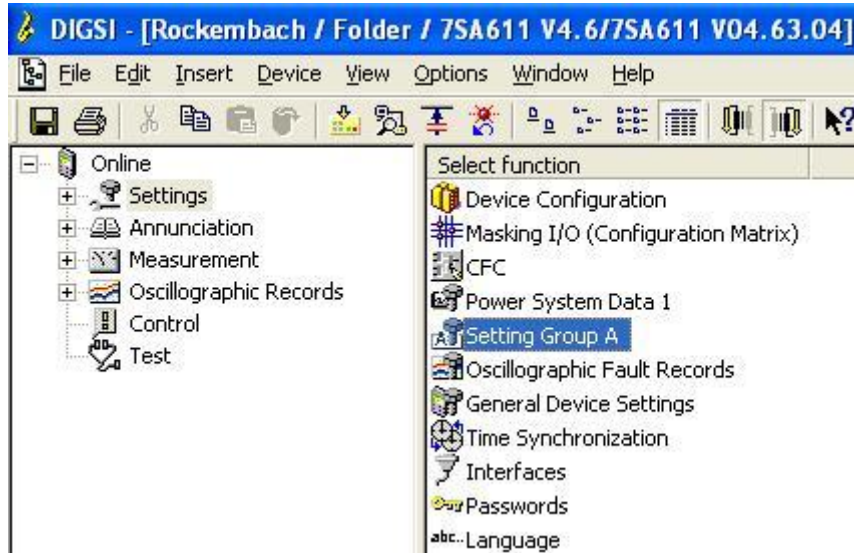


Figure 17

Double-click on the “Power System Data 2” option.

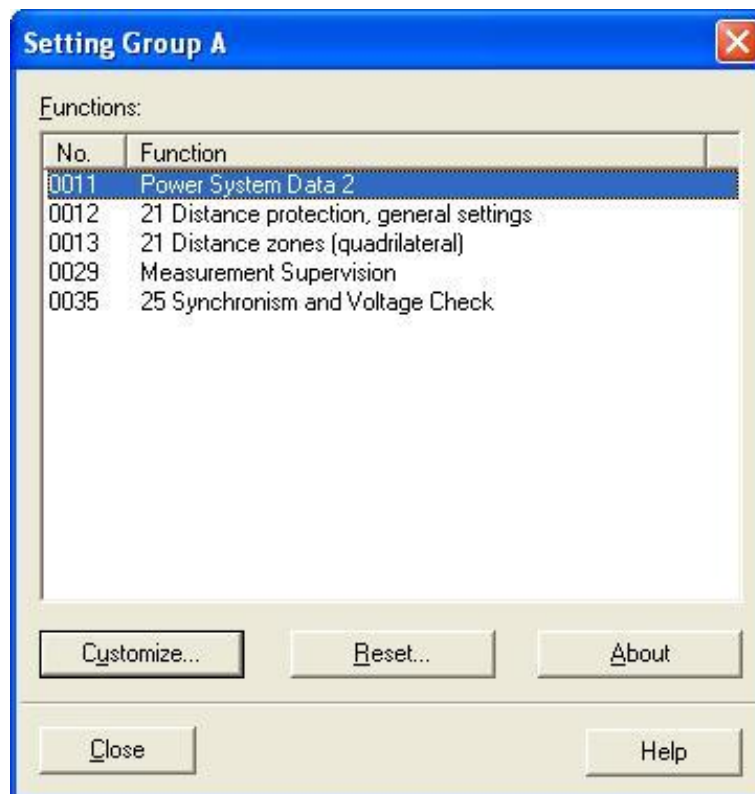


Figure 18

3.8 Power System

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To adjust system 2 enter the value of voltage and primary current.

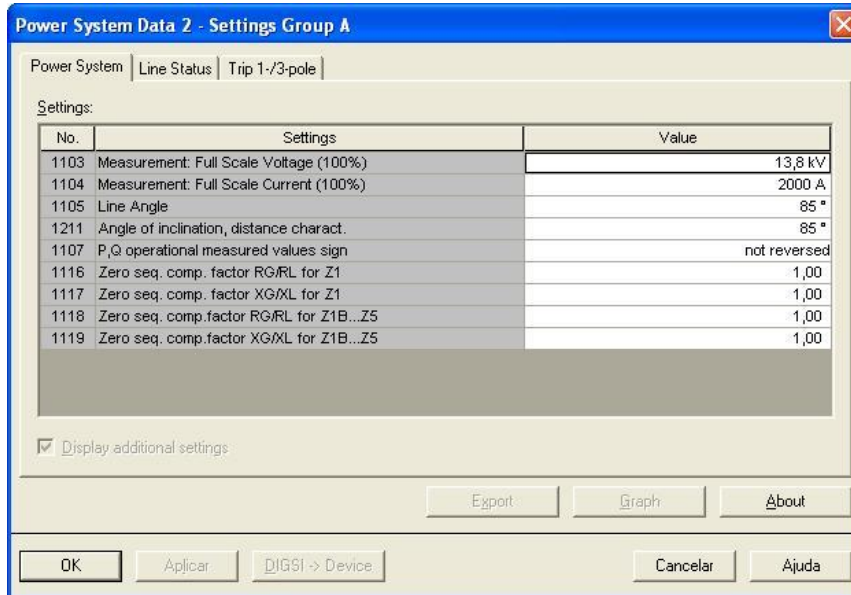


Figure 19

At address 1134 the option “Manual Close BI only” is chosen so that only the manual close signal via binary input is evaluated as close. Address 1151, on the other hand, configures the option that checks synchronism before closing due to a manual command. Another setting is address 1152 which needs to be set as “52 Breaker”.

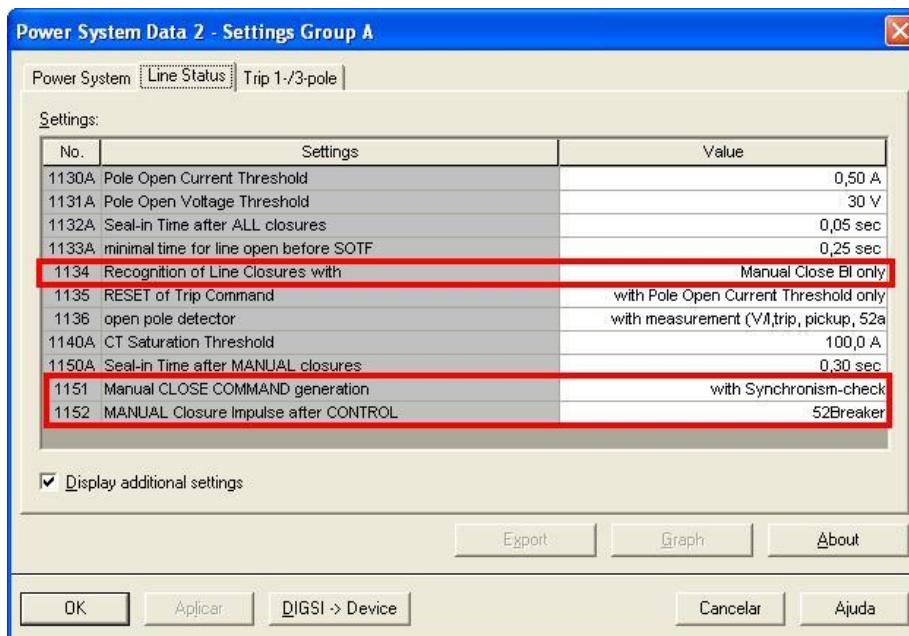


Figure 20

3.9 Trip 1-/3 pole

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The adjustments below are only relevant when there is reclosing. In this case, they do not influence the test.

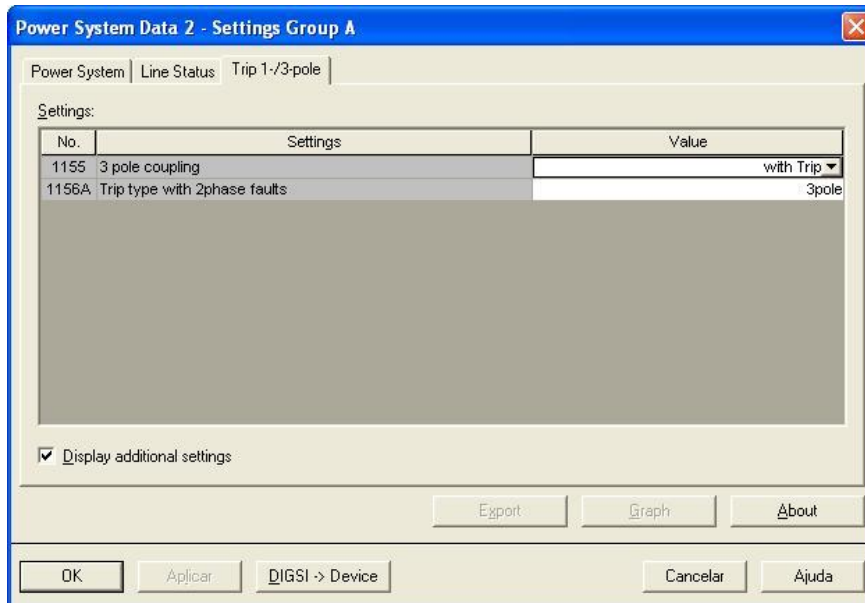


Figure 21

3.10 25 Synchronism and Voltage Check

The last step is to make the timing adjustments for this. Enter “Setting Group A” and then “25 Synchronism and Voltage Check”.

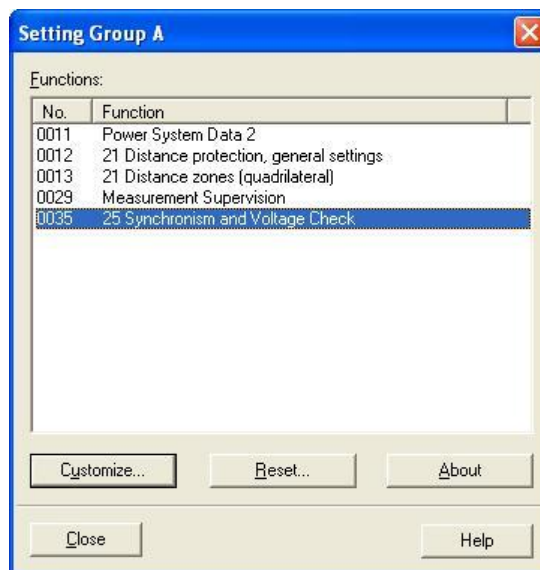


Figure 22

3.11 General

INSTRUMENTOS PARA TESTES ELÉTRICOS

Address 3501 activates the synchronism function. To set a maximum time for synchronism check, this value in seconds is inserted in address 3507, where in this case 13.0s was set. Another important setting is at address 3509 which must be set as “52Breaker”.

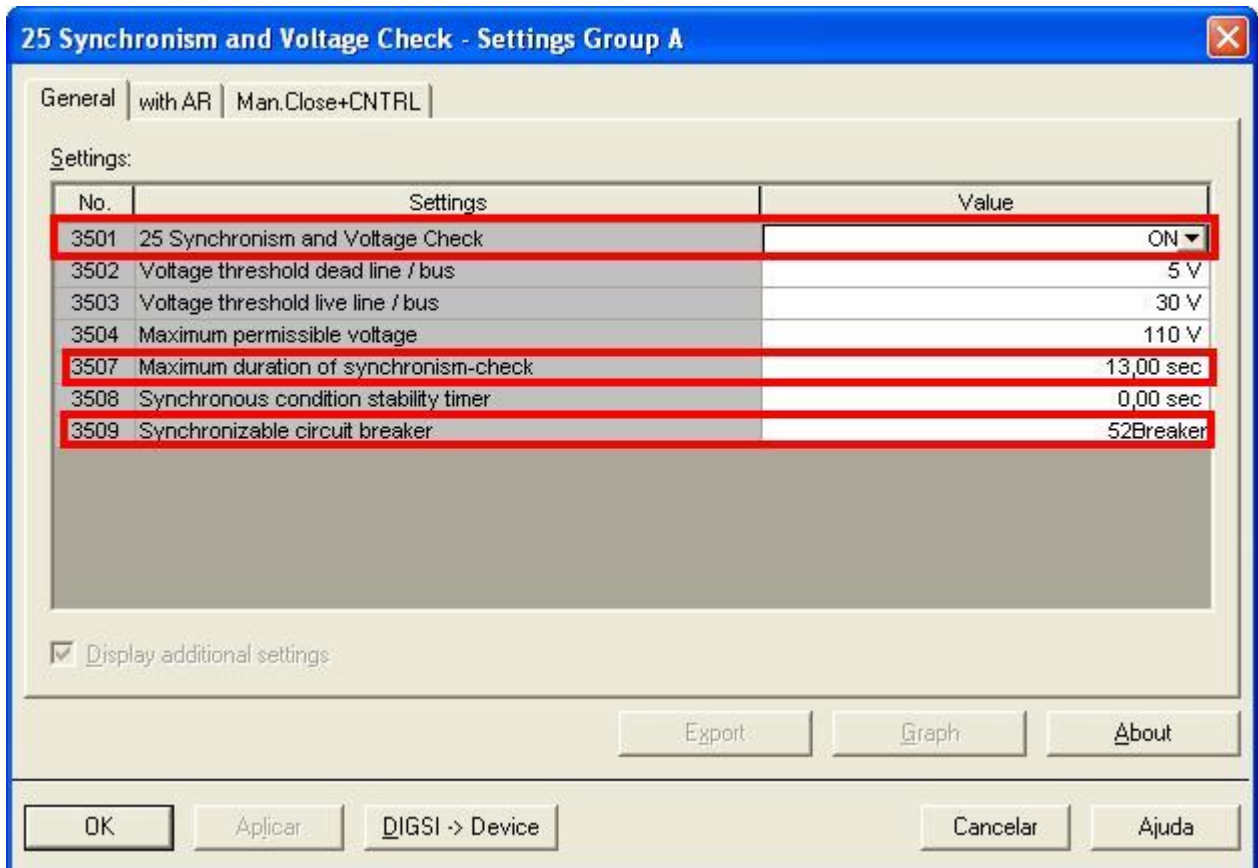


Figure 23

3.12 *Man. Close +CNTRL*

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To terminate the settings the relay sets address 3530 so that the circuit breaker closing time is taken into account. At addresses 3531, 3532 and 3533 the maximum voltage, frequency and angle differences between the two systems are set. The last setting is the “YES” option for address 3535A this means that both systems must be energized for manual closing and synchronism to occur.

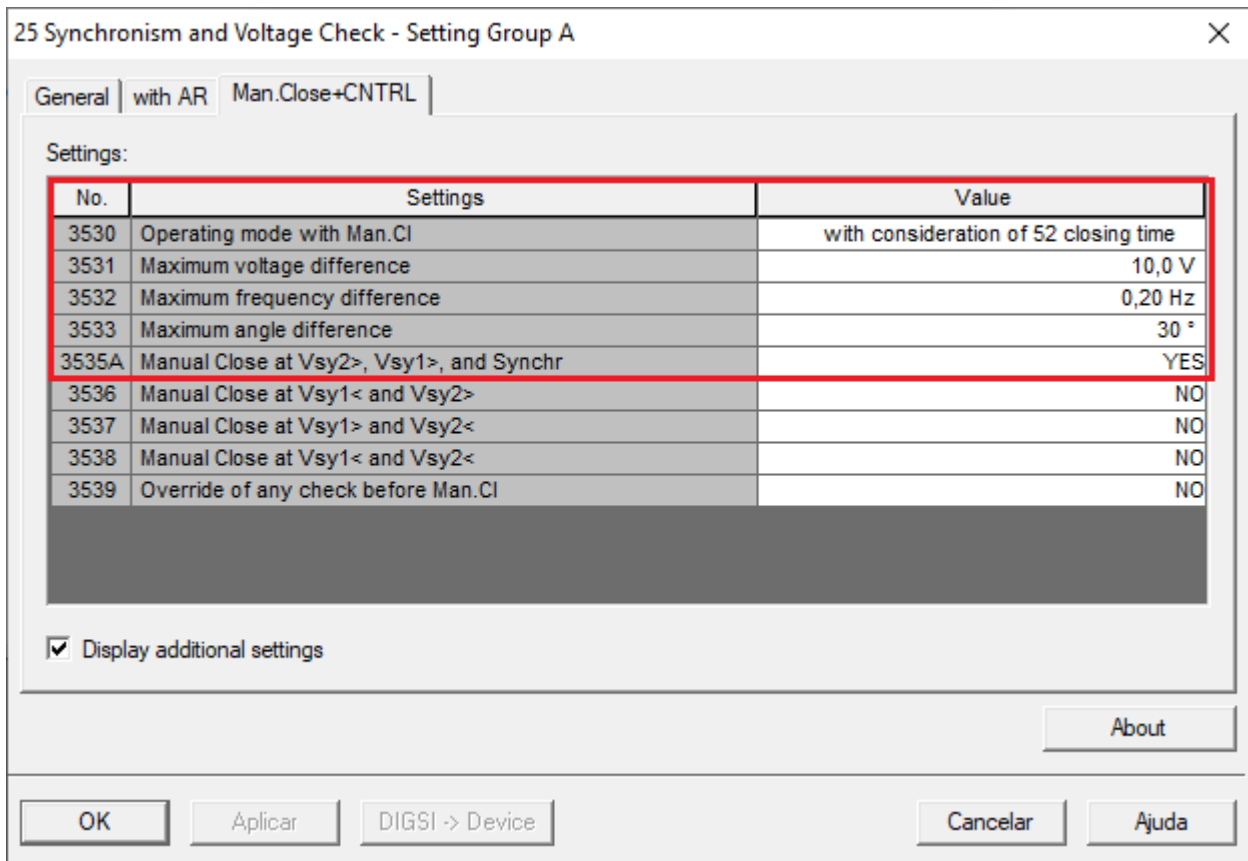


Figure 24

4. Synchronism software adjustment

INSTRUMENTOS PARA TESTES ELÉTRICOS

4.1 Opening the software

Open the Conprove Test Center (CTC) software, shown in the figure below.

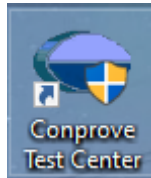


Figure 25

Click on the Synchronism software icon.

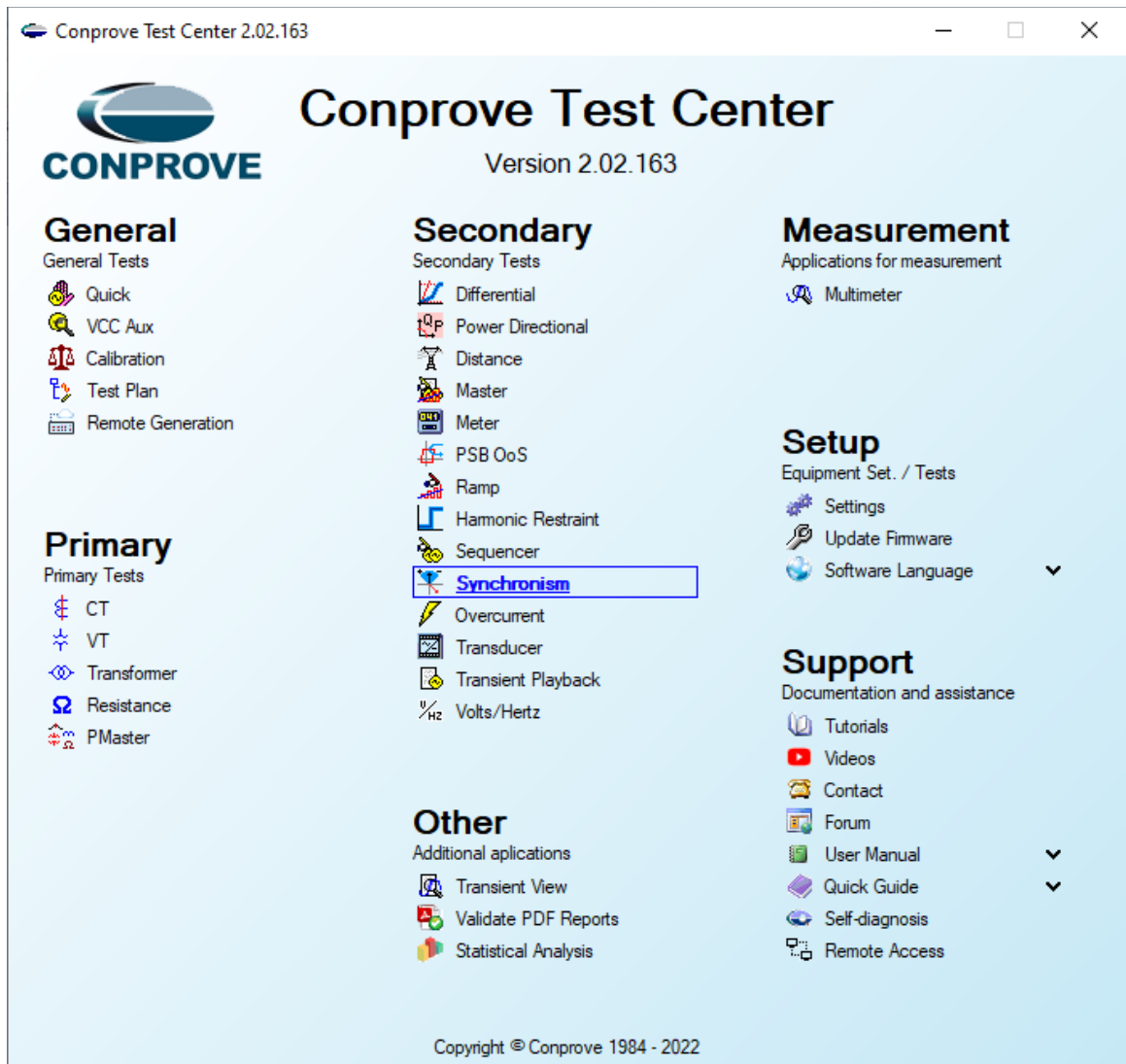


Figure 26

INSTRUMENTOS PARA TESTES ELÉTRICOS

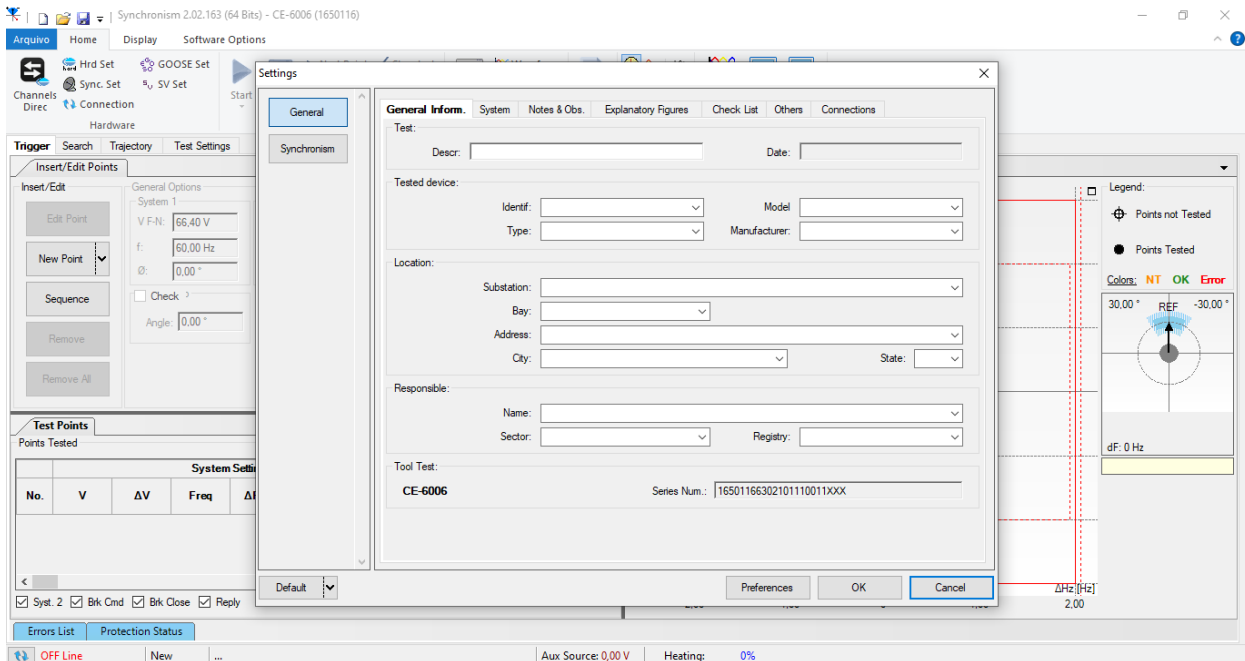


Figure 27

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.

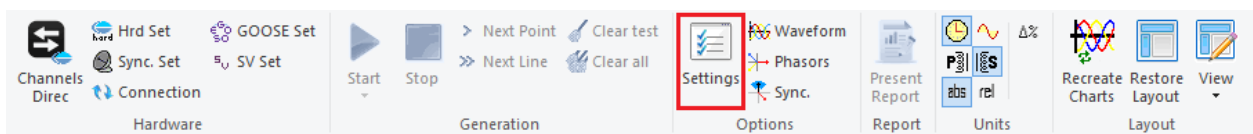


Figure 28

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

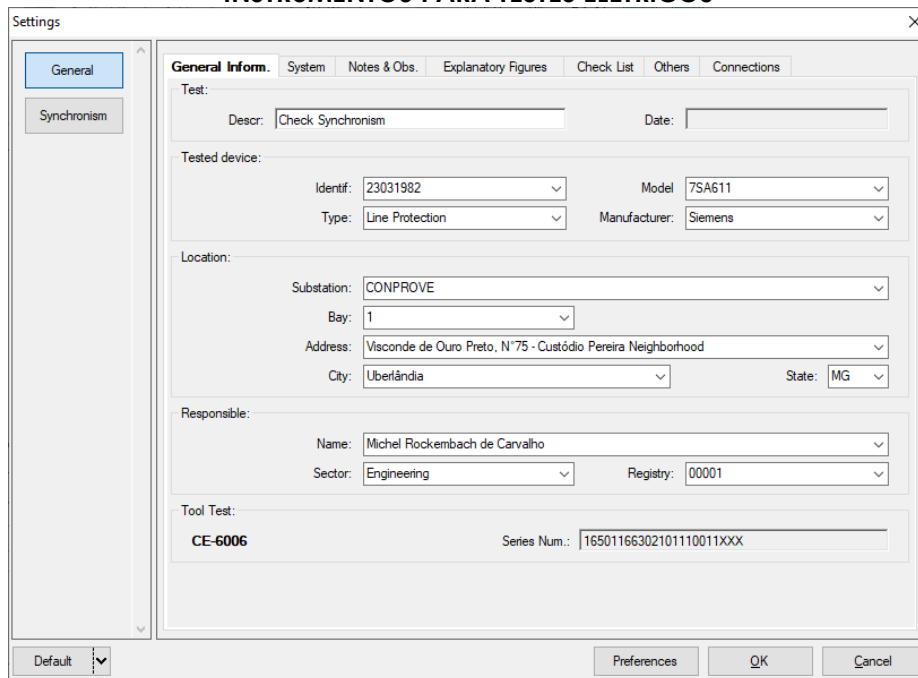


Figure 29

4.3 System

In the following screen, within the “Nominal” sub tab, the frequency values, 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.

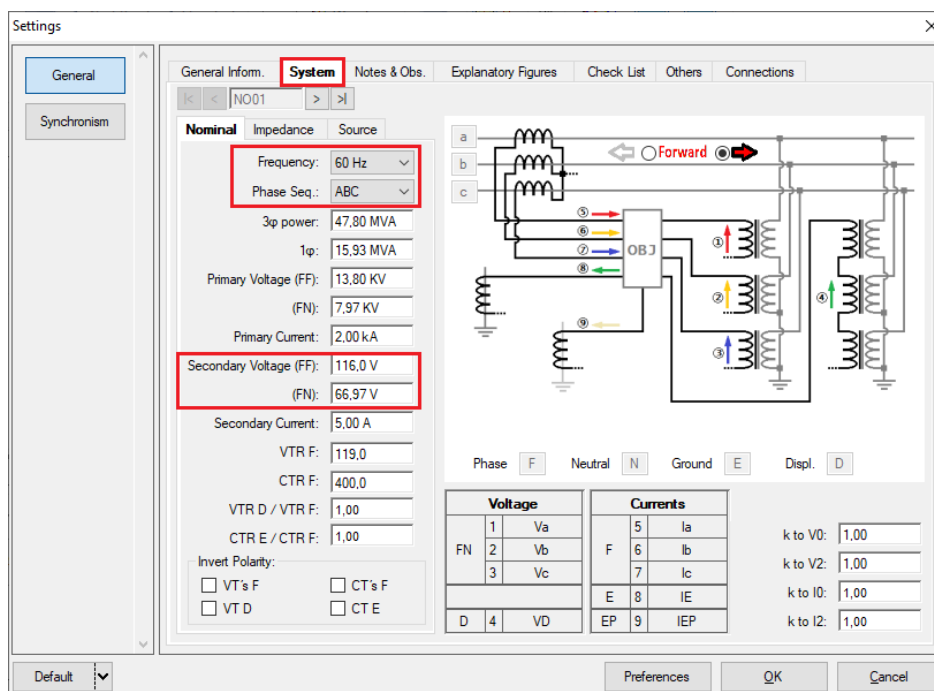


Figure 30

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There are other tabs where the user can enter “Notes & Obs”, “Explanatory Figures”, can create a “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 tested equipment.

5. Channel Targeting and Hardware Configurations

Click on the icon illustrated below.

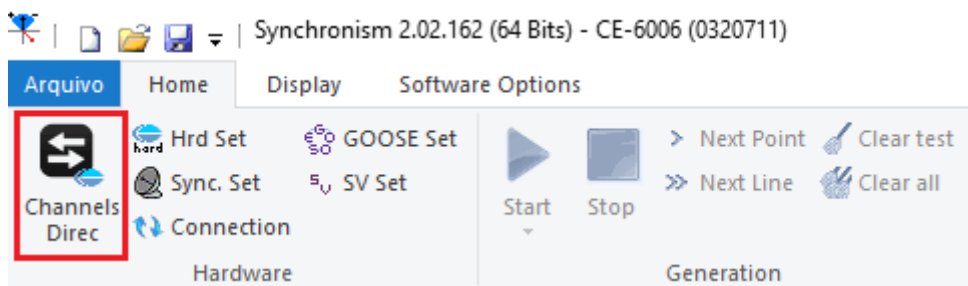


Figura 31

Then click on the highlighted icon to configure the hardware.

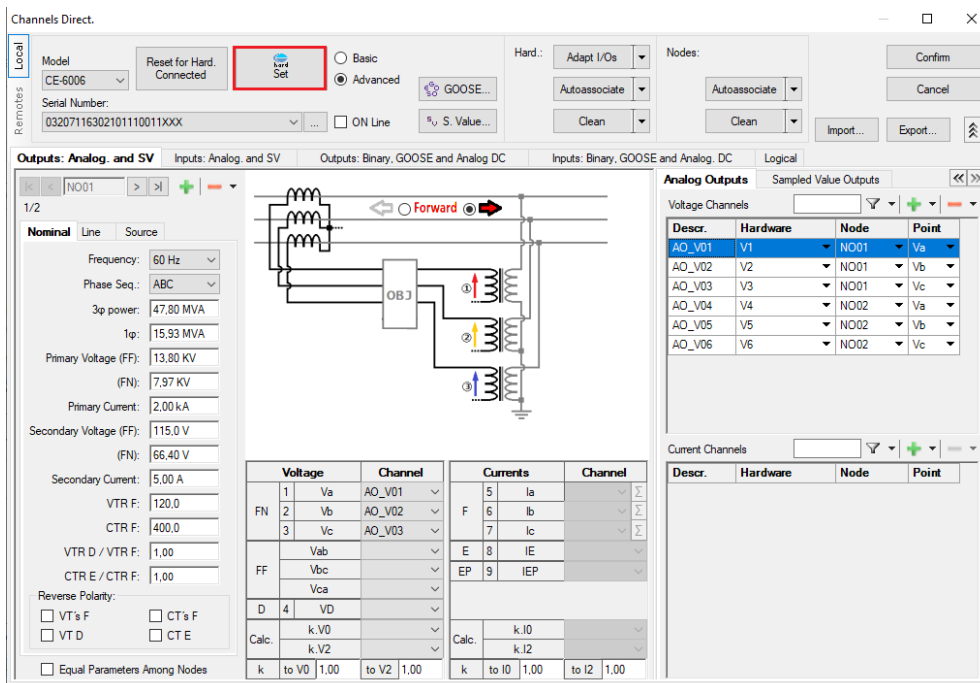


Figure 32

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

INSTRUMENTOS PARA TESTES ELÉTRICOS

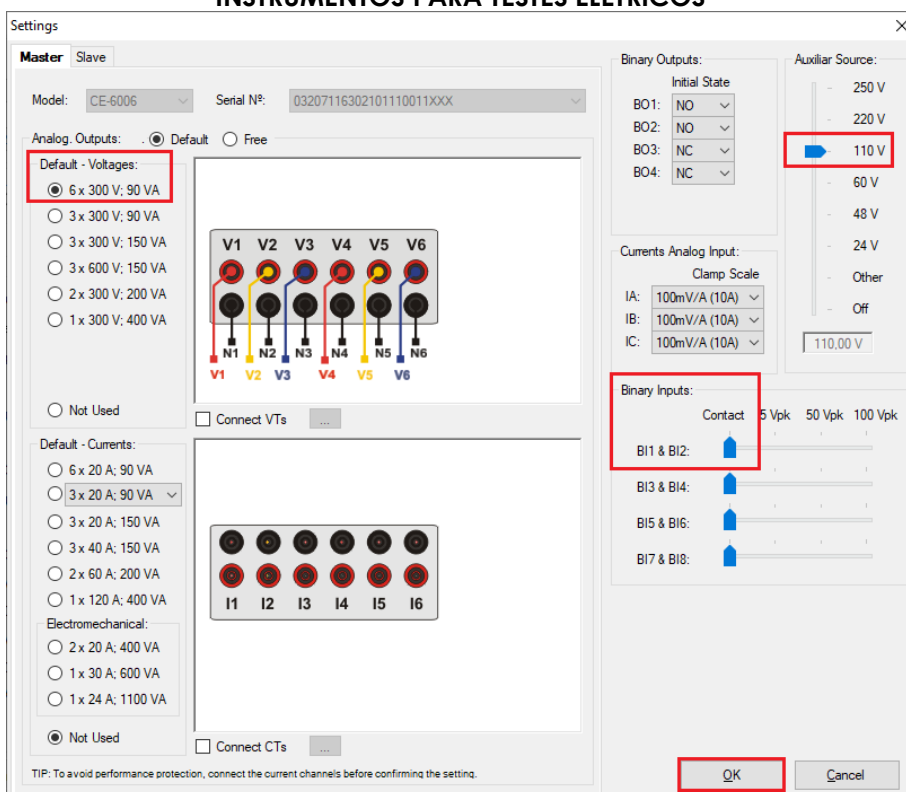


Figure 33

On the next screen choose “Basic” and on the next window (didn’t show) choose “YES”, finally click on “Confirm”.

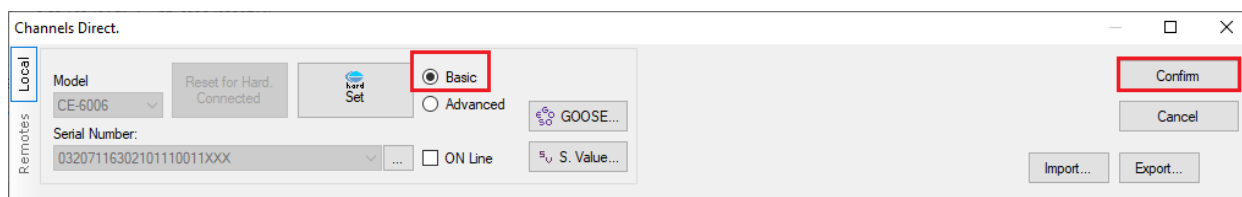


Figure 34

6. Synchronism Adjustments

6.1 Synchronism > Systems Screen

Click again on the “Settings” icon and then “Synchronism > Systems”. In this tab, the data of system 1 must be inserted, specifying its composition: Single-phase, Three-phase FN or Three-phase FF. The reference voltage must be adjusted, and depending on the case, it is necessary to compensate for the phase shift inserted by the transformer.

For system 2, it must be configured similarly to system 1 regarding its composition and reference voltage. In this same screen, the primary and secondary voltage values are adjusted, in addition to the primary and secondary currents. For the circuit breaker, the time value for its effective closing must be entered. There is also the

INSTRUMENTOS PARA TESTES ELÉTRICOS

“Equal Levels of System 1” field, which when selected, equals the voltages of system 2 to system 1.

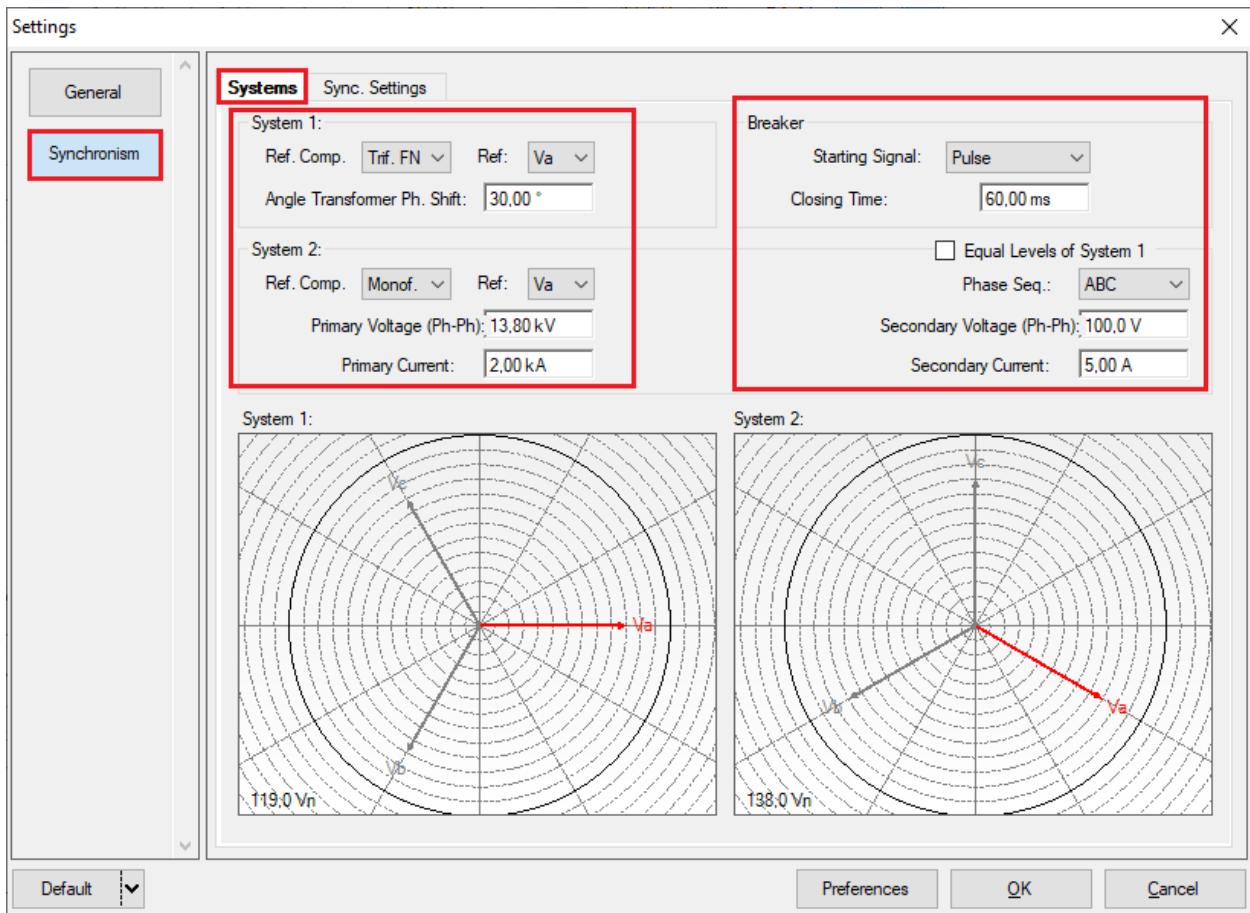


Figure 35

6.2 Synchronism > Sync. Settings

This screen stipulates the differences in voltage, frequency and the maximum tolerable angle for synchronism to occur. The maximum and minimum permitted voltage and frequency values are also adjusted so that synchronism occurs. These values are adjusted in percentage referring to the nominal values of the system 1. Also set the maximum time for synchronism to occur 13.0s and the relative and absolute tolerances for voltage, frequency, time and the absolute tolerance for the angle. Tolerances are adjusted according to the values in Appendix A.

INSTRUMENTOS PARA TESTES ELÉTRICOS

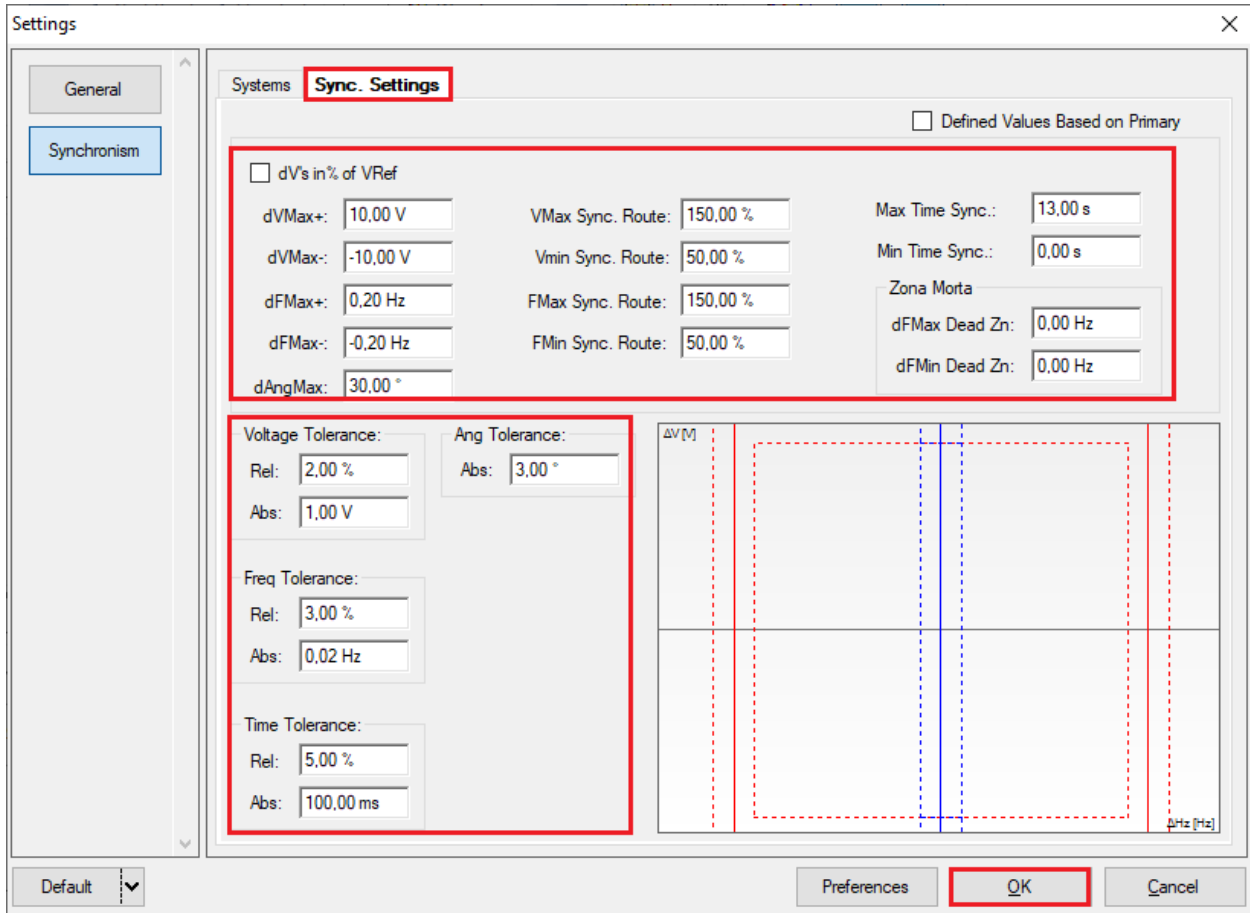


Figure 36

7. Test Settings

In the “*Test Settings*” tab, the correct direction of the voltage generation channels and the stopwatch interface must be done. The binary input responsible for the synchronism function is BI01.

INSTRUMENTOS PARA TESTES ELÉTRICOS

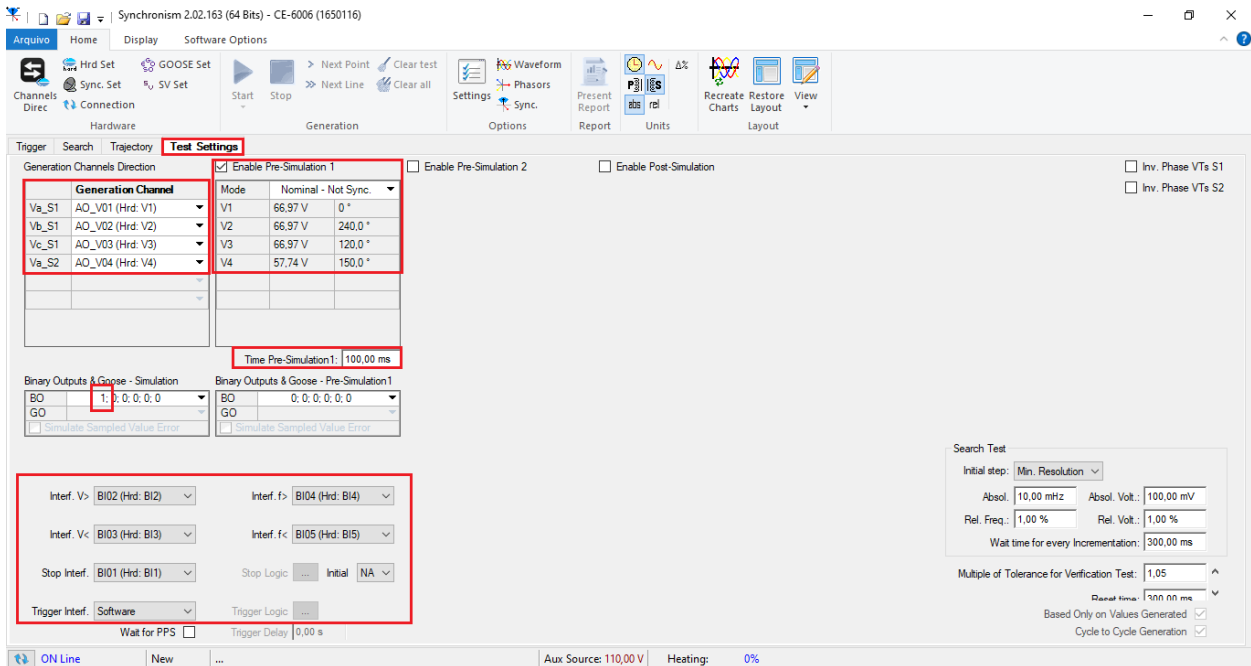


Figure 37

8. Trigger Test

In the trigger test, test points inside and outside the synchronism zone. Point's difference of two and frequency with respect to system 1. You can also specify an angle difference for the systems. To insert the points, click on "New Point" and choose a point directly on the graph and then on the item "Confirm". Another option is to choose voltage difference values, frequency and planning values in their respective fields. The last option would be to click on the "Sequence" option and choose an angle step so that multiple points are automatically created on the sync edges. The voltage and frequency nominal values of system 1 must be set. The figure below illustrates this situation.

INSTRUMENTOS PARA TESTES ELÉTRICOS

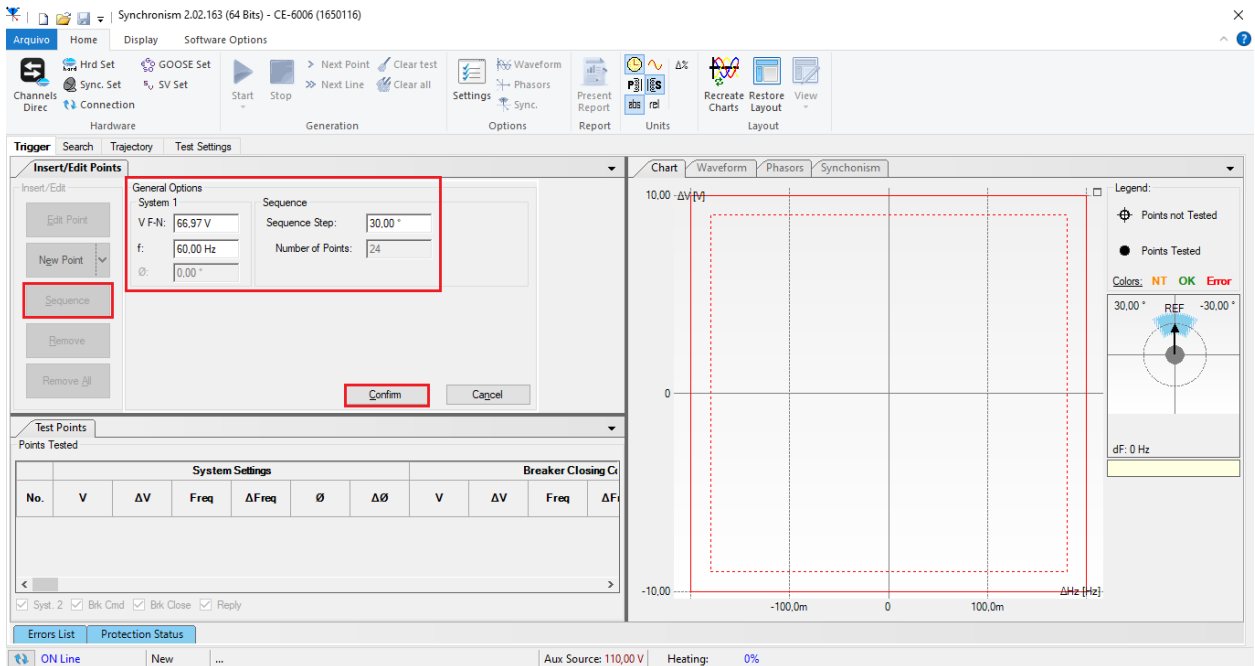


Figure 38

Choosing the sequence with a step of 30.00°, phase-to-neutral voltage of 66.97 volts, frequency of 60.00Hz and clicking on the “Confirm” button the following points are created:

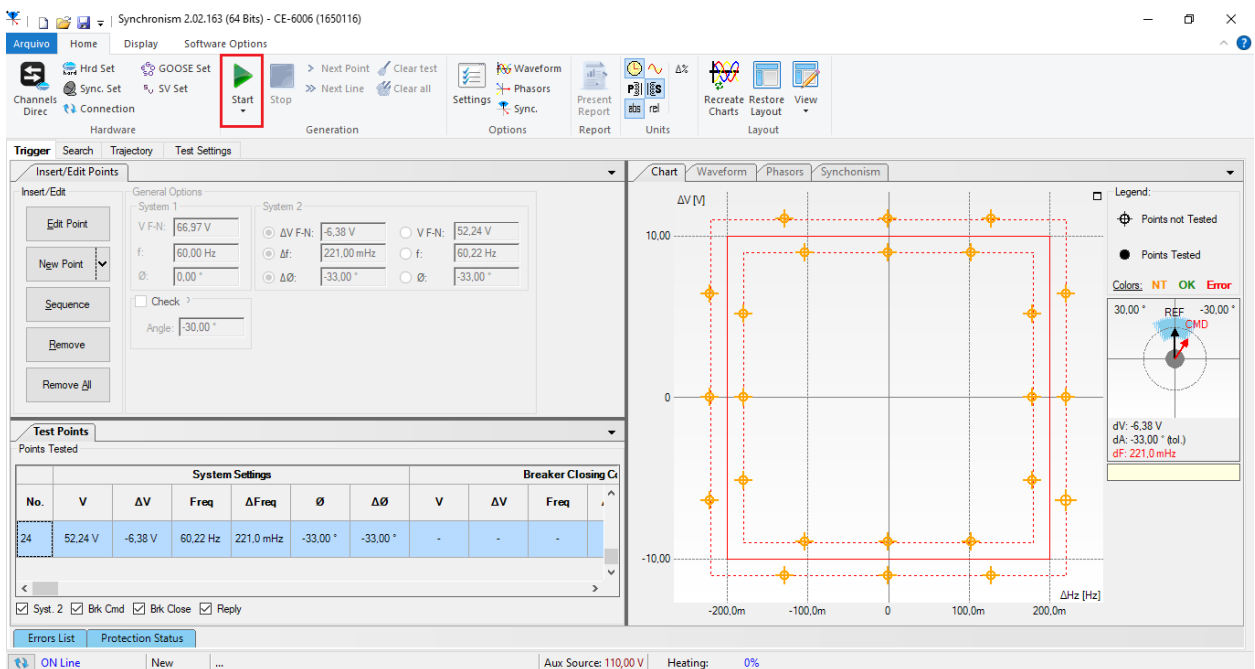


Figure 39

The next step is to start the generation through the “Start” button or the shortcut “Alt + G”. The figure below shows the final test result.

INSTRUMENTOS PARA TESTES ELÉTRICOS

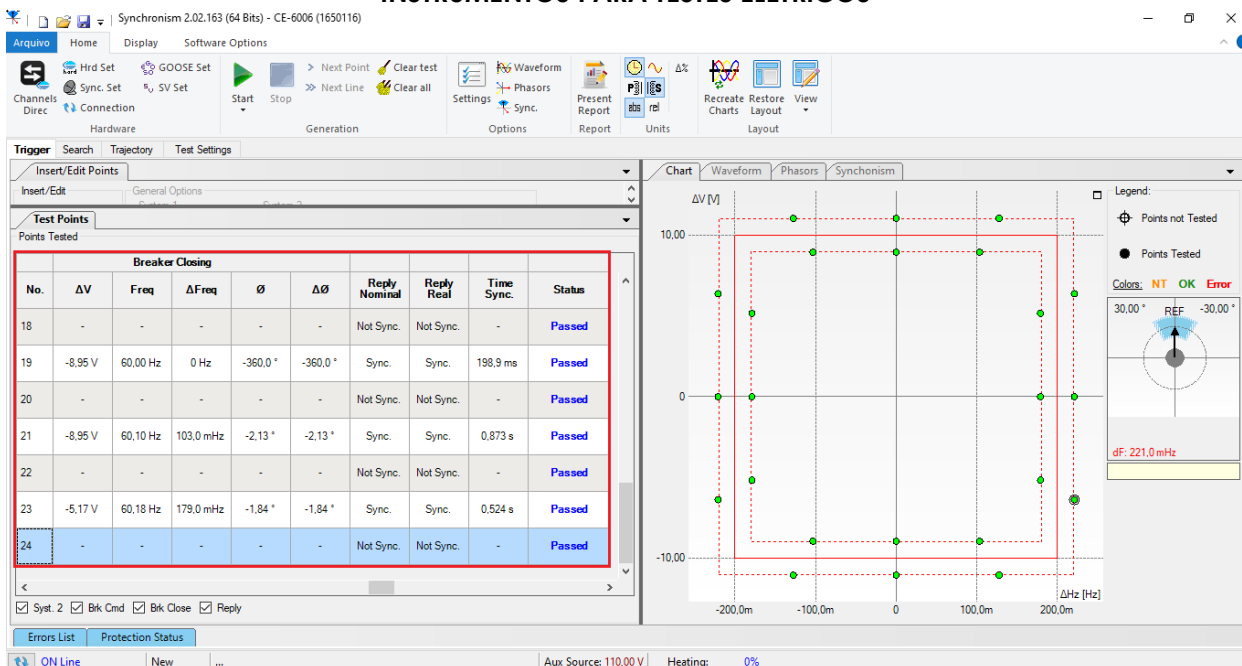


Figure 40

9. Search Test

The search test finds the limits of the sync region. For this test, the “Sequence” option is used with a step of 90° and the “Chk Sync after Search” option is enabled, with the “Start Ang Evaluation” being equal to 0°.

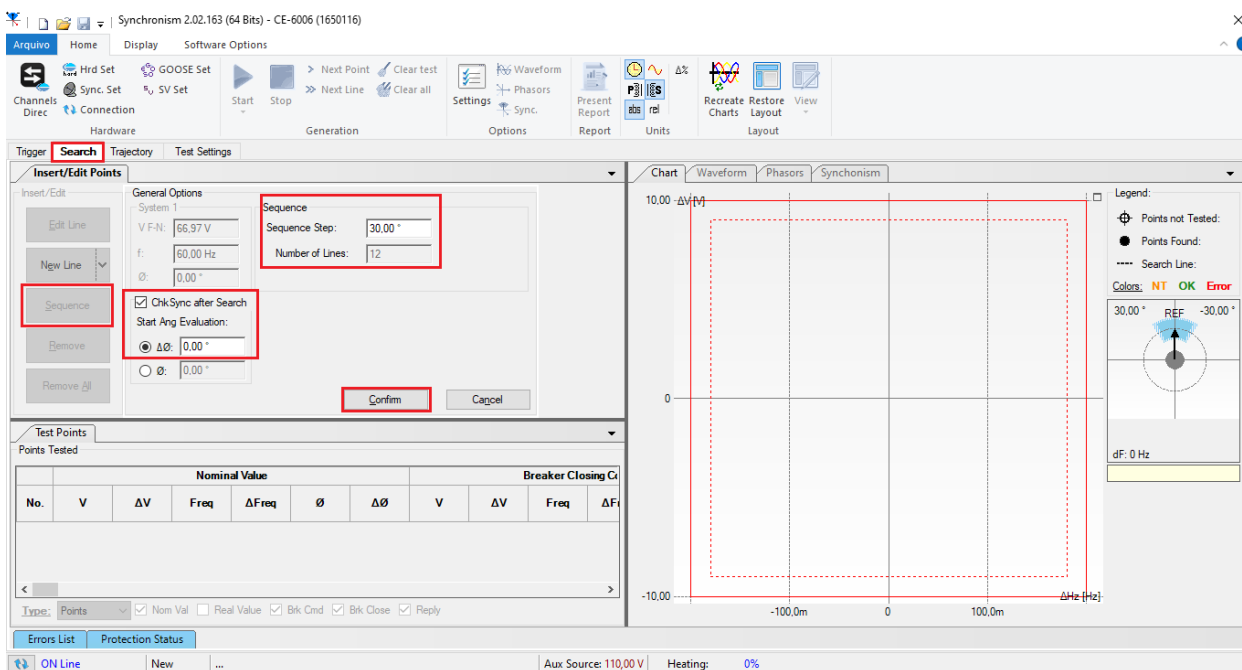


Figure 41

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Then click on the “Confirm” button, the following figure shows the lines created automatically:

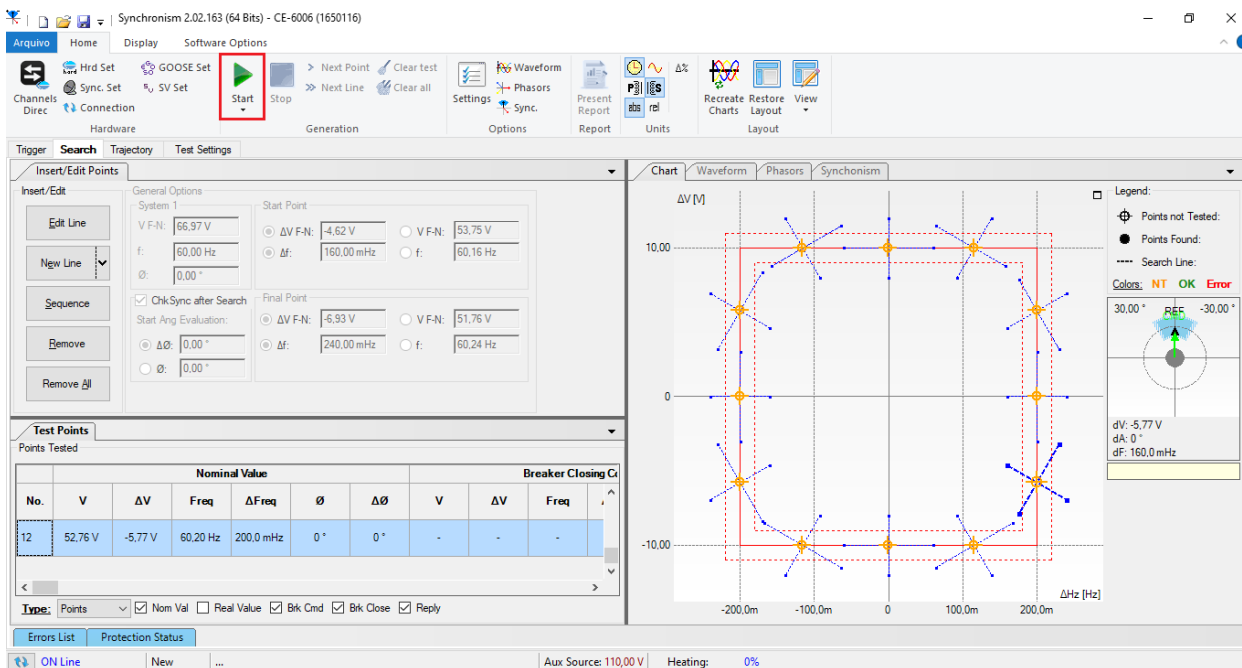


Figure 42

The next step is to start the generation through the “Start” button or the shortcut “Alt + G”. The figure below shows the final test result.

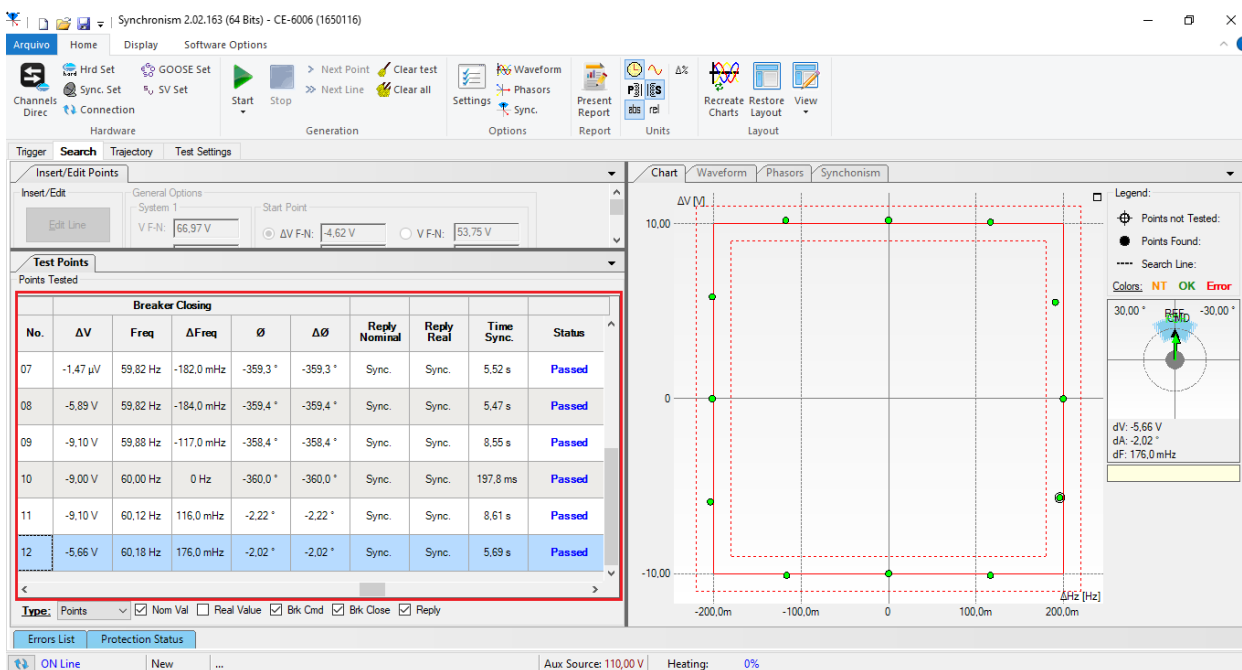


Figure 43

10. Trajectory Test

This test has the same objective as the “*Trigger Test*”, finding the moment of synchronism, however the big difference is that the voltage and current values of system 2 vary over time. Differently from what happens in the “*Trigger Test*” where these values are fixed. To perform the test, use the “*Sequence*” option with the step equal to 30.0° reaching the following screen.

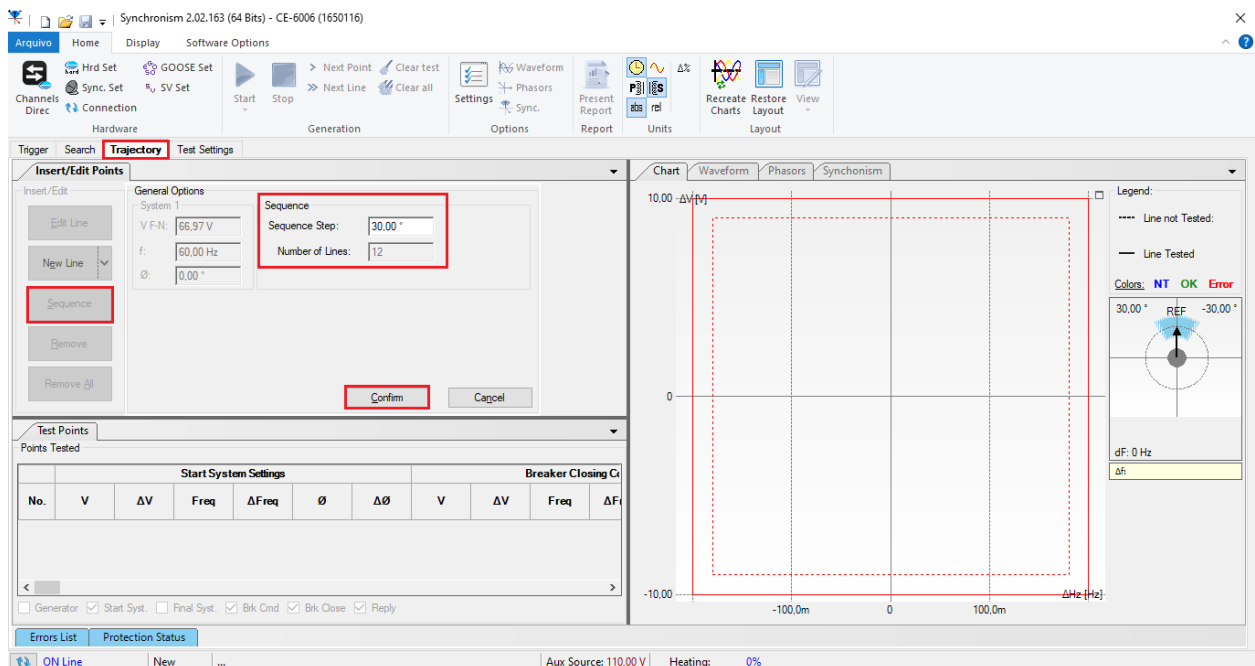


Figure 44

Clicking on the “*Confirm*” button automatically creates the lines shown below:

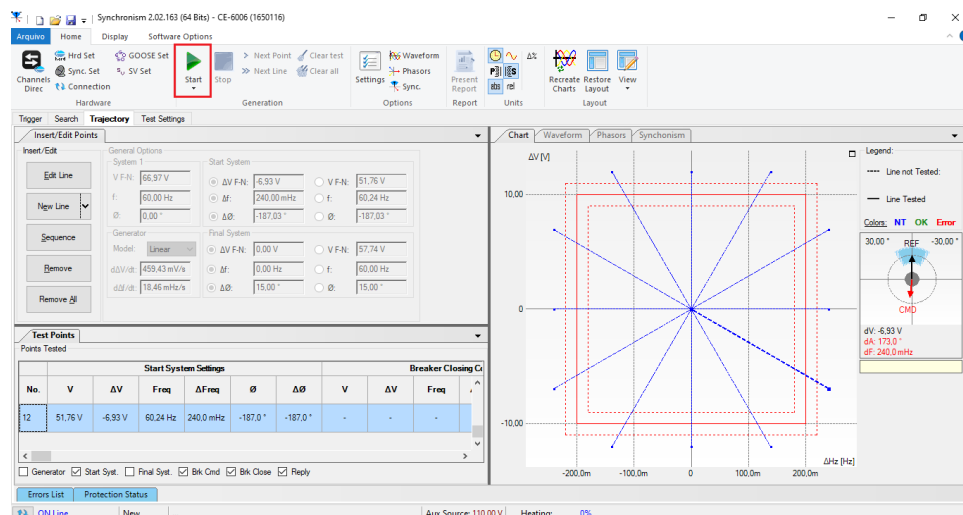


Figure 45

INSTRUMENTOS PARA TESTES ELÉTRICOS

The next step is to start the generation through the “Start” button or the shortcut “Alt + G”. The figure below shows the final test result.

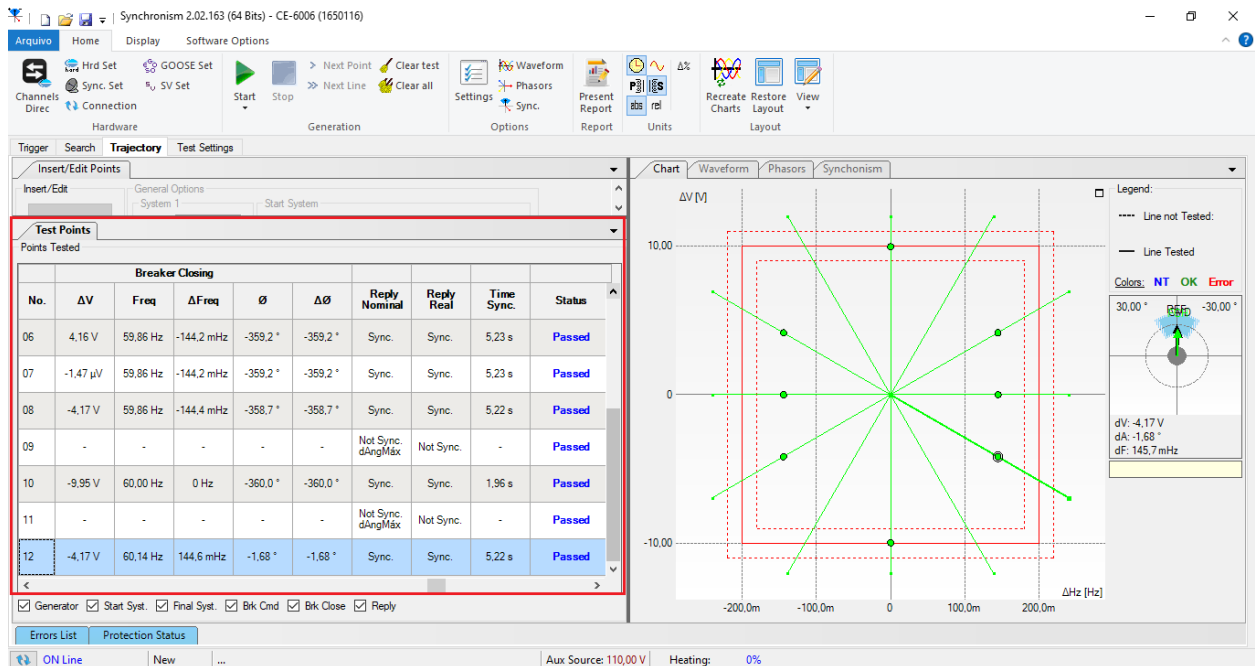


Figure 46

11. Report

After finishing the test, click on the “Present Report” icon 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.

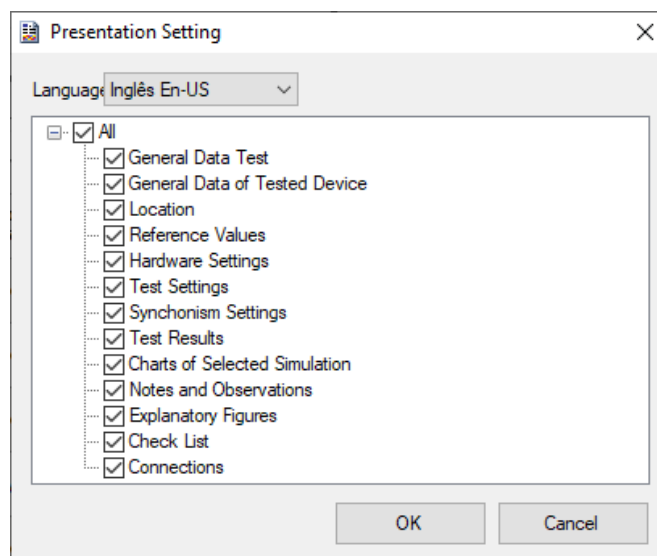


Figure 47

INSTRUMENTOS PARA TESTES ELÉTRICOS

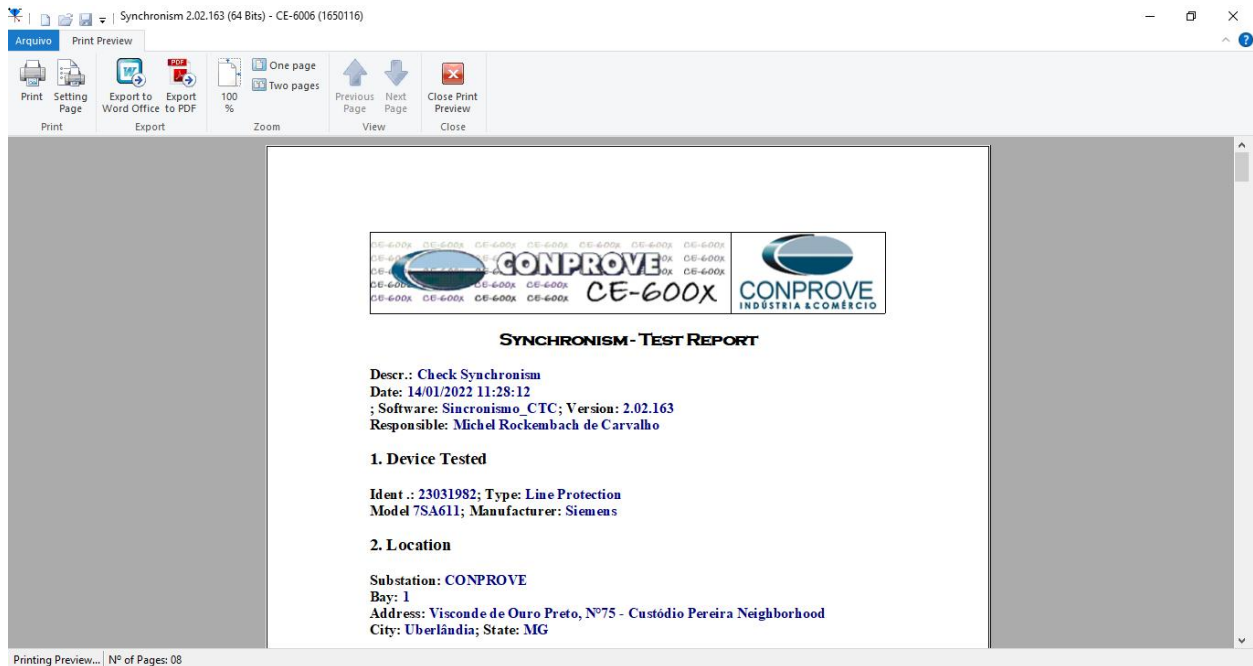
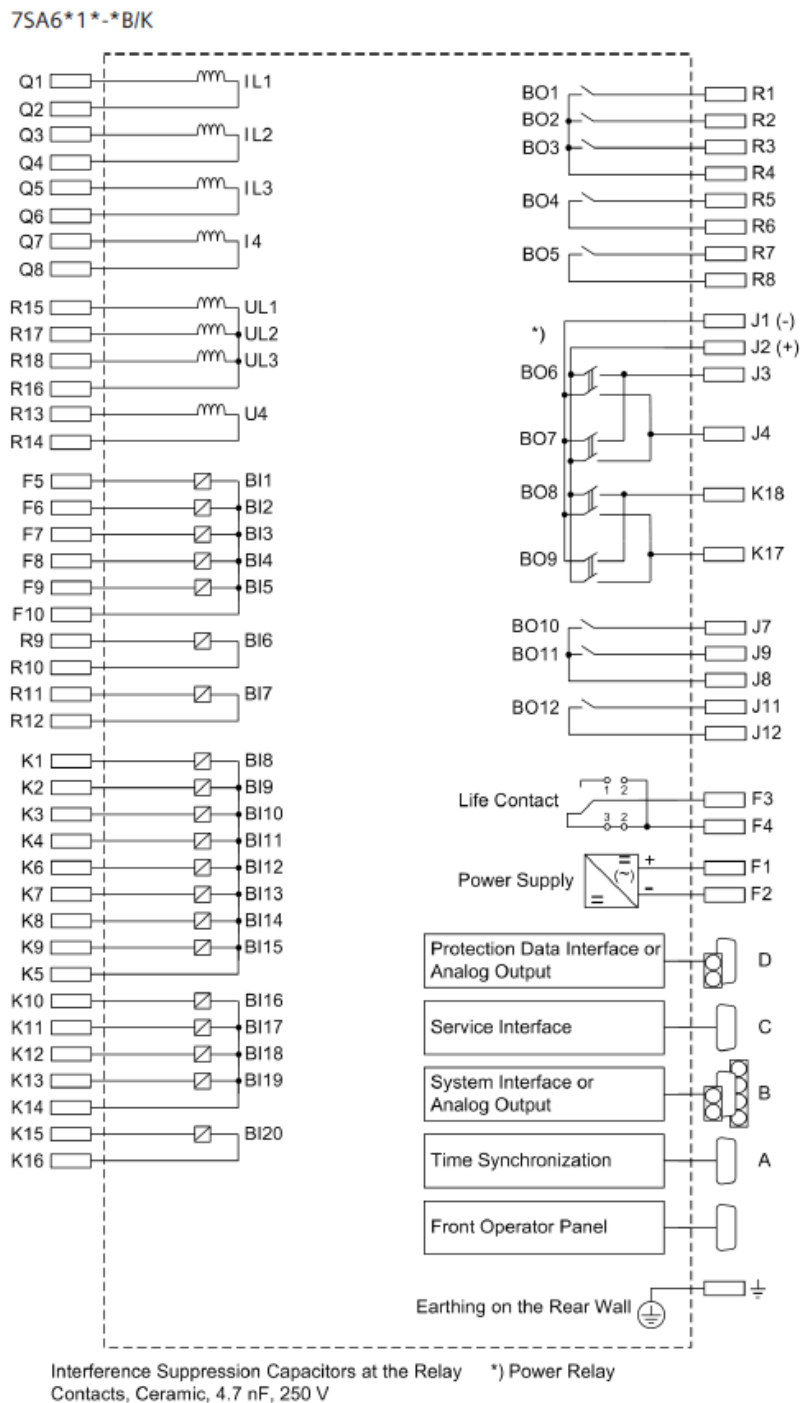


Figure 48

APPENDIX A

A.1 Terminal Designations



[schränkebau-7sa6-1-b-k-oz-050802, 1, en_G8]

Figure B-4 General diagram for 7SA6*1*-*B/K (panel flush mounting or cubicle mounting)

Figure 49

A.2 Technical Data

Voltages

Maximum operating voltage	20 V to 140 V (phase-to-phase)	Increments 1 V
U< for dead status	1 V to 60 V (phase-to-phase)	Increments 1 V
U> for voltage present	20 V to 125 V (phase-to-phase)	Increments 1 V
Tolerances	2 % of the pickup value or 1 V	
Dropout to pickup ratio	approx. 0.9 (U>) or 1.1 (U<)	

ΔU measurement

Voltage difference	1.0 V to 60.0 V (phase-to-phase)	Increments 0,1 V
Tolerance	1 V	
Dropout to pickup ratio	Approx. 1,05	

Synchronous power conditions

$\Delta\phi$ measurement	2° to 80°	Increments 1°
Tolerance	2°	
Δf measurement	0.03 Hz to 2.00 Hz	Increments 0,01 Hz
Tolerance	15 mHz	
Enable delay	0,00 s to 30,00 s	Increments 0.01 s

APPENDIX B

Equivalence of software parameters and the relay under test.

Table 1

Synchronism Software		Siemens 7SA6 Relay	
Parameter	Figure	Parameter	Figure
System 1		Power System Data 1	
Secondary Voltage (F-F)	30	Rated Secondary Voltage (Ph-Ph)	14
Ref	35	VT connection for Vsy2	14
Angle Transformer Ph. Shift	35	Angle adjustment Vsy2 – Vsy1	14
System 2		Power System Data 1	
Secondary Voltage (Ph-Ph)	35	[Rated Secondary Voltage (Ph-Ph)] / [Matching ratio Vsy1/Vsy2]	14
Ref	35	VT connection for Vsy2	14
Closing Time	35	Closing (operating) time of 52	16
dVMax+	36	Maximum voltage difference	24
dVMax-	36	Maximum voltage difference (negative signal)	24
dFMax+	36	Maximum frequency difference	24
dFMax-	36	Maximum frequency difference (negative signal)	24
dAngMax	36	Maximum angle difference	24
Max Time Sync	36	Maximum duration of Synchronism-check	23