Test Tutorial

Equipment Type: Protection Relay

Brand: SIEMENS

Model: 7SA86

Function: 25 or RSYN – Synchronism

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

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

Version Control:

Version	Descriptions	Date	Author	Reviewer
1.0	Initial Version	28/09/2021	M.R.C.	M.P.S

Summary

Rua Visconde de Ouro Preto, 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202.
Fone (34) 3218-6800 Fax (34) 3218-6810
Home Page: www.conprove.com.br - E-mail: conprove@conprove.com.br

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

Sequence for testing the 7SA86 relay in the Synchronism software

1. Relay connection to CE-6006

Appendix A shows the relay terminal designations.

1.1 *Auxiliary Source*

Connect the positive (red terminal) of the Vdc Aux. Source to pin B1 in *"slot 2B"* of the relay and the negative (black terminal) of the Vdc Aux. Source to pin B2 of *"slot 2B"*.

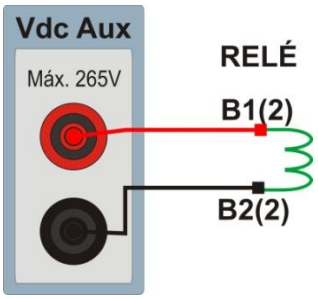


Figura 1

1.2 *Voltage Coils*

Connect the V1, V2, V3 and V4 voltage channels to pins B1, B3, B5 and B7 in *"slot 1B"* of the relay, then the four common voltage channels to pins B2, B4, B6 and B8 of the relay.

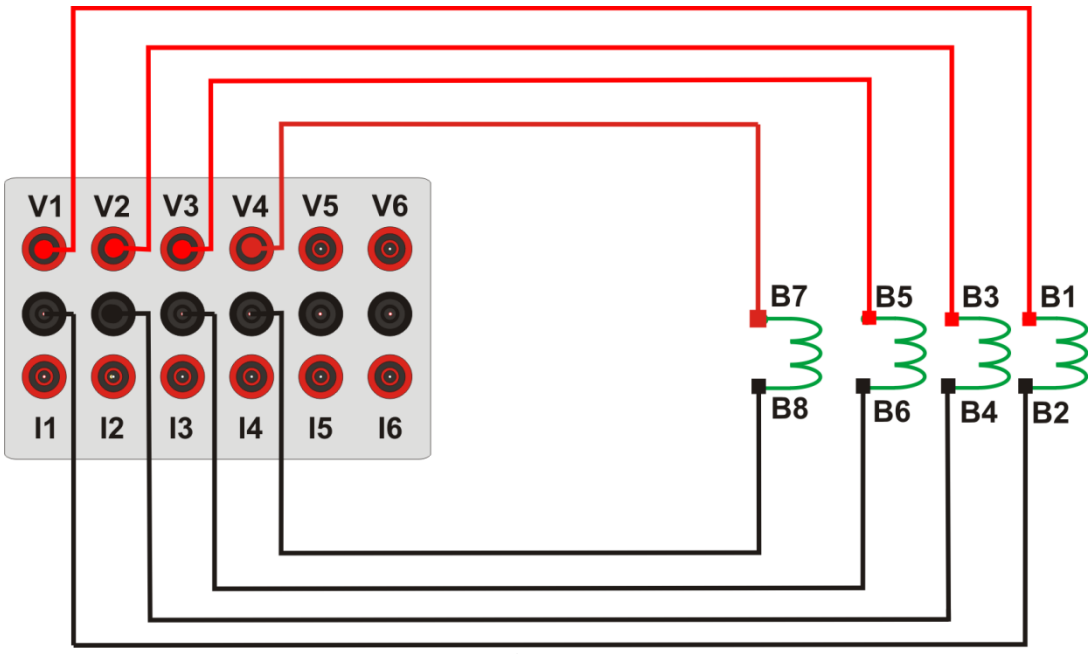


Figure 2

1.3 *Binary Inputs*

Connect the CE-6006 binary inputs to the binary outputs in *"slots 1B and 1C"* of the relay terminal.

- BI1 to pin B09 and its common to pin B10;
- BI2 to pin B11 and its common to pin B12.

The following figure shows the details of these connections.

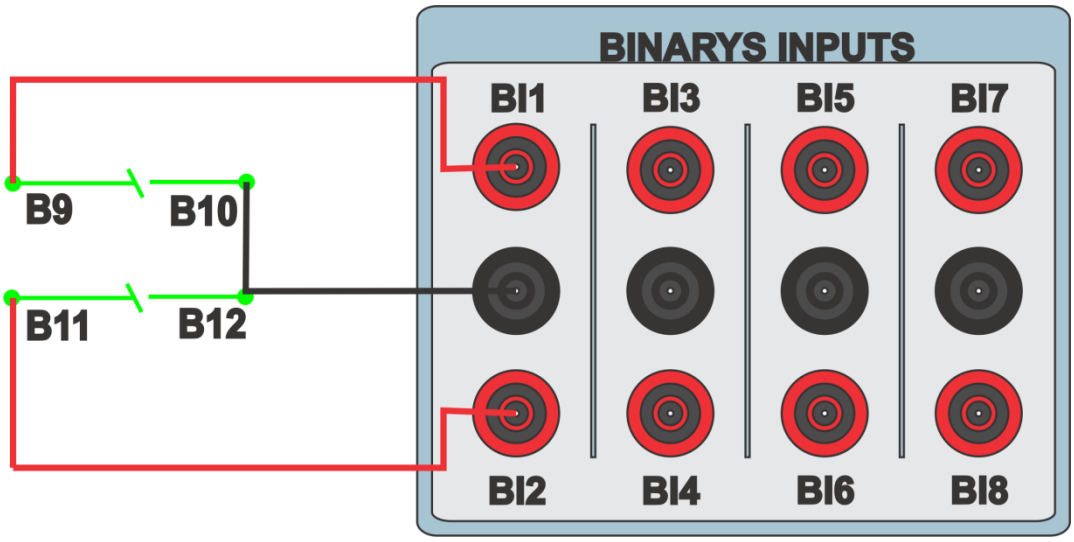


Figure 3

1.4 *Binary Outputs*

Connect the CE-6006 binary output to the auxiliary power supply red terminal. Connect auxiliary source common to relay pin D1. Finally connect the binary output common to pin C13 of the relay.

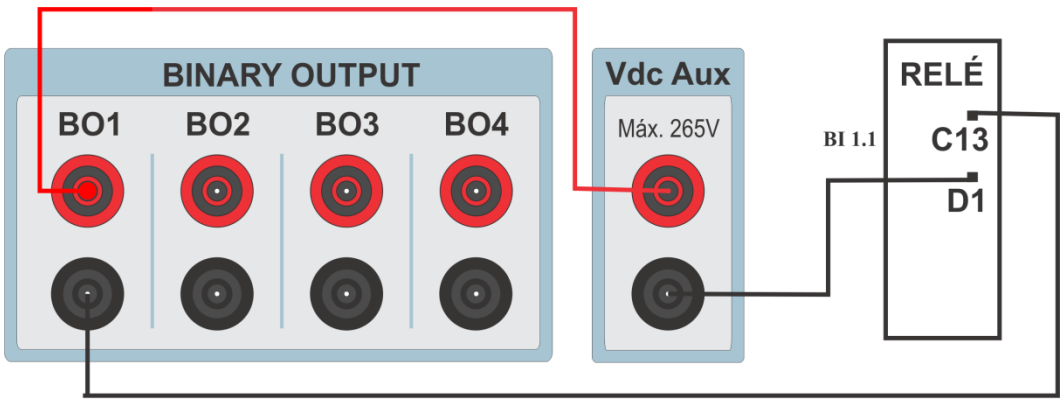


Figure 4

2. Communication with 7SA86 relay

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

Figure 5

When opening the program, click on the *"Project"* option and choose the *"New"* option.

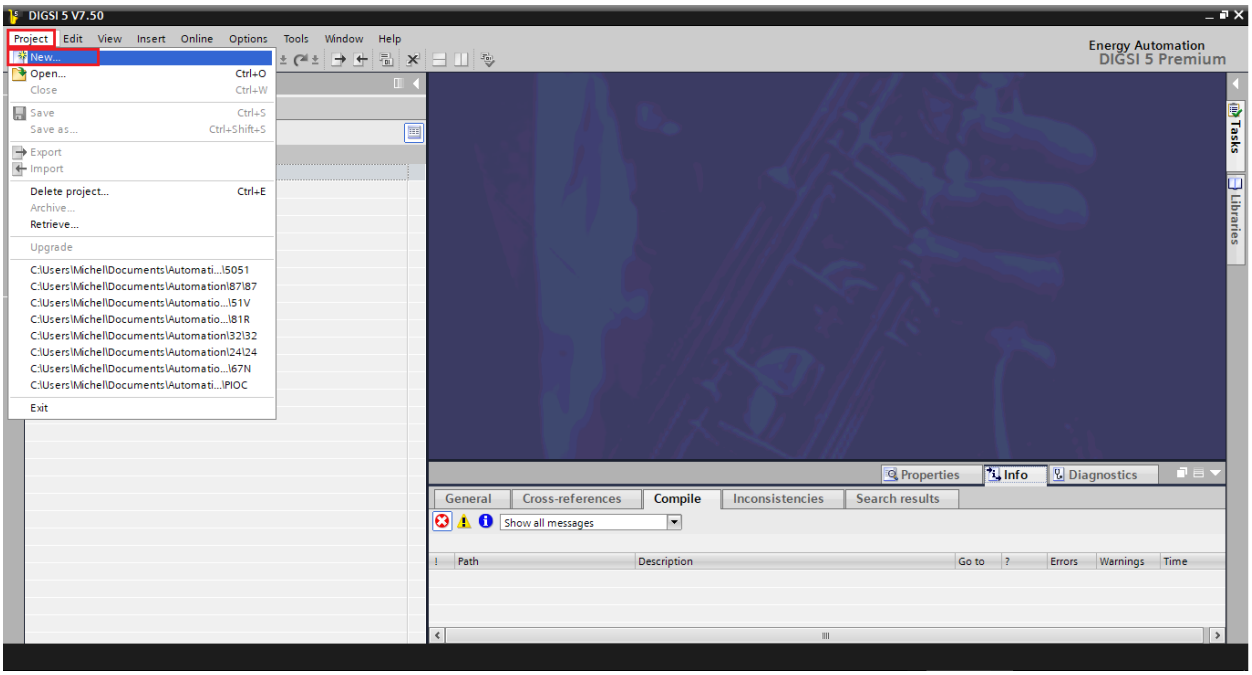


Figure 6

Enter a name for the project and then click *"Create"*, as highlighted below.

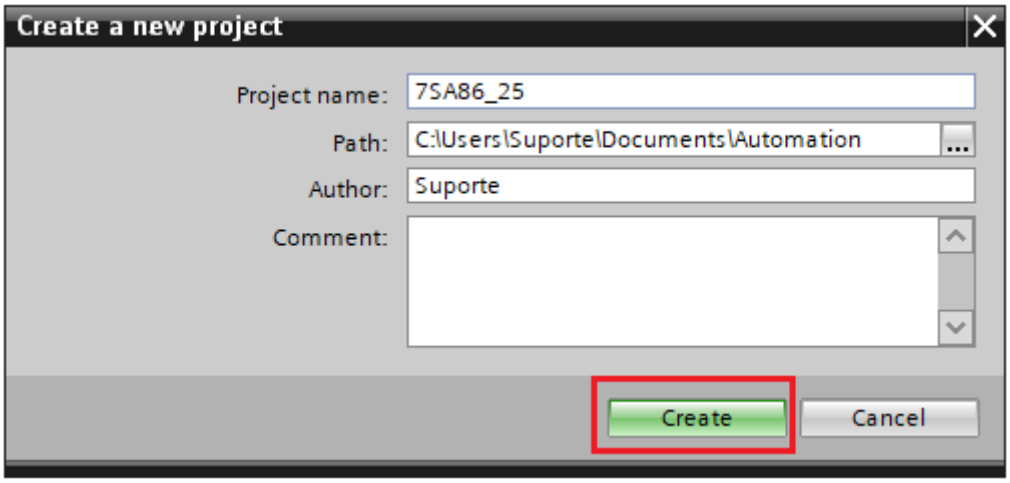


Figure 7

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

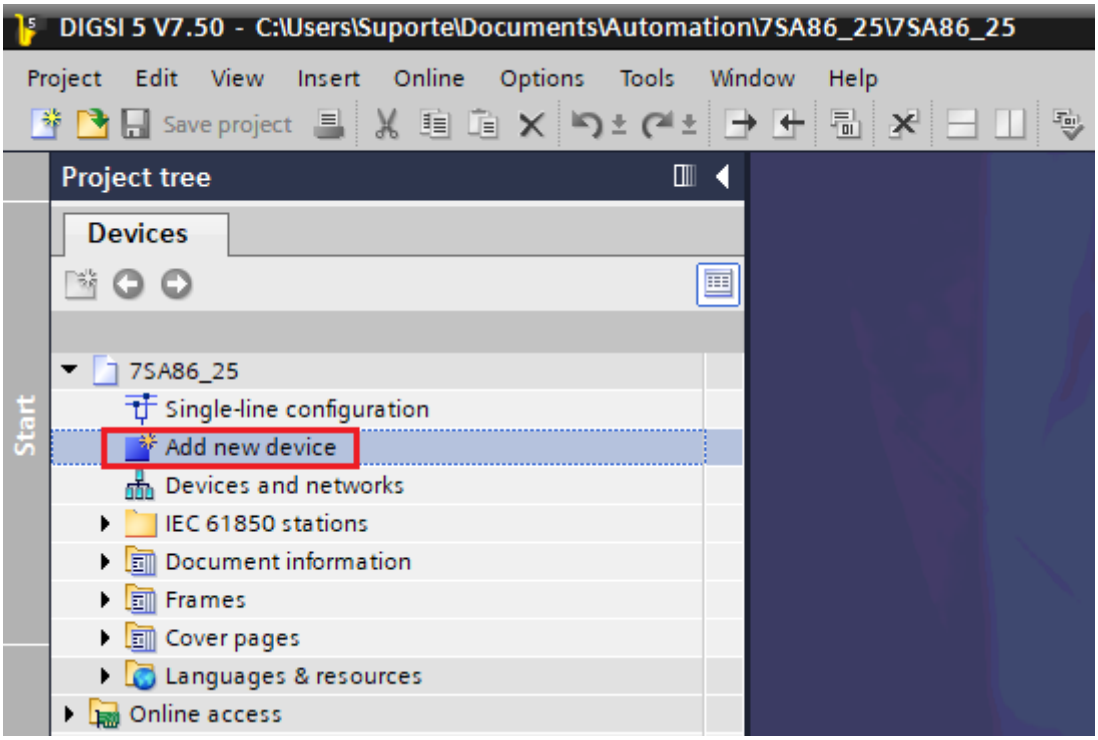


Figure 8

Enter the relay short code located on its side, then click *"Verify"* as highlighted below.

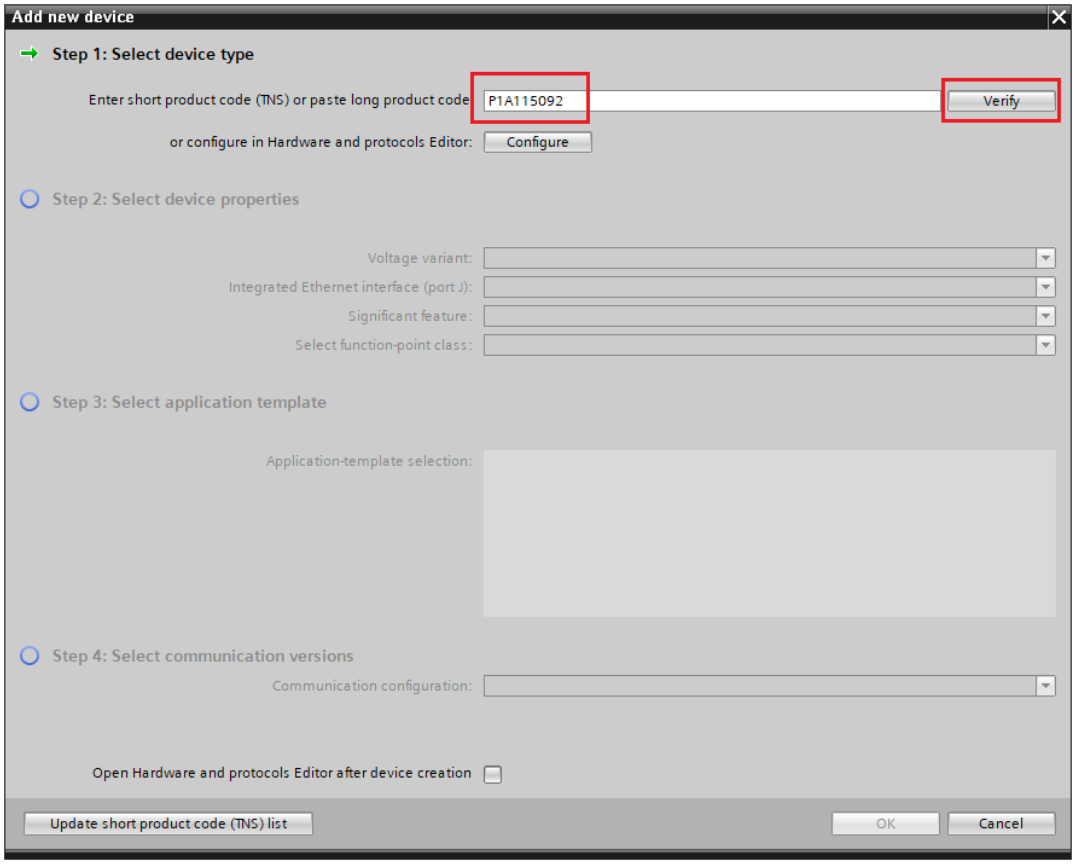


Figure 9

Select the highlighted *"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"*.

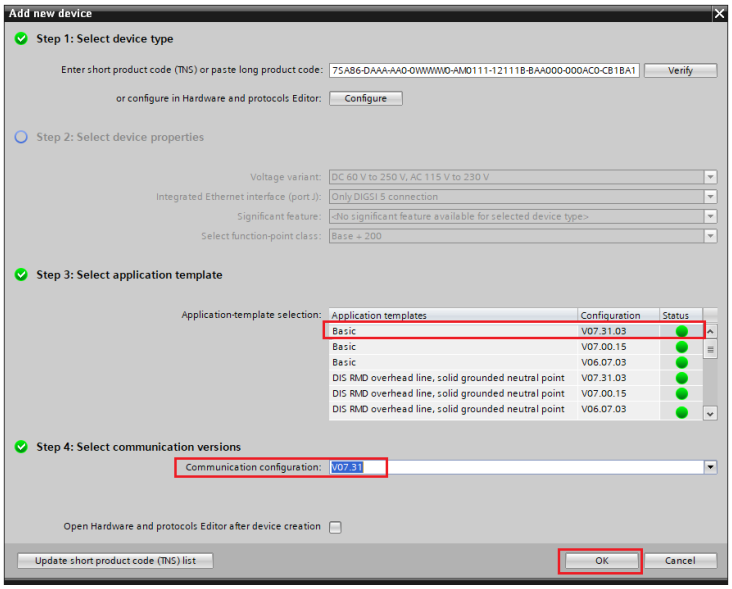


Figure 10

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"*.

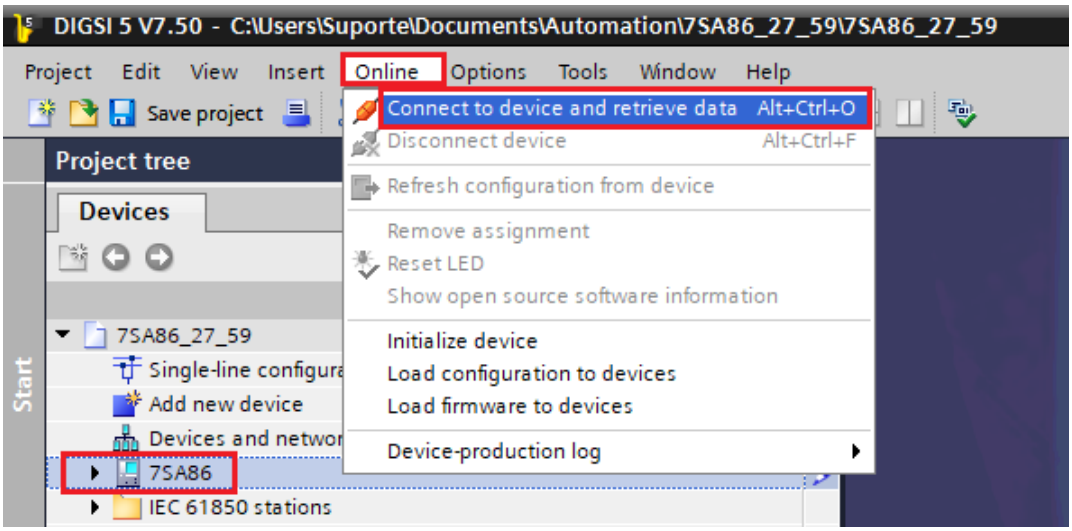


Figure 11

After establishing communication with the relay, it is necessary to read the parameterized configurations. Right-click on the relay icon (highlighted in green in the previous figure) and choose the option *"Update configuration from target device"*.

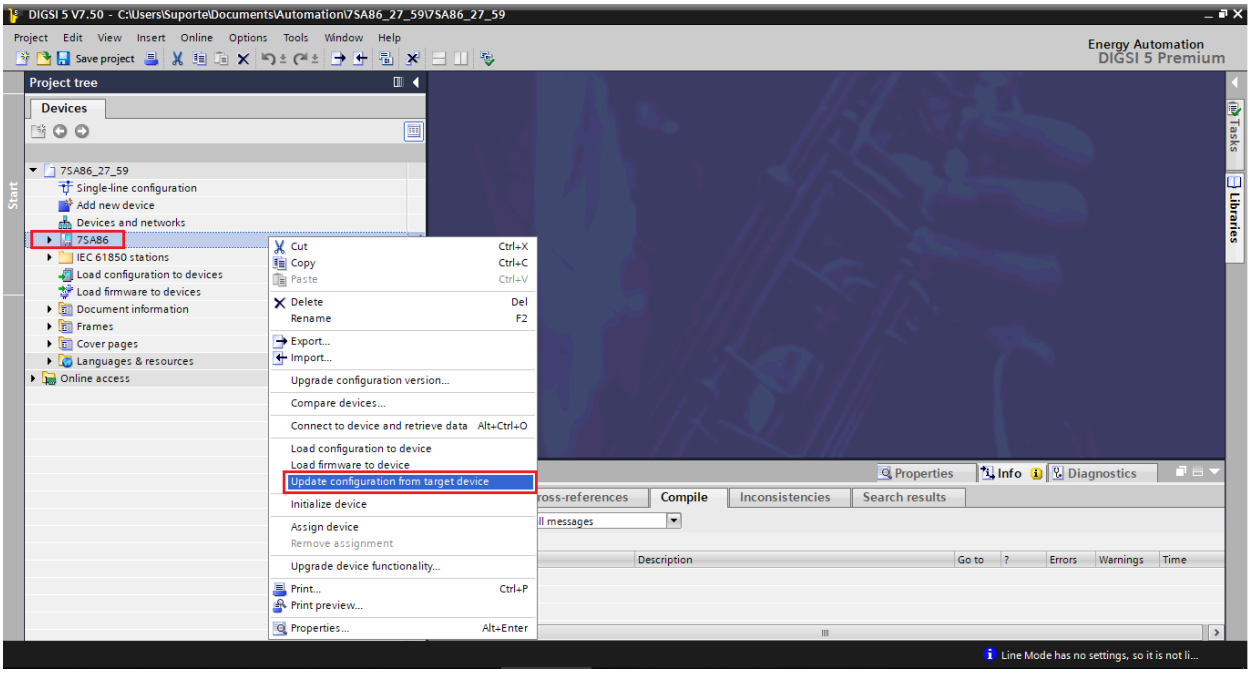


Figure 12

Click *"Yes"* for the following message:

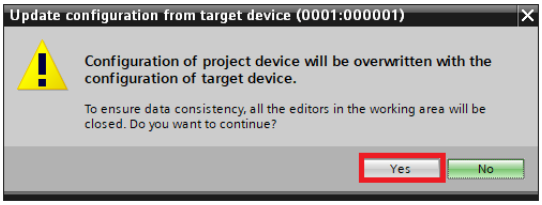


Figure 13

There will be other warning messages (didn't shown), click *"Yes"* on all. If the procedure is carried out properly, the following screen appears.

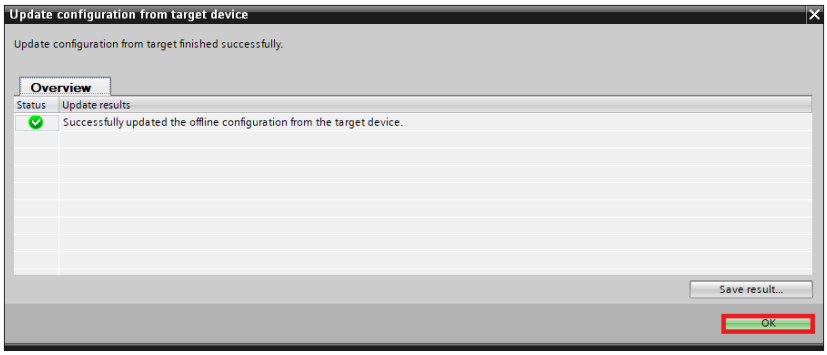


Figure 14

Export the created file in .dex5 format in order to have a backup of the settings. Right-click on the relay icon and choose the *"Export..."* option.

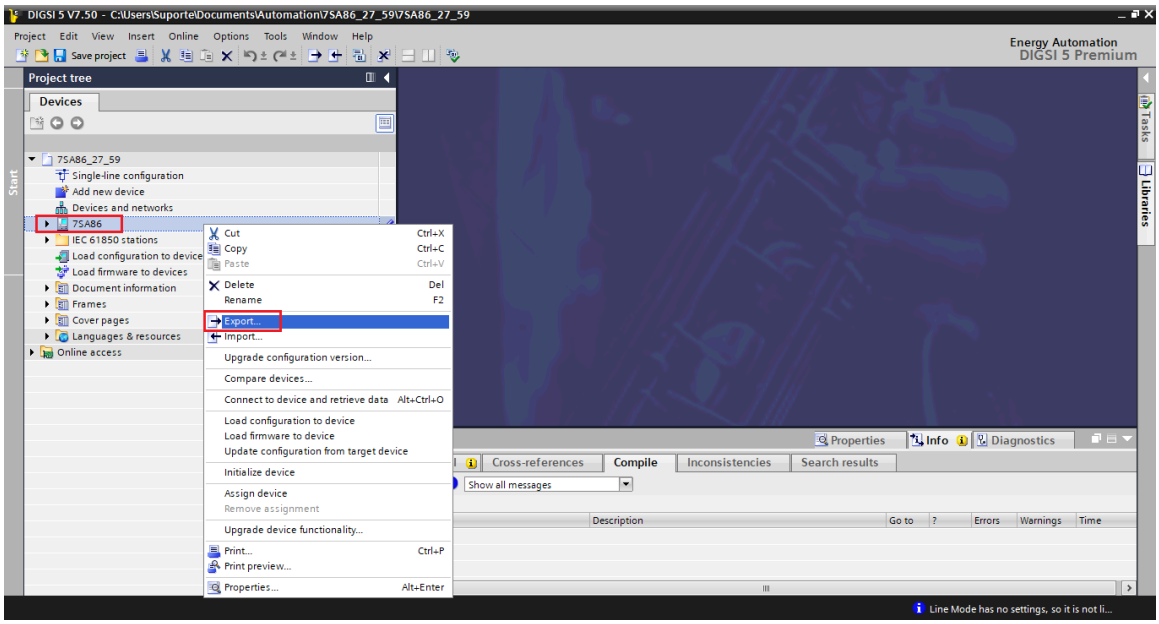


Figure 15

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

3. Parameterization of the 7SA86 relay

3.1 *Measuring-points routing*

After the connection has been established, open the device section *"7SA86"*. Then choose the *"Measuring-points routing"* option. Under *"Voltage-measuring points"* change the *"Connection type"* field to the *"3 ph-to-gnd voltages"* option.

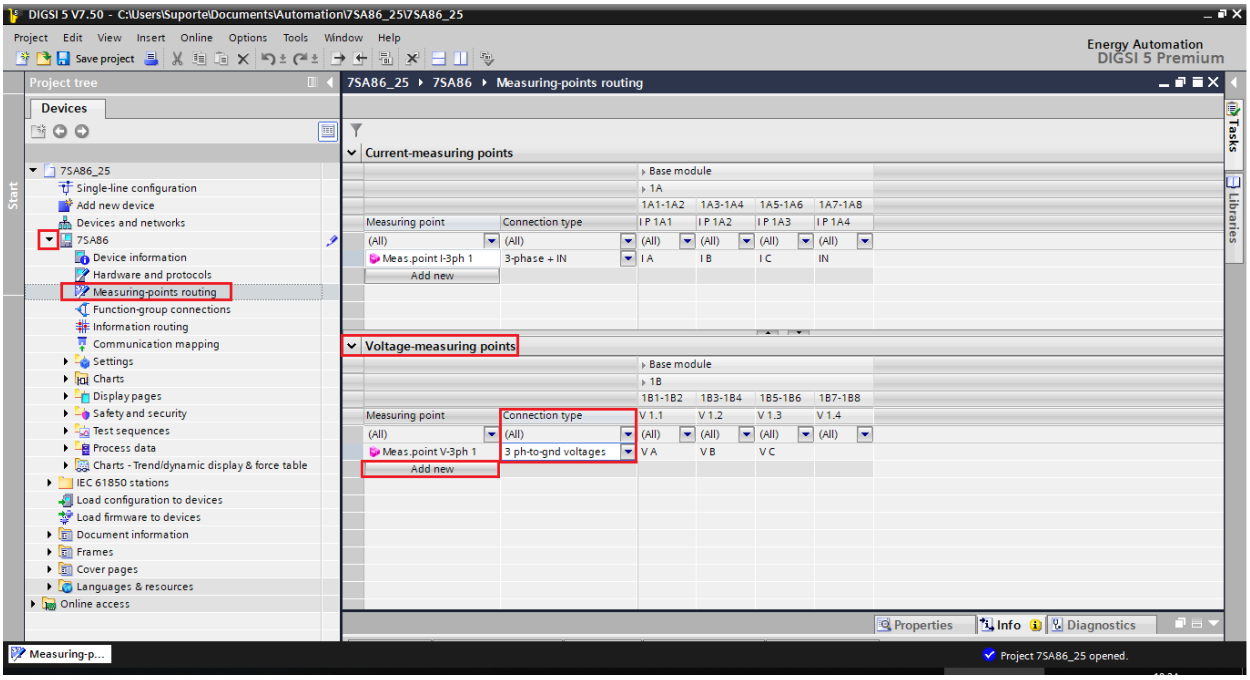


Figure 16

Click on the *"Add new"* button to add the fourth voltage channel choosing the *"Type"* as *"1-phase"*.

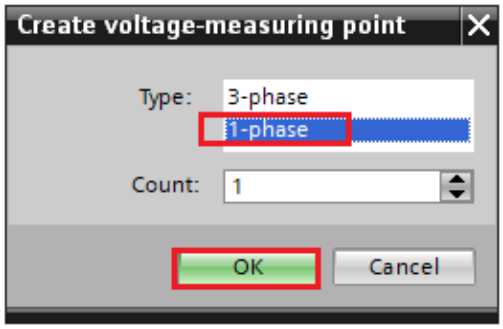


Figure 17

Set the voltage that will be used for synchronism, *"VA"* in this case.

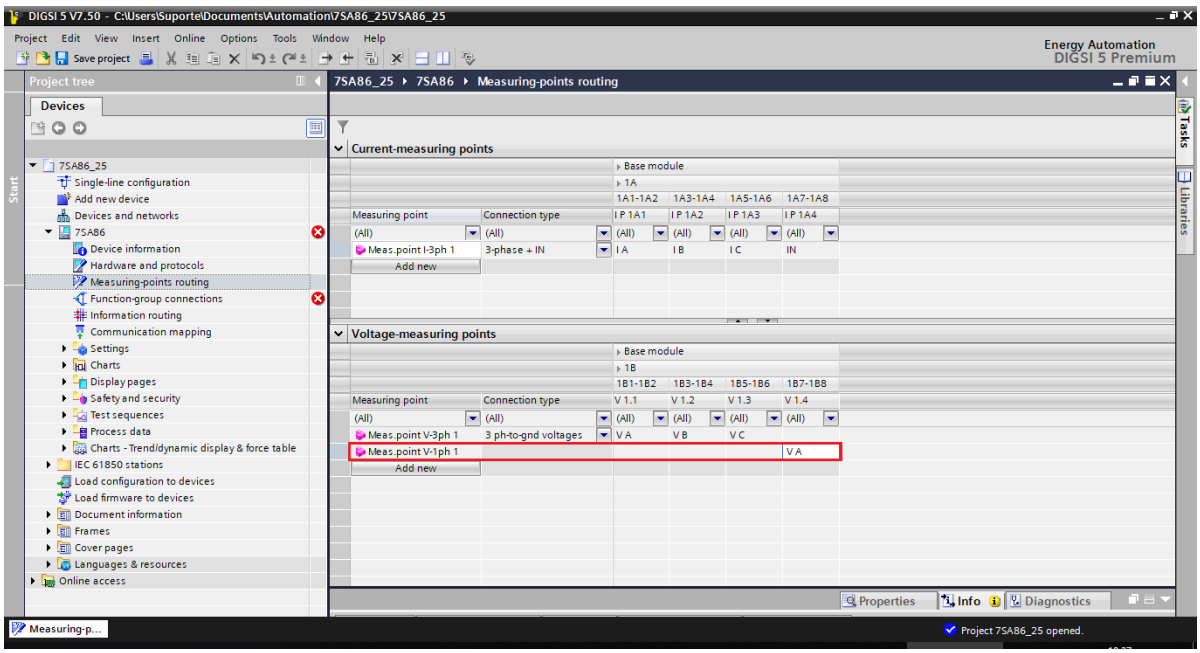


Figure 18

3.2 *Function-group connections*

Choose the option *"Function-group connections"* and configure who is system 1 and system 2 used for synchronism.

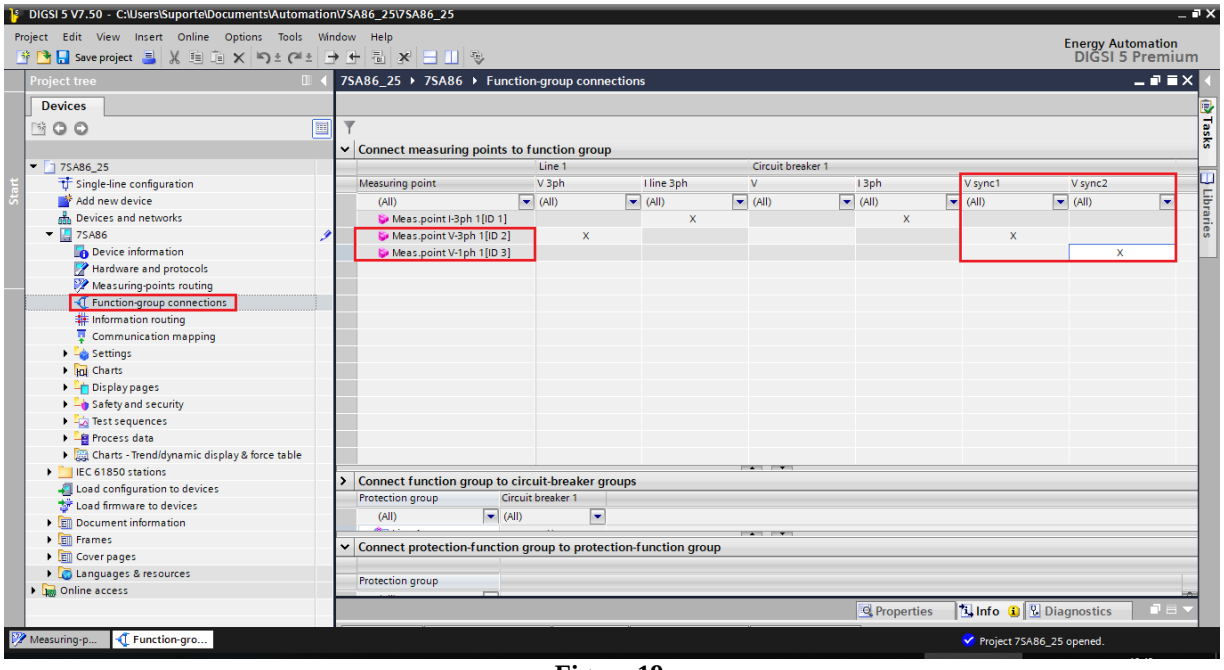


Figure 19

3.3 *Device Settings*

After the connection has been established, open the device section *"7SA86"*. Then open the *"Settings"* section, finally choose the *"Device Settings"* option. Check that group 1 is active, that the nominal frequency is 60Hz and that the minimum operating time is zero seconds.

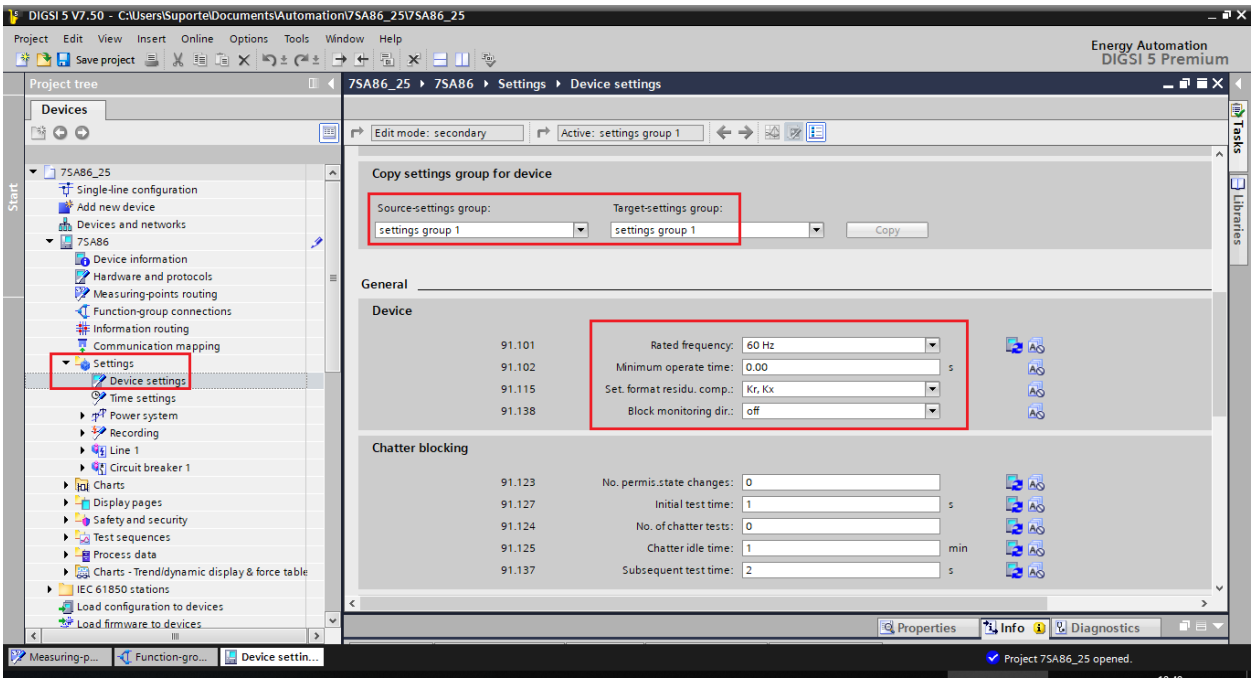


Figure 20

3.4 *Power System - General*

Open the *"Power System"* section and select the *"General"* option. Check the parameterized phase sequence.

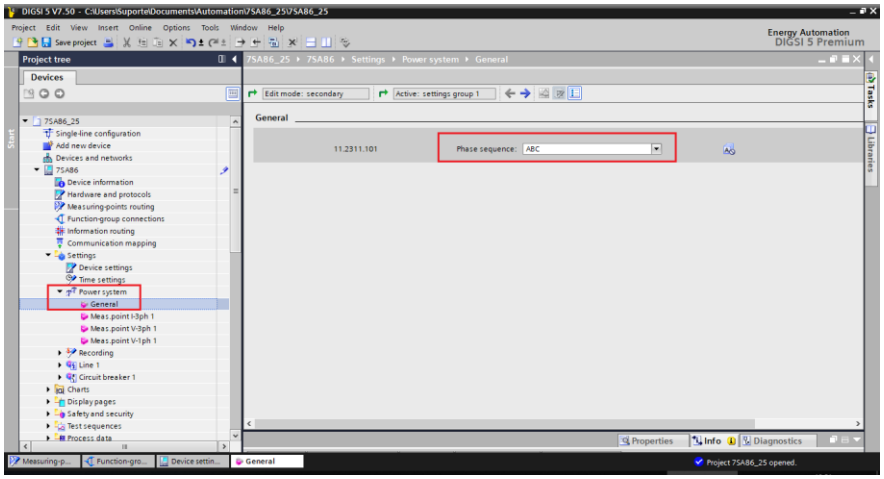


Figure 21

3.5 *Meas. Point V-3ph 1*

Select the option *"Meas. Point V-3ph 1"*. Adjust the values of primary, secondary voltages and magnitude compensation factor for the first winding and disable the supervision functions. Click on the *"Info"* tab to hide it and enlarge the settings window.

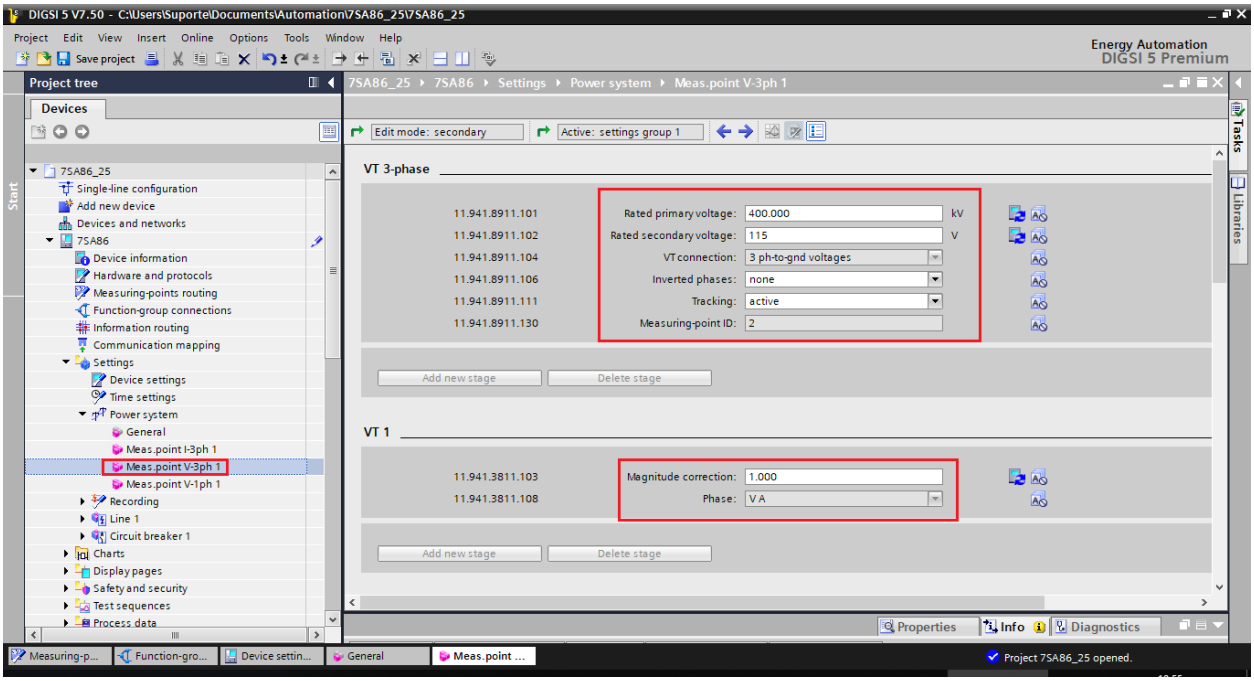


Figure 22

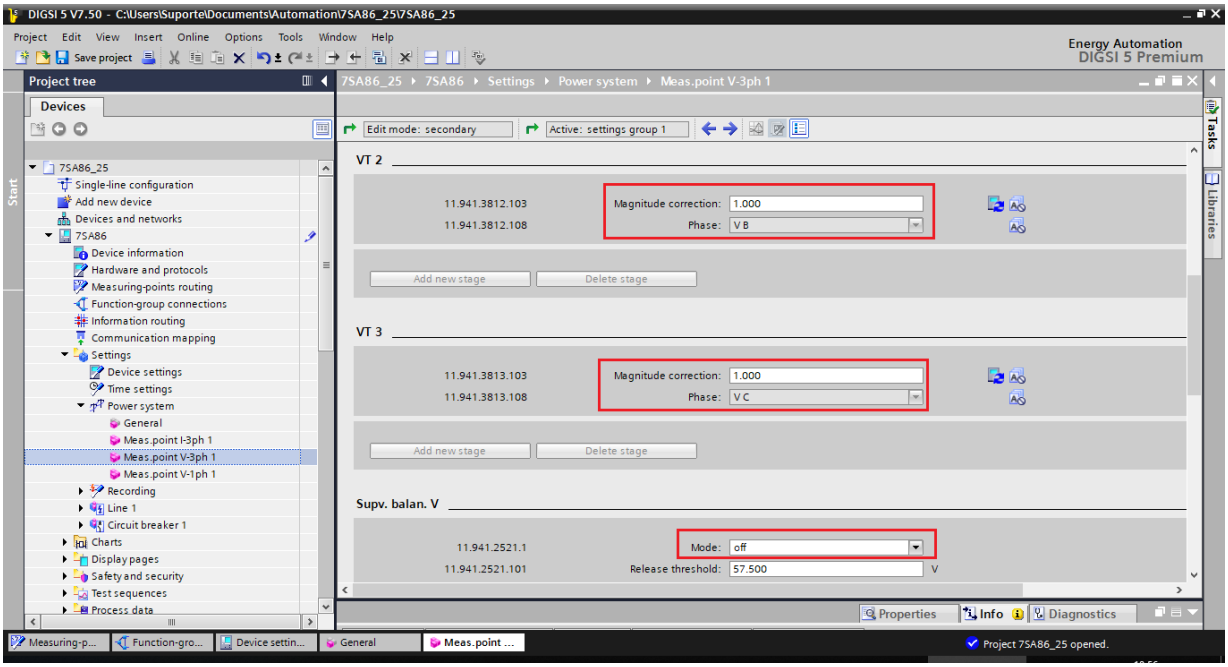


Figure 23

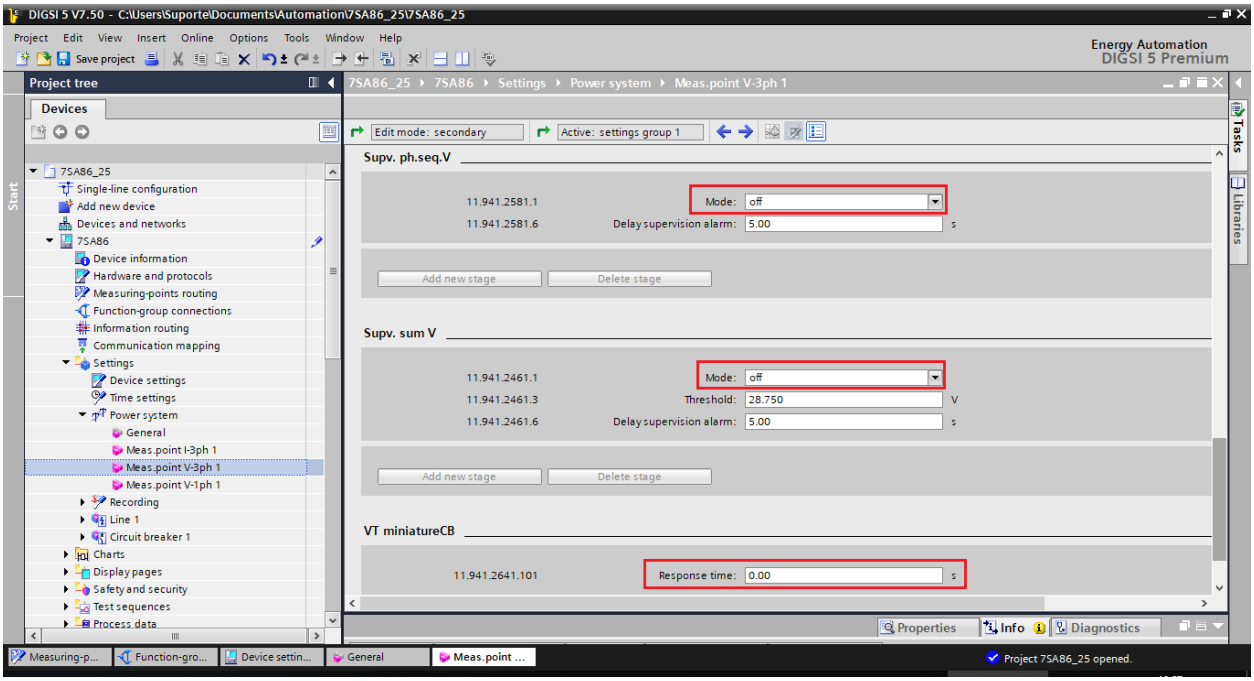


Figure 24

3.6 *Meas. Point V-3ph 1*

Select the option *"Meas. Point V-1ph 1"*. Adjust the primary, secondary voltage values and magnitude compensation factor for the fourth voltage input.

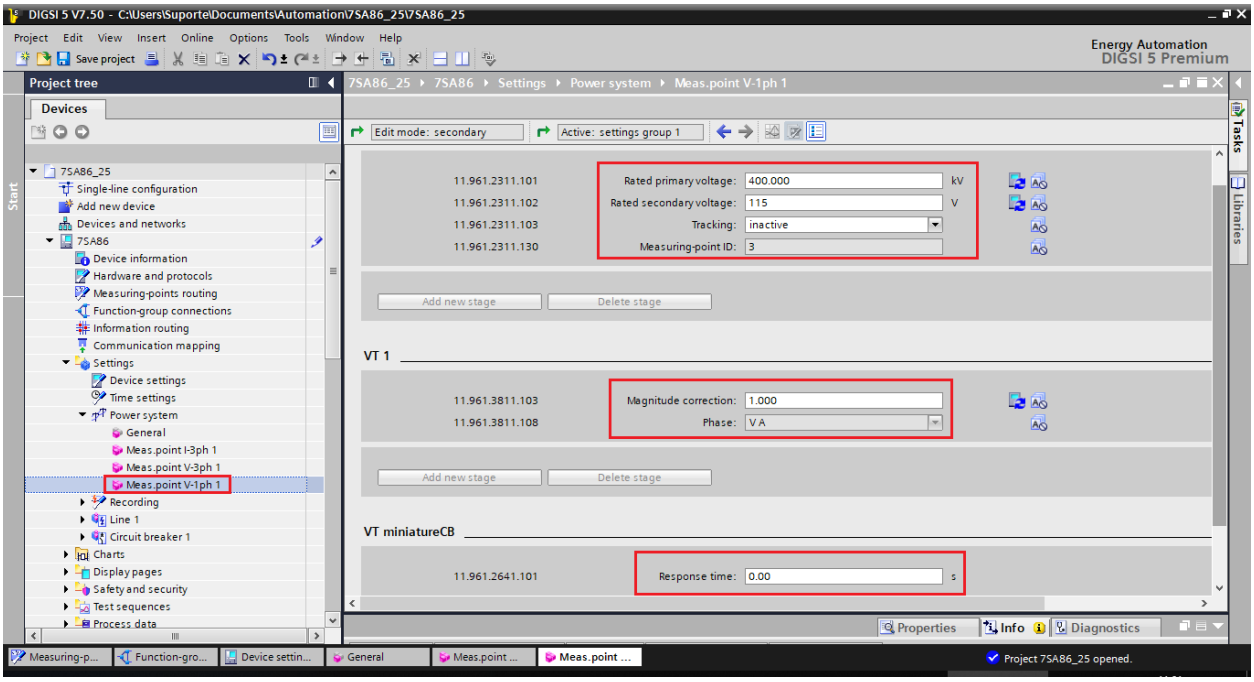


Figure 25

3.7 *General*

Open the *"Line 1"* option and double-click the *"General"* option to carry out the nominal adjustments for voltage and current. Configure line data.

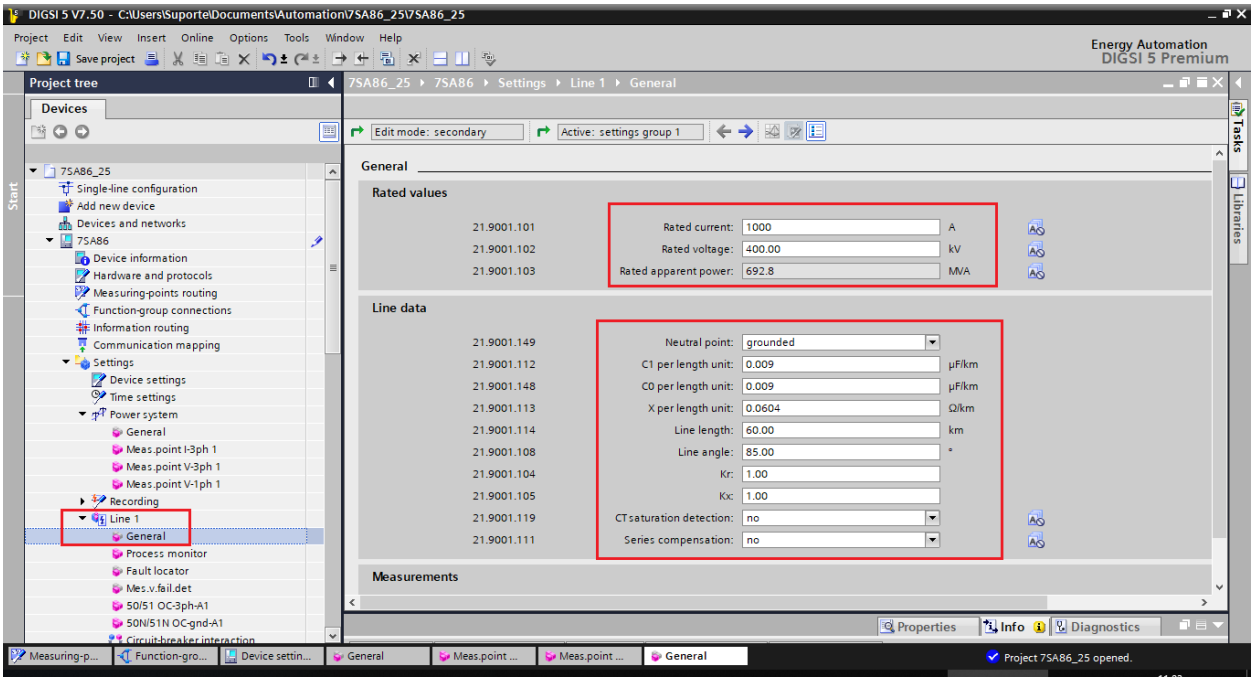


Figure 26

3.8 *Inserting function 25*

Click on the *"Libraries"* option and follow the path *"Global DIGSI 5 Library > Types > Line protection > 7SA86 Distance prot. 3pole > FG Circuit breaker > 25 Synchronization"*. Drag the *"25 Synchronization"* sign onto the *"Circuit breaker"* icon and release.

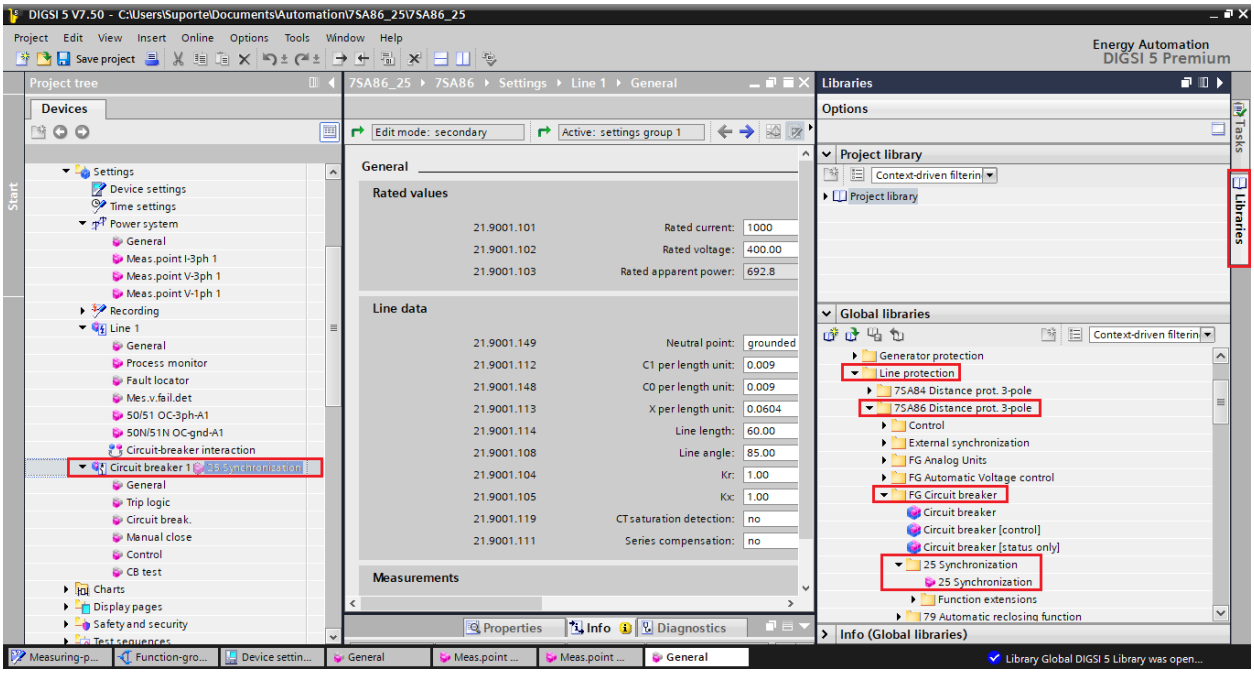


Figure 27

3.9 *25 Synchronization*

Double-click *"25 Synchronization"* to adjust the synchronism function. Initially set the angle of the power transformer, in this case equal to zero. Activate the *"Synchrocheck 1"* function configure the minimum and maximum voltage values and the synchronism check time.

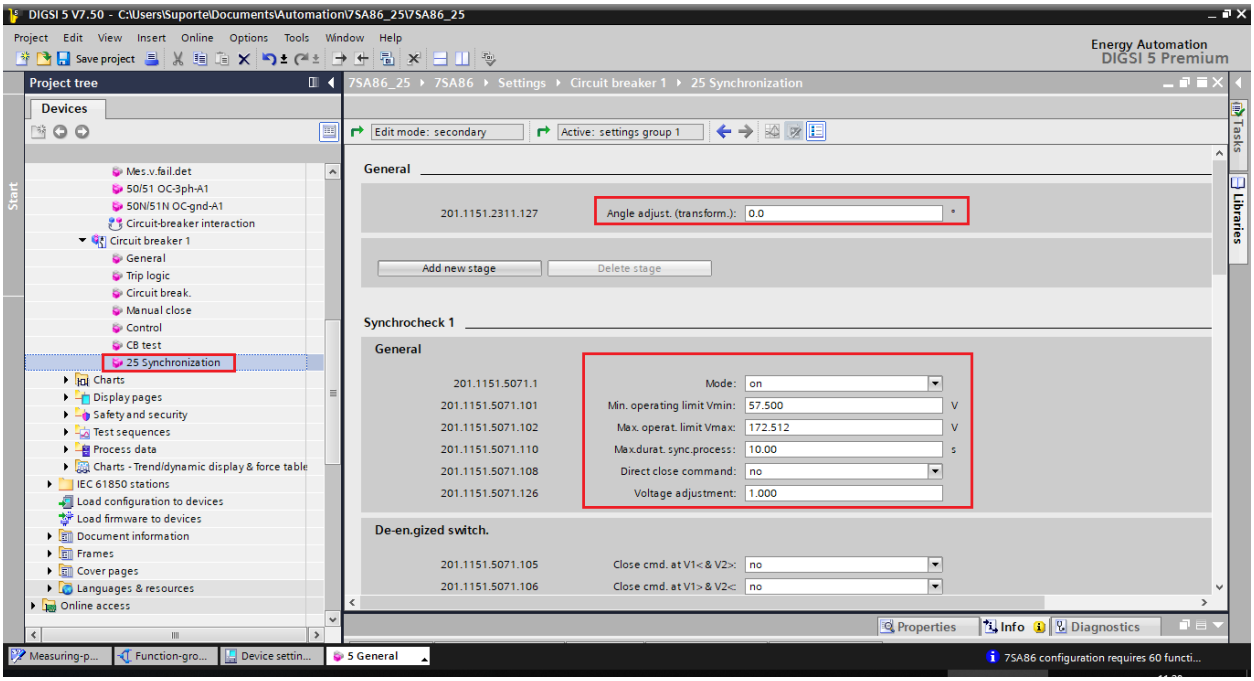


Figure 28

Set the minimum and maximum differences in voltages, frequencies and angles allowed for synchronism.

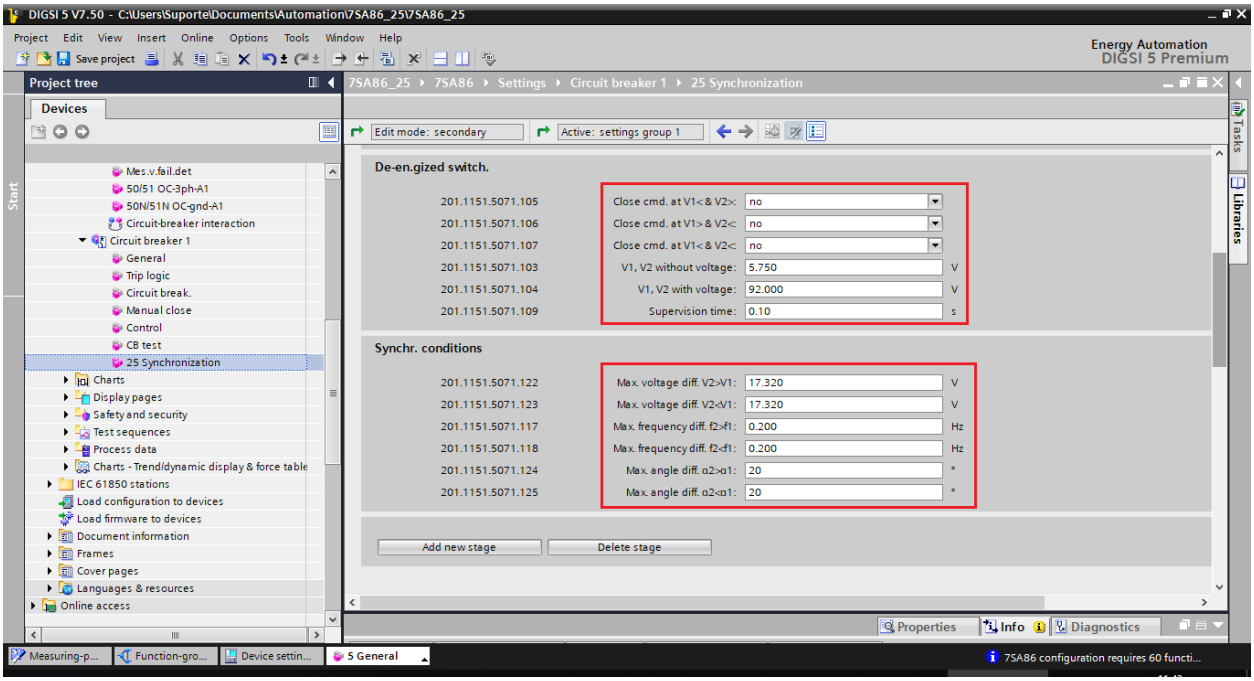


Figure 29

3.10 *Information Routing*

The *"Information Routing"* option associates the command to check the synchronism and the synchronism command. For easier viewing maximize the window.

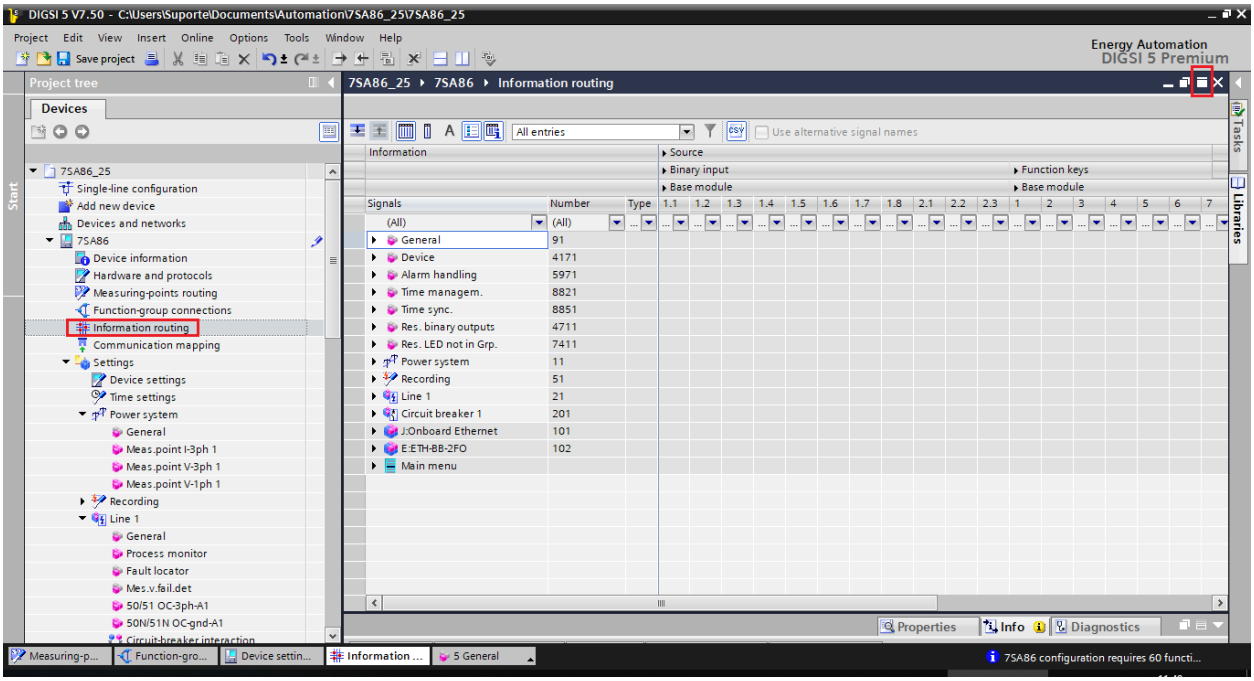


Figure 30

The first columns are associated with the binary inputs of the relay. In this case, the following adjustment signal is used as *"H"*, that is, when this input is with voltage, the relay checks the synchronism, if there is no voltage, it interrupts the synchronism check. Enter the options *"Circuit breaker 1 > 25 Synchronization > Synchrocheck"*.

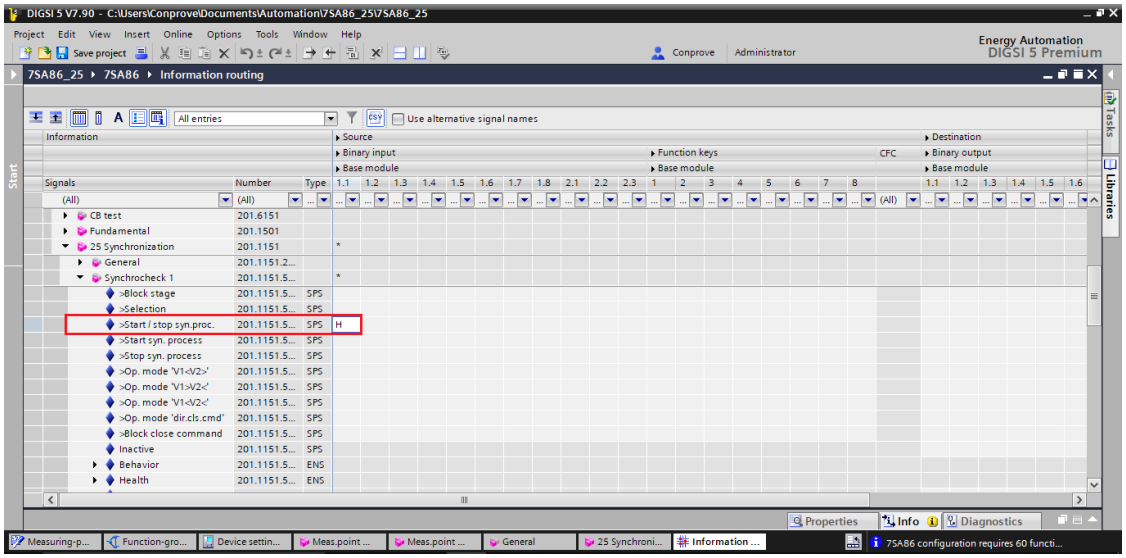


Figure 31

Associate the sign *"Release close cmd."* to exit 1.1. Look at the columns for this signal *"Destination > Binary output > Base module"*.

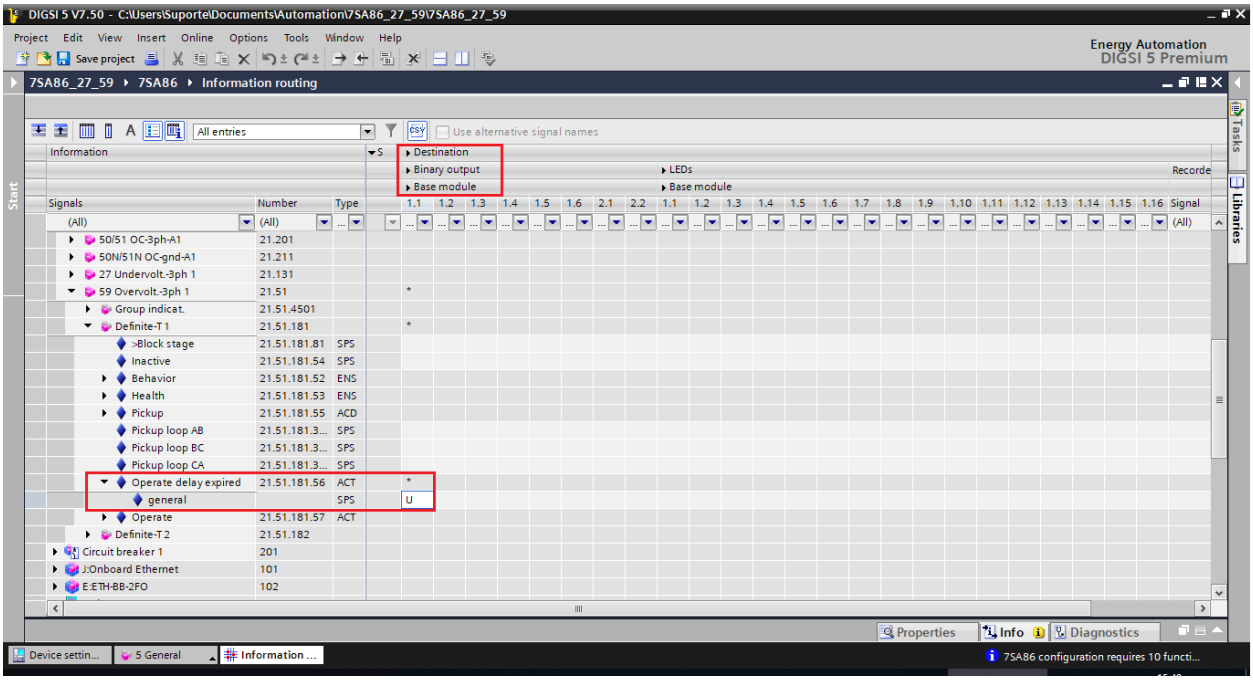


Figure 32

The option *"U"* must be used, which means *"Unlatched"* (without seal), that is, the relay activates and when the fault ceases, it automatically returns to the initial binary state. If the user chooses the *"L"* or *"Latched"* option (with seal), the relay activates and remains activated even if the fault has been extinguished. (This option is not suitable for testing). For output 1.2 configure the following signals.

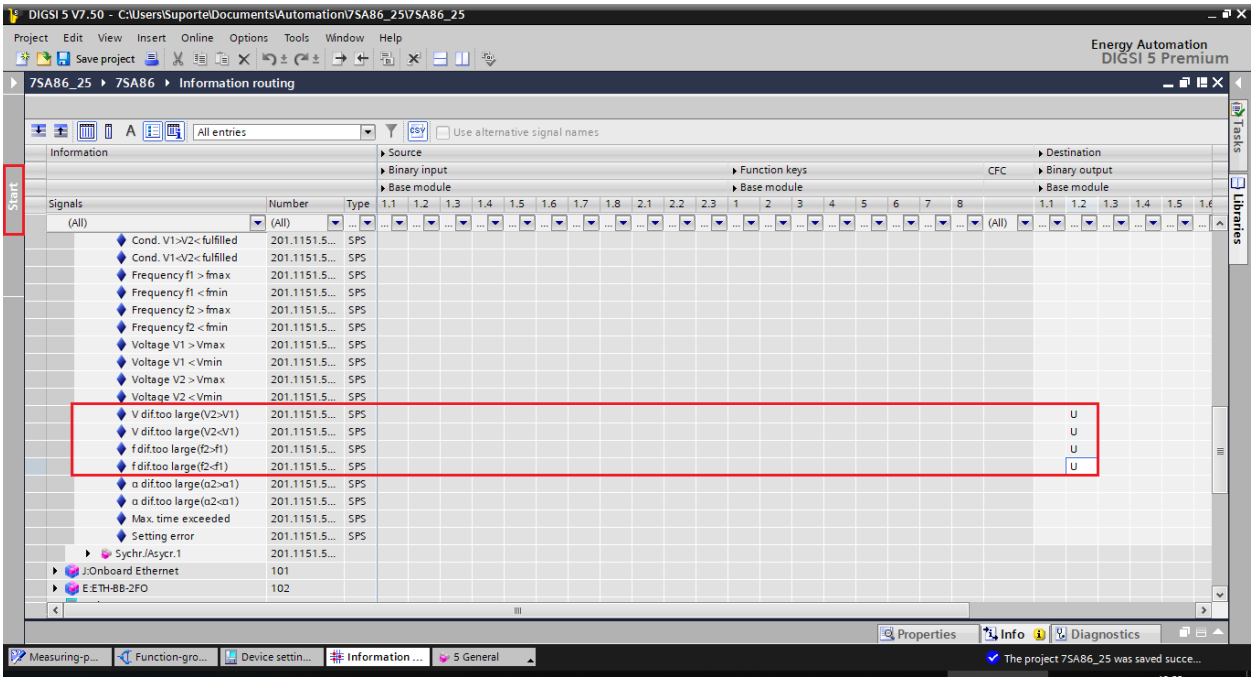


Figure 33

Click on the *"Start"* option so that the *"Project tree"* window is shown again.

3.11 *Sending adjustments*

To send the parameterization changes, right-click on the *"7SA86"* relay icon and choose the option *"Load configuration to device"*.

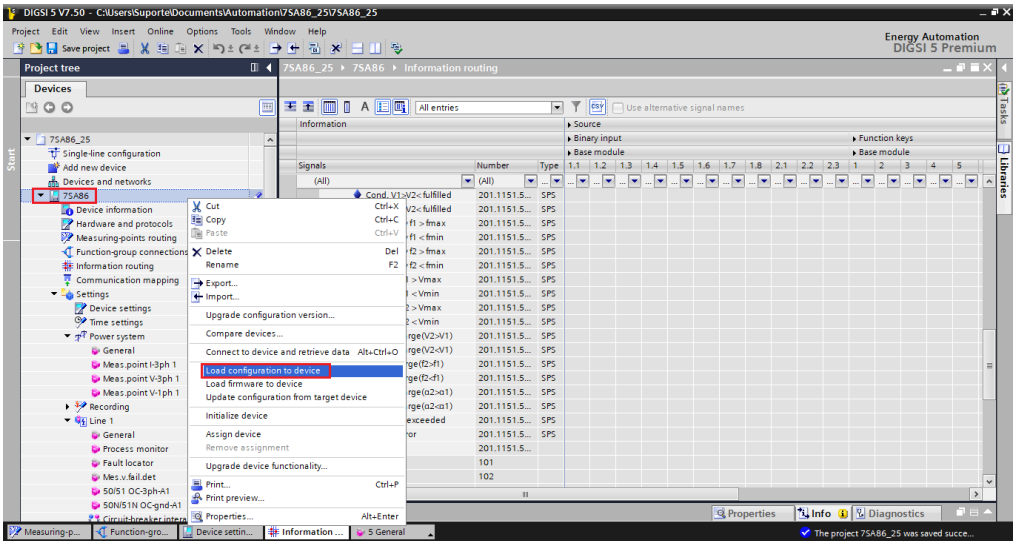


Figure 34

Remembering the default password of Siemens SIPROTE 5: "**222222**".

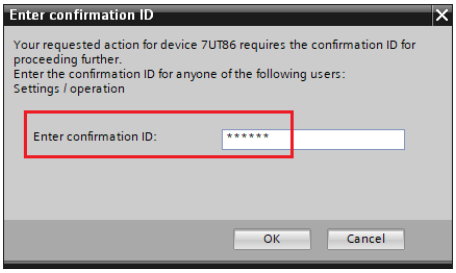


Figure 35

In the next two windows didn't shown, choose the option *"Yes"*.

4. Synchronism software adjustments

4.1 *Opening Synchronism*

Click on the CTC application manager icon.

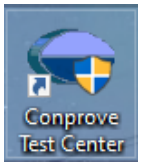


Figure 36

Click on the Synchronism software icon.

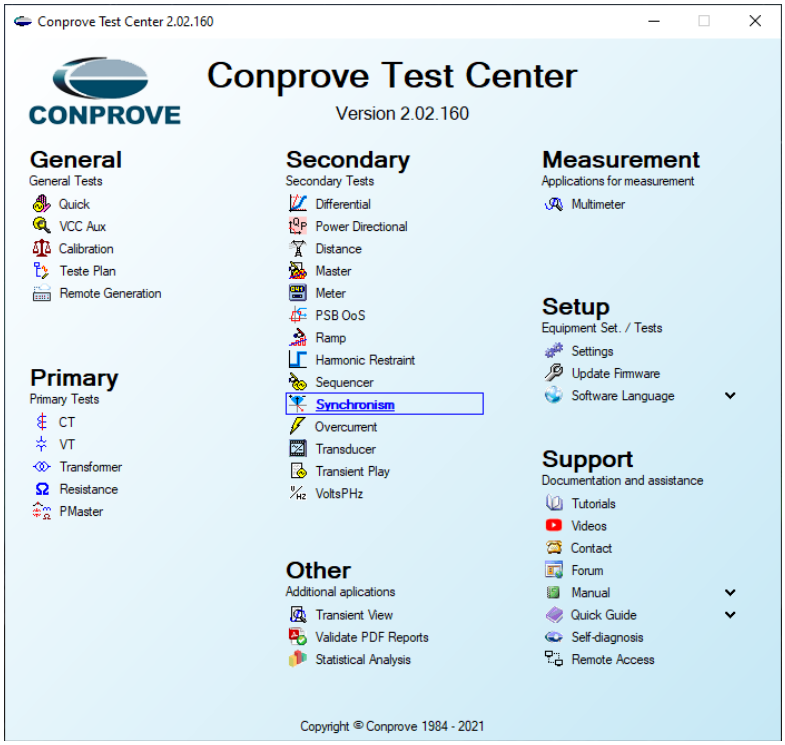


Figure 37

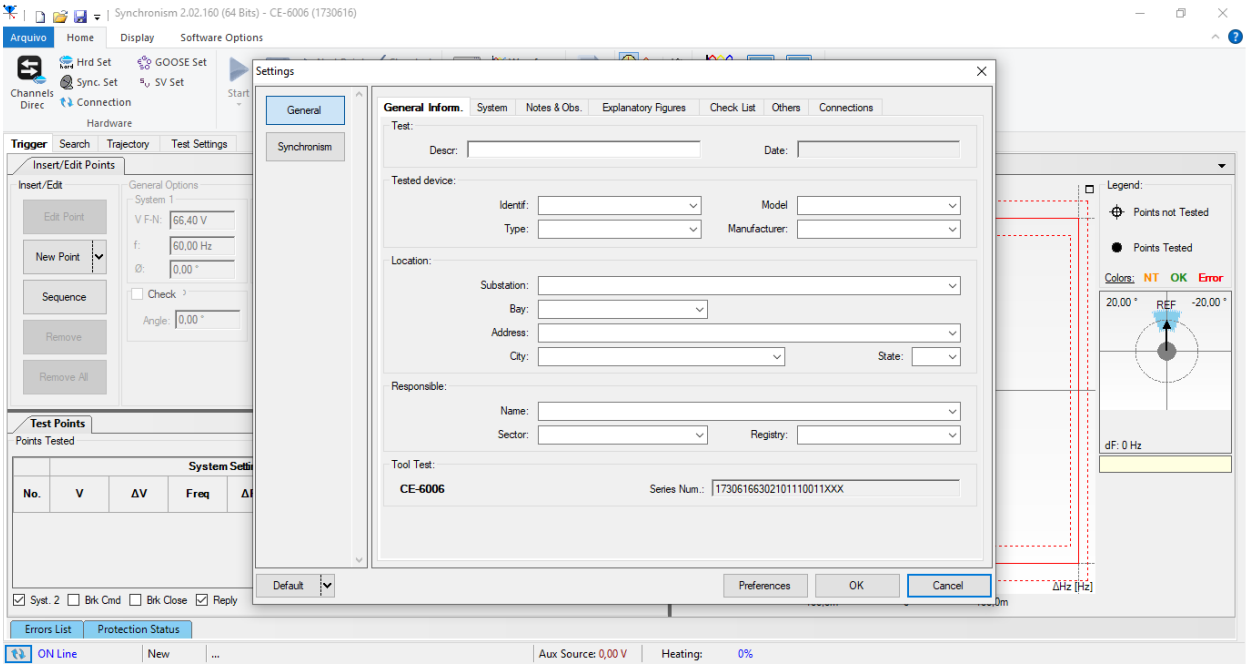


Figure 38

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.

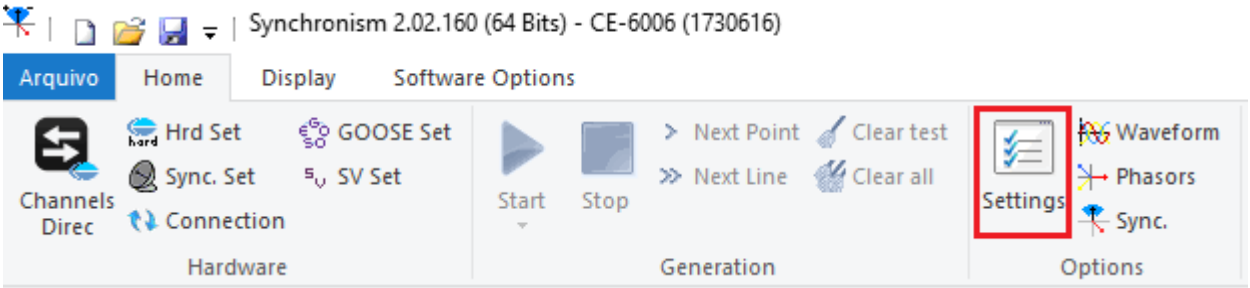


Figure 39

Inside the *"Settings"* screen, fill in the *"General Inform."* with details of the tested device, installation location and the person responsible. This facilitates the elaboration of the report as this tab will be the first to be shown.

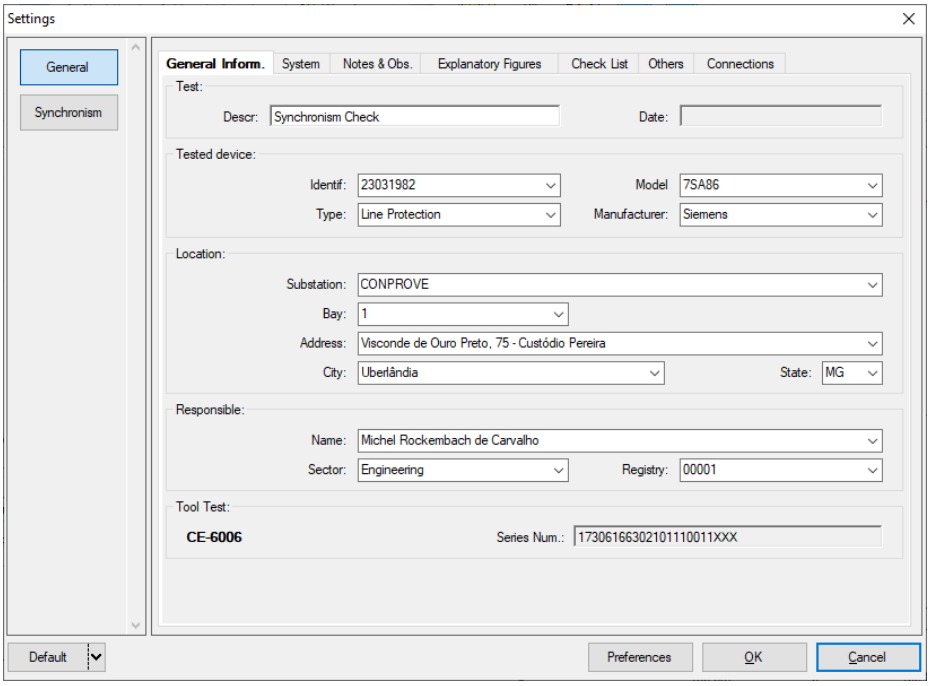


Figure 40

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 is not relevant for this test.

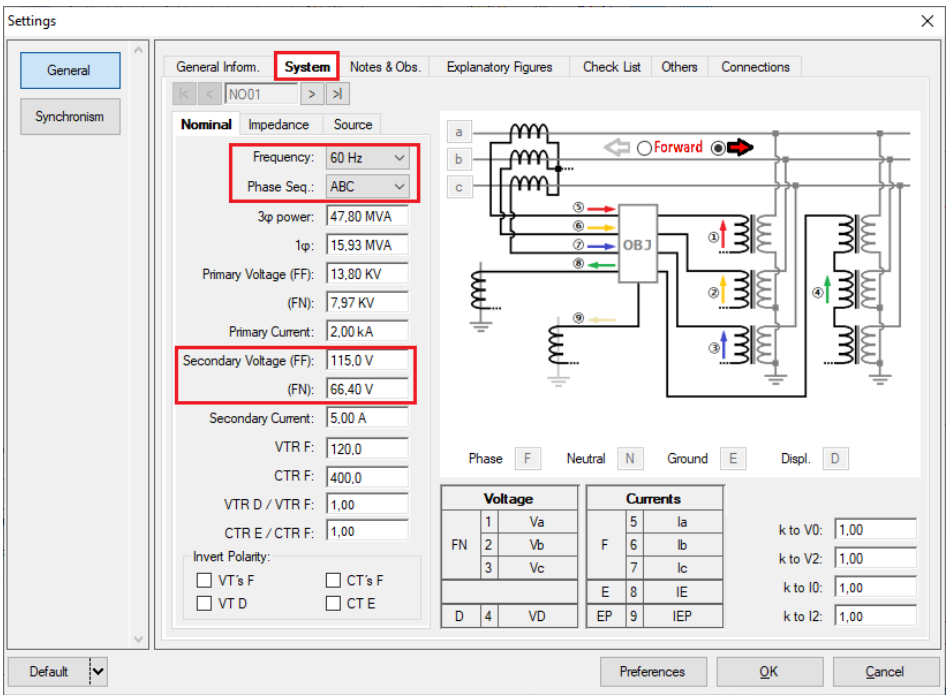


Figure 41

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.

5. Synchronism Adjustments

5.1 *Synchronism > Systems Screen*

In this tab you must enter the data of system one, specifying its composition: Single-phase, Three phase FN or Three phase FF. The reference voltage must be adjusted, and depending on the case, the phase shift inserted by the transformer must be compensated.
For system two, it must be configured similarly to system one with respect to 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 *"Levels Equal to System 1"* field, which when selected, equals the voltages of system 2 to system 1.

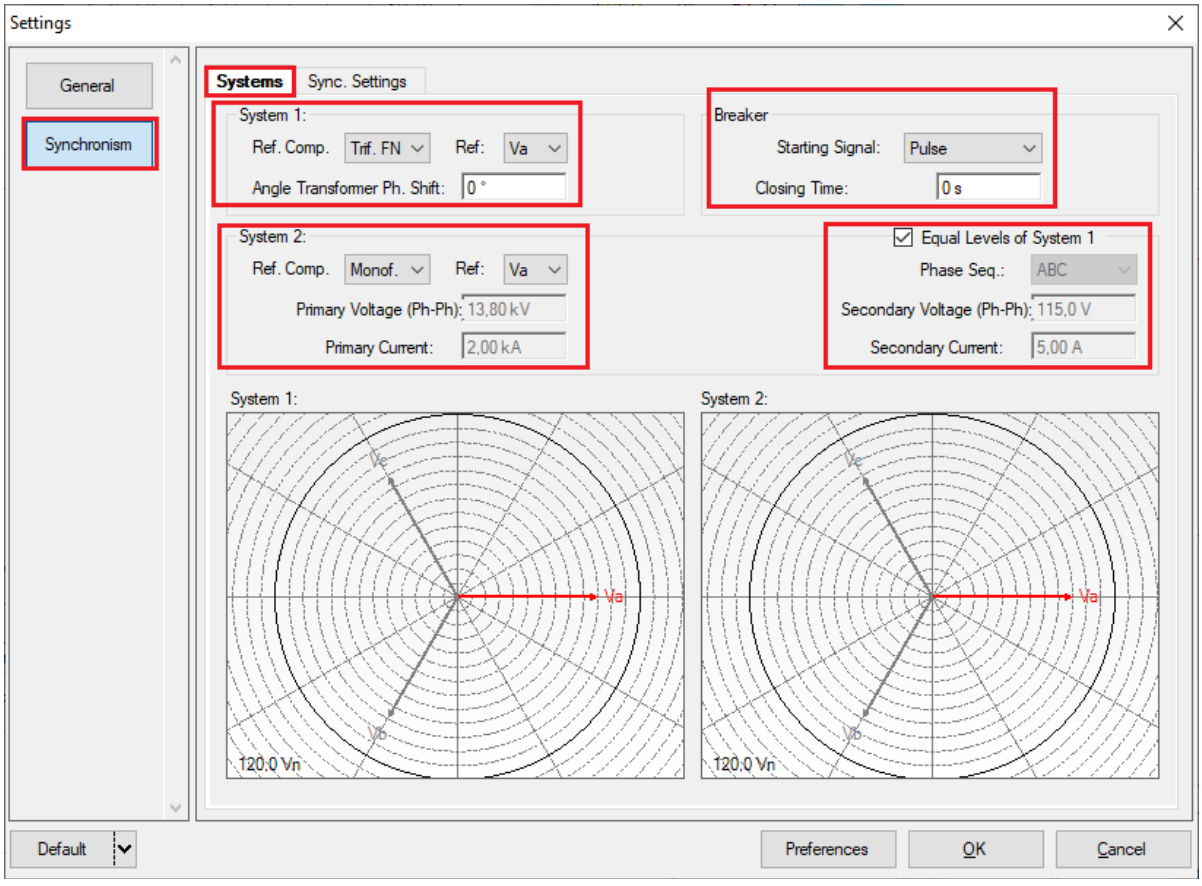


Figure 42

5.2 *Synchronism Screen > 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 as a percentage relative to the nominal values of system 1. Also set the maximum time for synchronism to occur, and the relative and absolute tolerances for voltage, frequency, time and the absolute tolerance for the angle. These adjustments must be made in accordance with the information given in the relay manufacturer's manual.

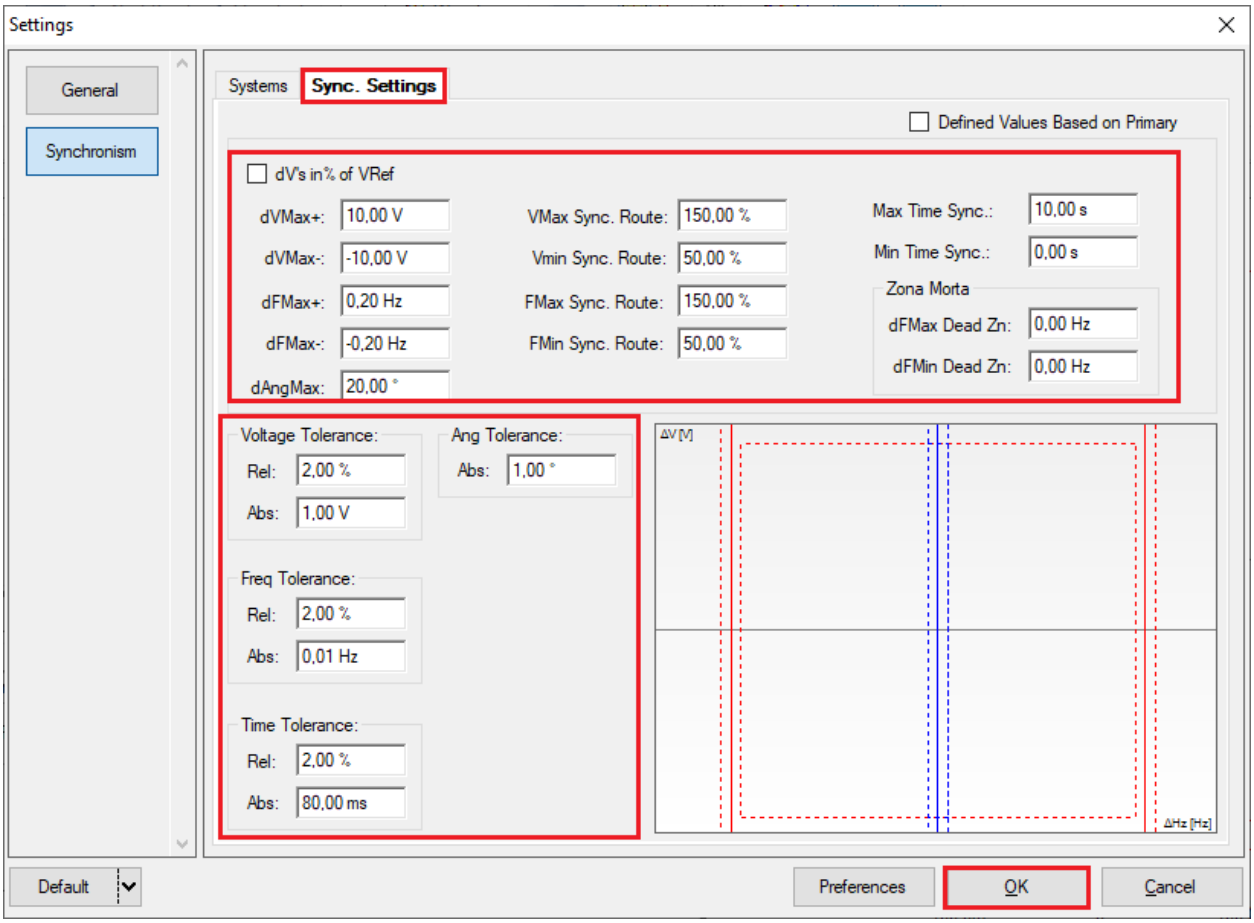


Figure 43

6. Channel Targeting and Hardware Configurations

Click on the icon illustrated below.

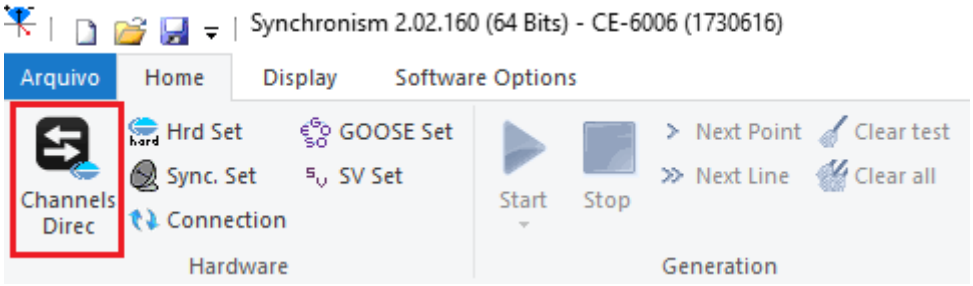


Figure 44

Then click on the highlighted icon to configure the hardware.

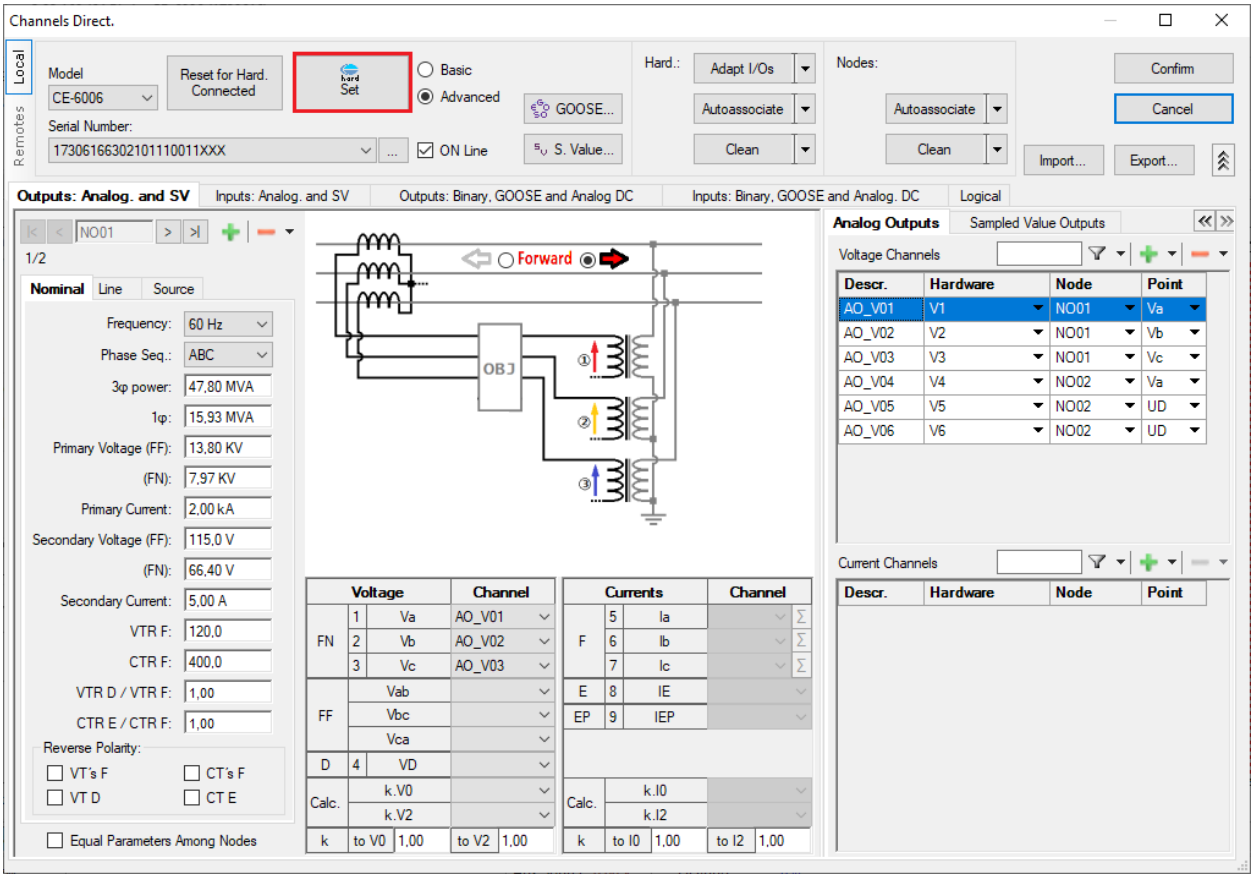


Figure 45

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

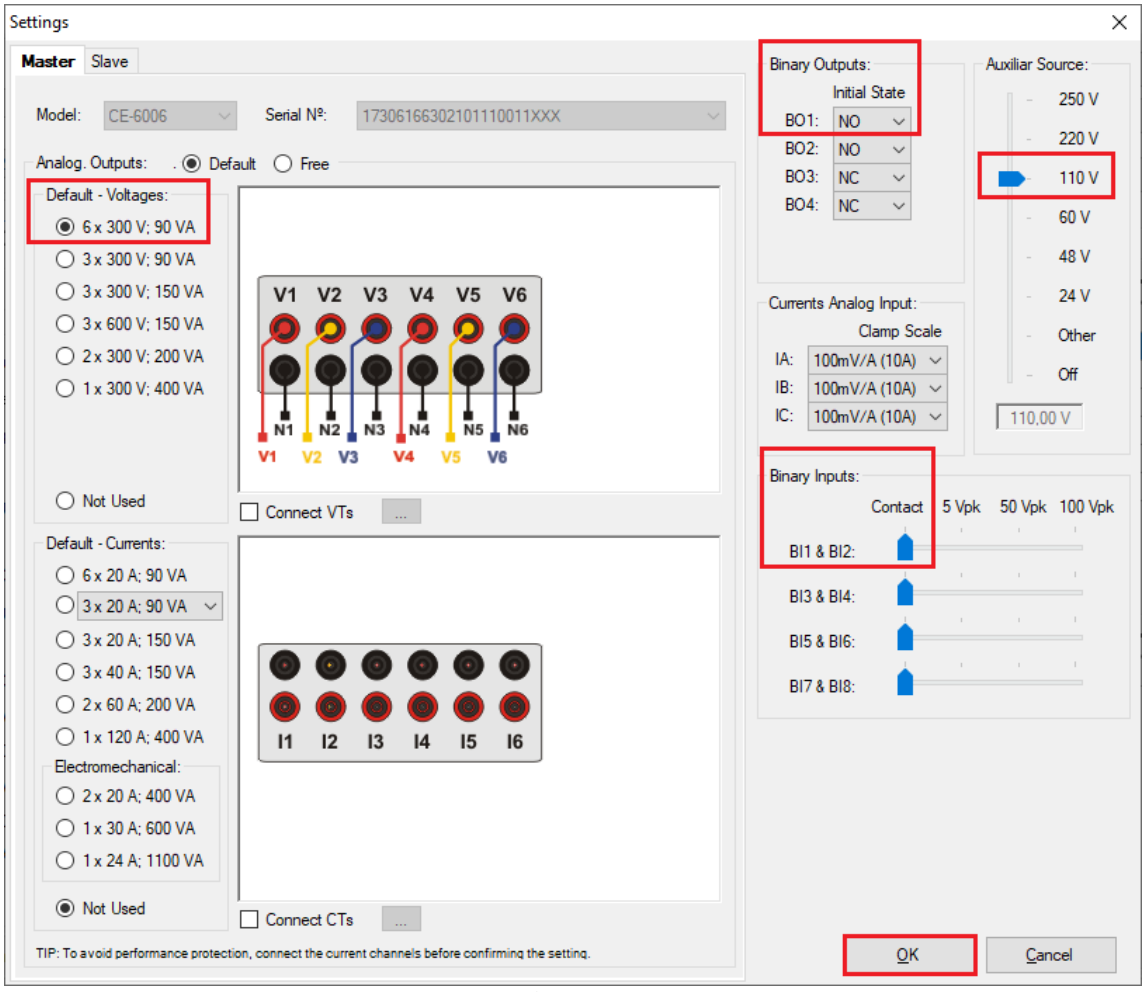


Figure 46

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

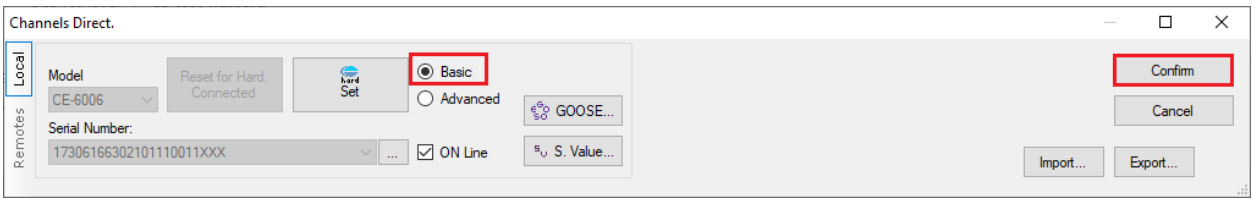


Figure 47

7. Test Settings

In the *"Test Settings"* tab, the correct direction of the voltage generation channels and the stop interface must be done. During the tests, the BO1 must be closed so that the relay checks the synchronism. A pre-simulation is injected with nominal voltages, yet a lag 180°. The binary input responsible for the synchronism command is BI1 while for voltage and frequency differences BI2 is used.

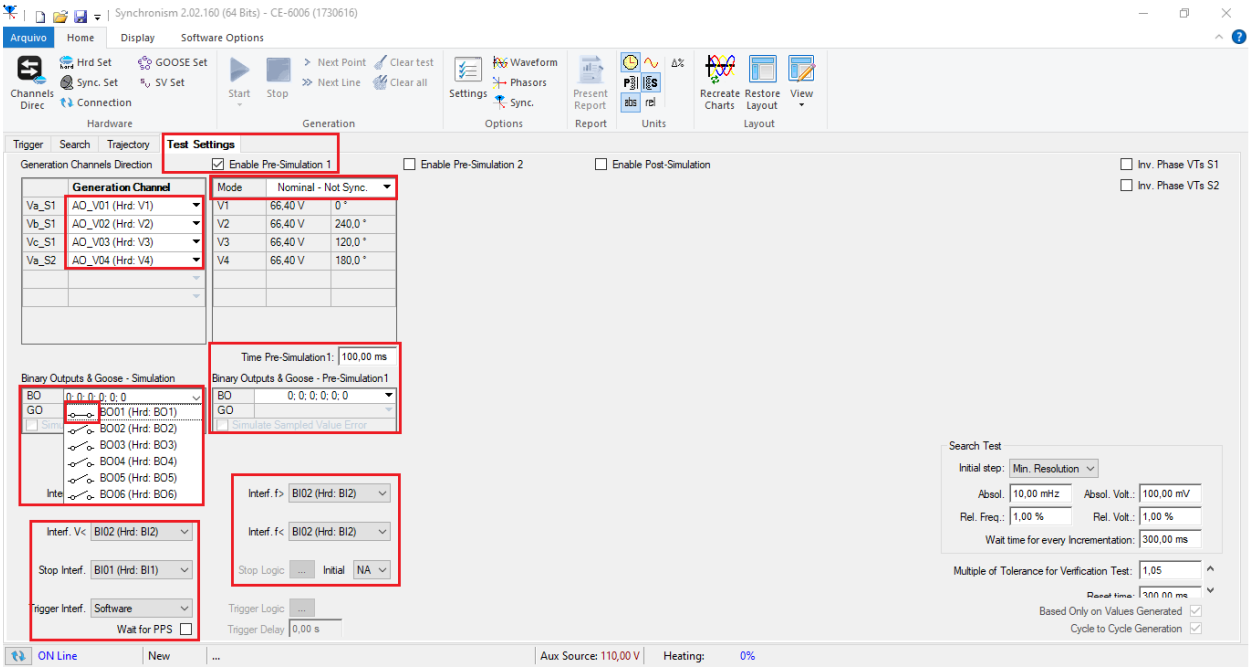


Figure 48

8. Trigger Test

In the trigger test, points inside and outside the sync zone are tested. The points represent the difference in voltage and frequency with respect to system 1. You can also specify an angle difference for the two 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 the voltage, frequency and angle difference values by writing these values in their respective fields. The last option would be to click on the *"Sequence"* option and choose an angle step so that several points are automatically created on the edges of the sync zone. The nominal values of voltage and frequency of system 1 must be set. The figure below illustrates this situation.

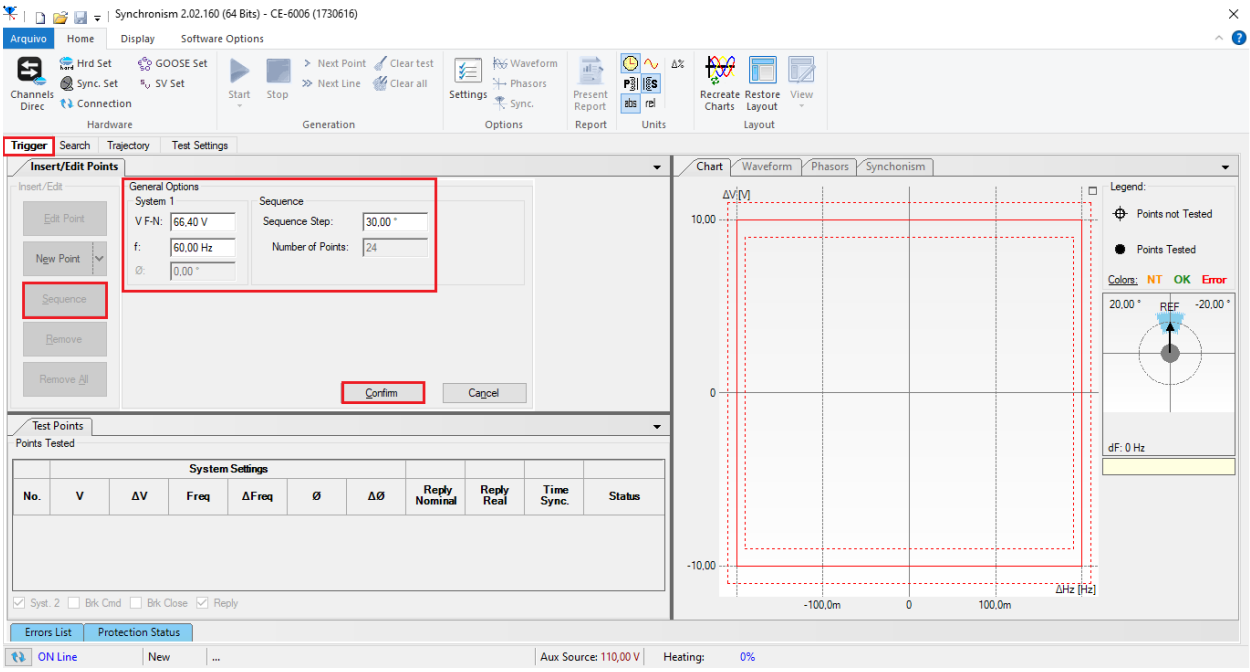


Figure 49

Choosing the sequence with a step of 30.00°, phase-neutral voltage of 66.40V, frequency of 60.00Hz and clicking on the *"Confirm"* button, the following points are created:

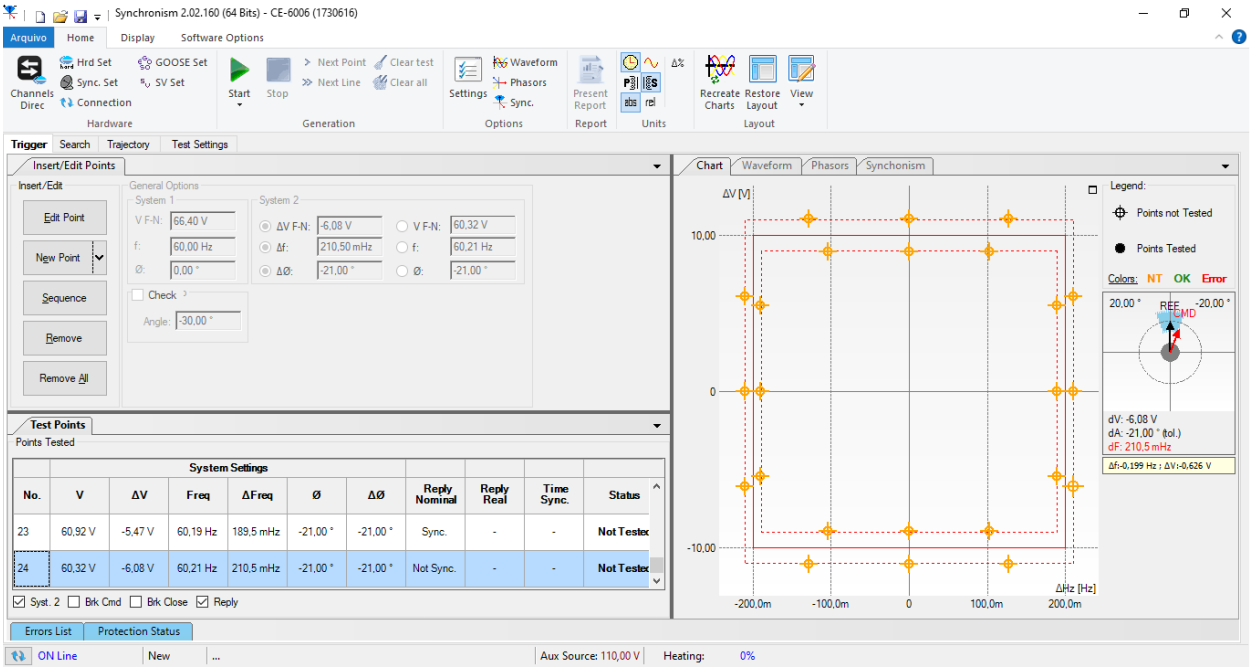


Figure 50

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.

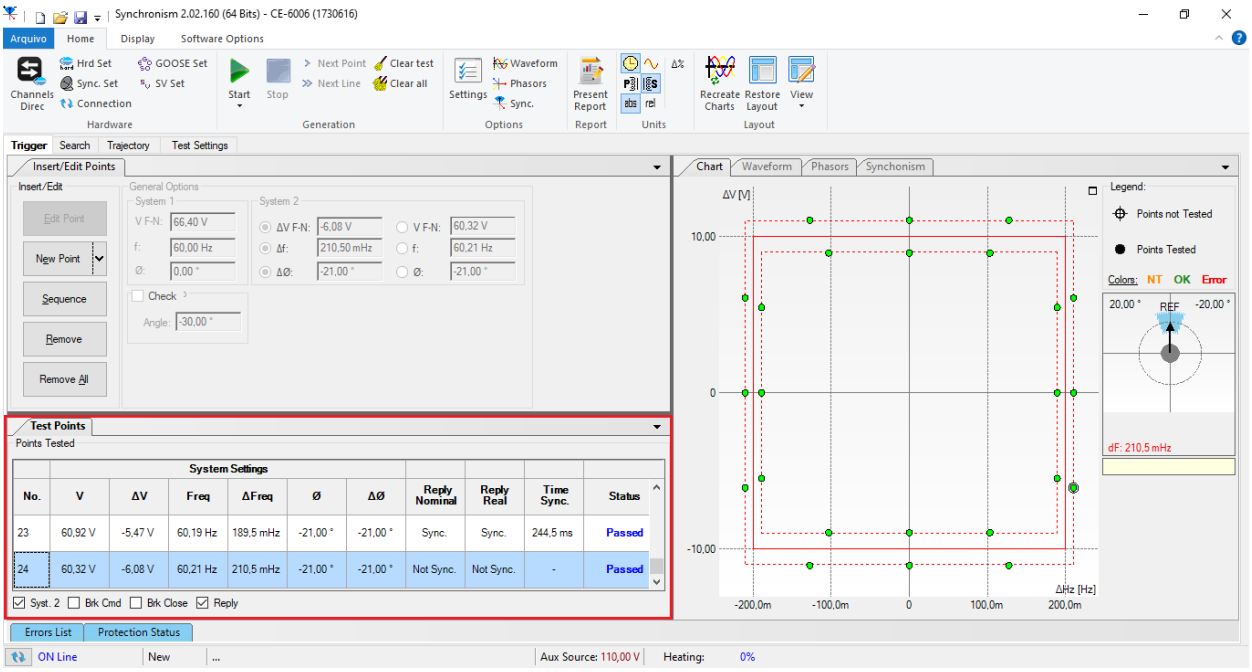


Figure 51

It is verified that in the sync region there is the command and in the external region there is no command.

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 40°.

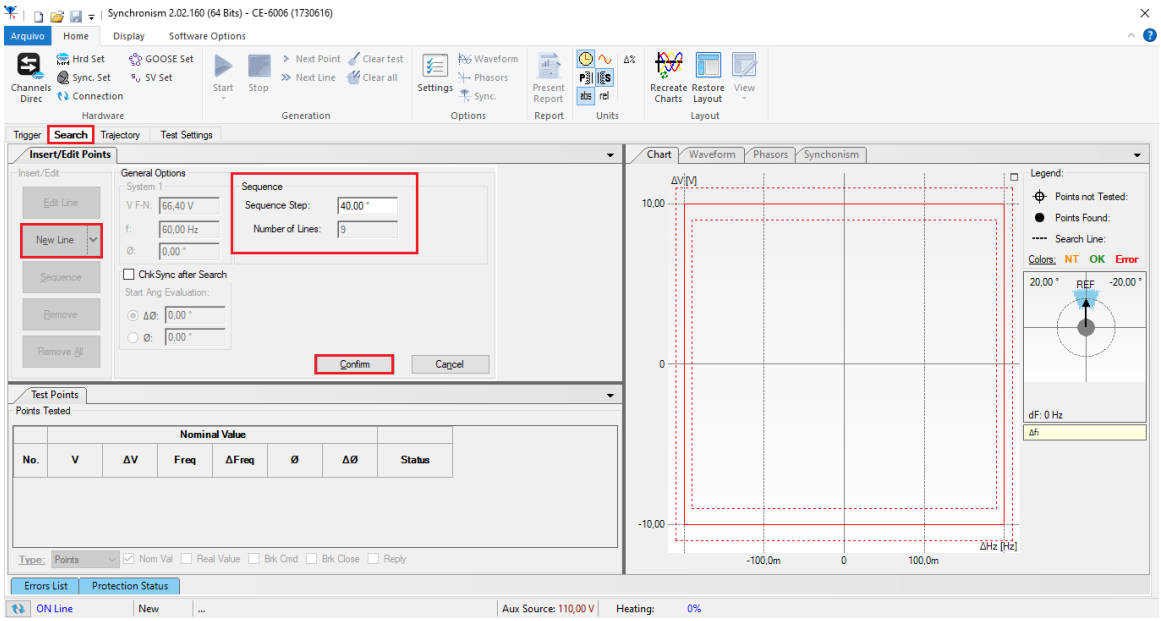


Figure 52

Then click on the *"Confirm"* button, the figure below shows the lines created automatically:

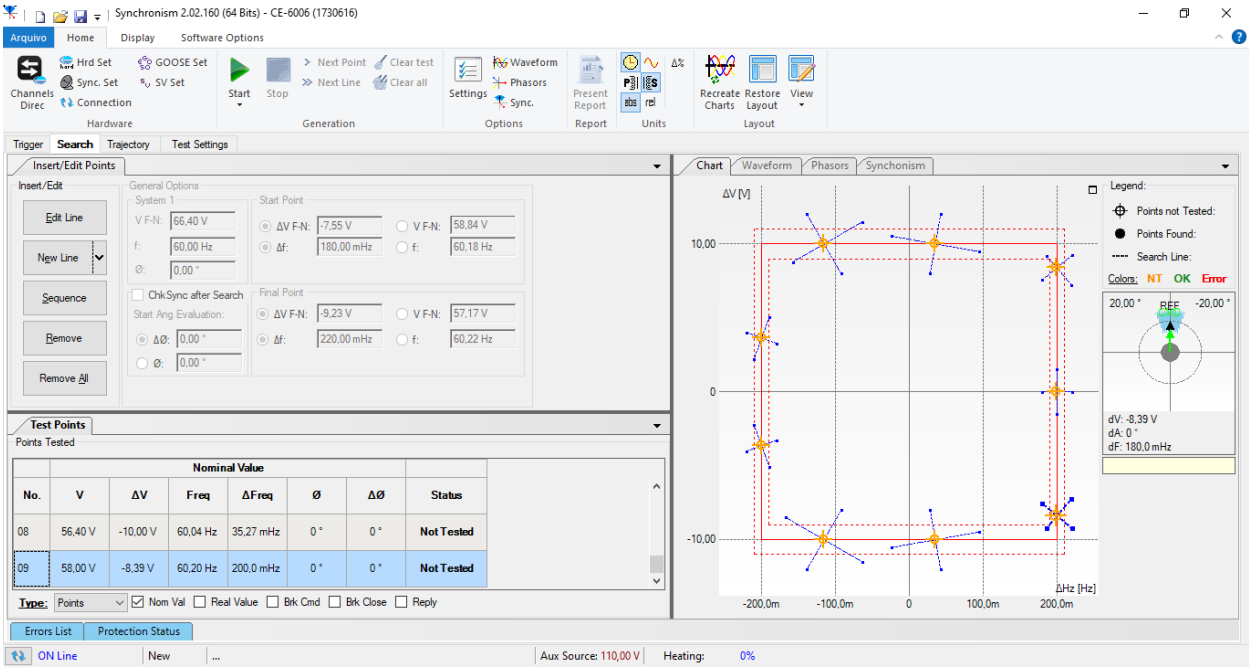


Figure 53

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.

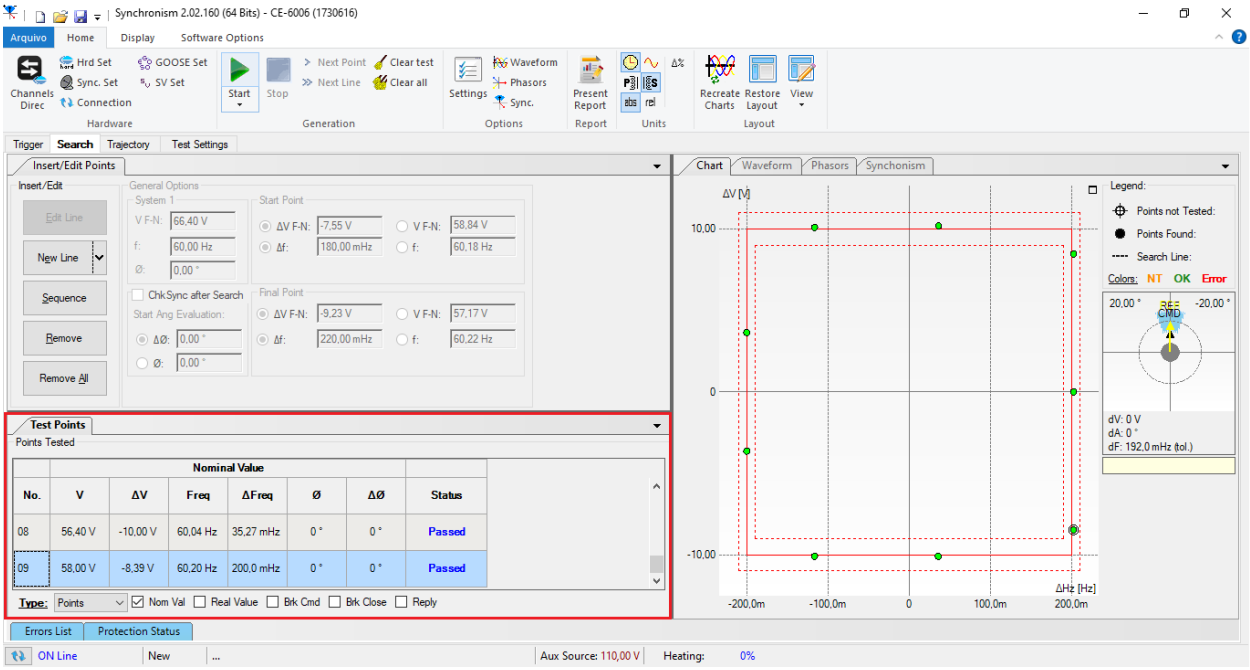


Figure 54

10. Trajectory Test

This test has the same objective as the *"Trigger Test"*, finding the moment of synchronism, however the difference is that the voltage and frequency 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 45.0° reaching the following screen.

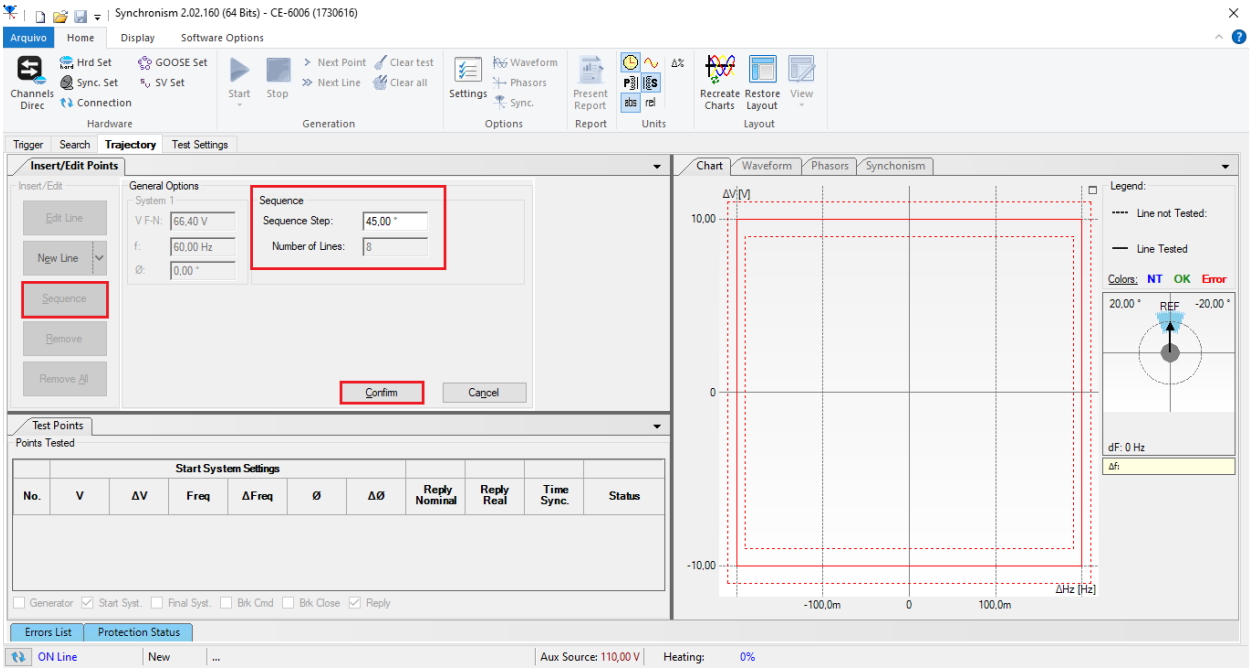


Figure 55

Clicking the *"Confirm"* button automatically creates the lines shown below:

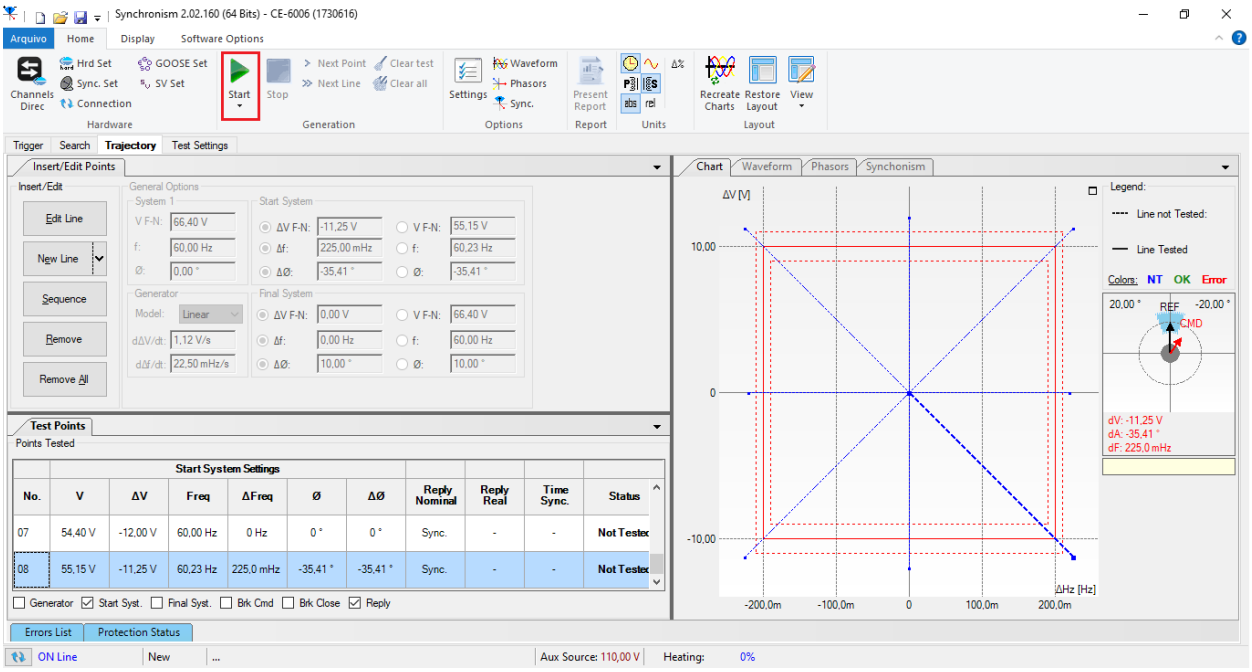


Figure 56

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.

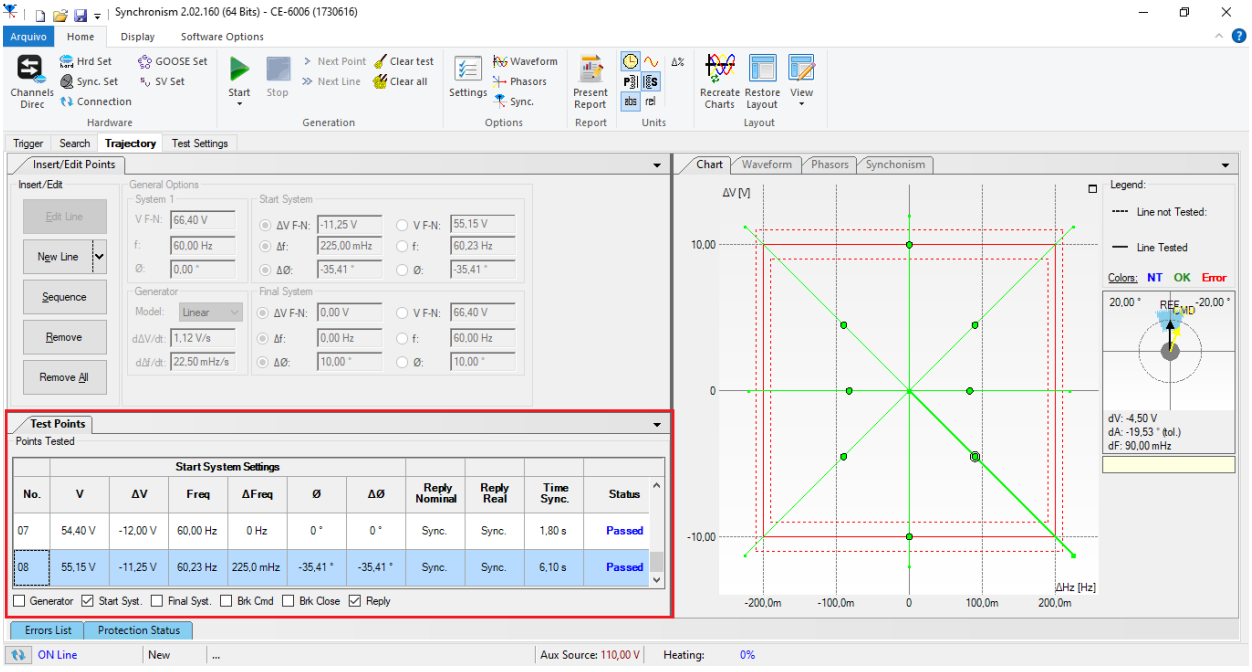


Figure 57

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.

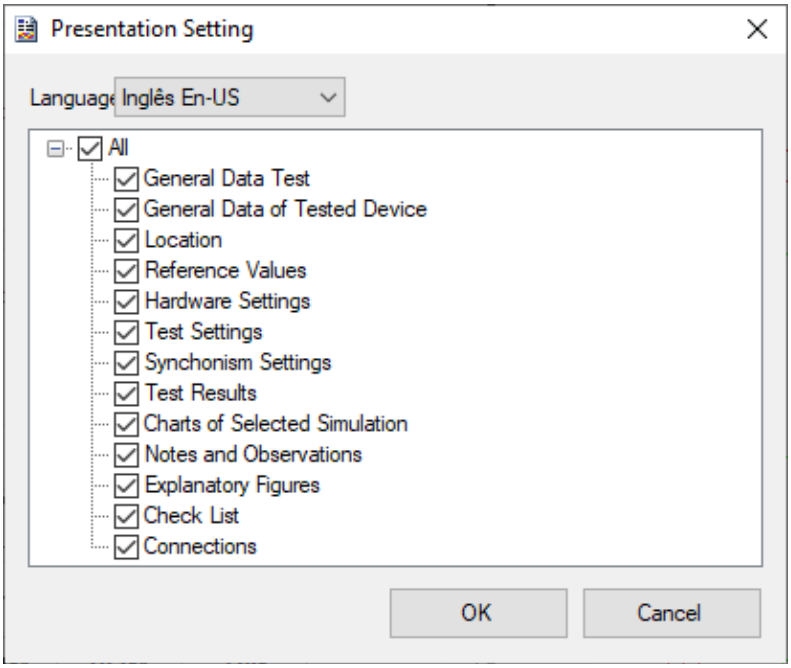


Figure 58

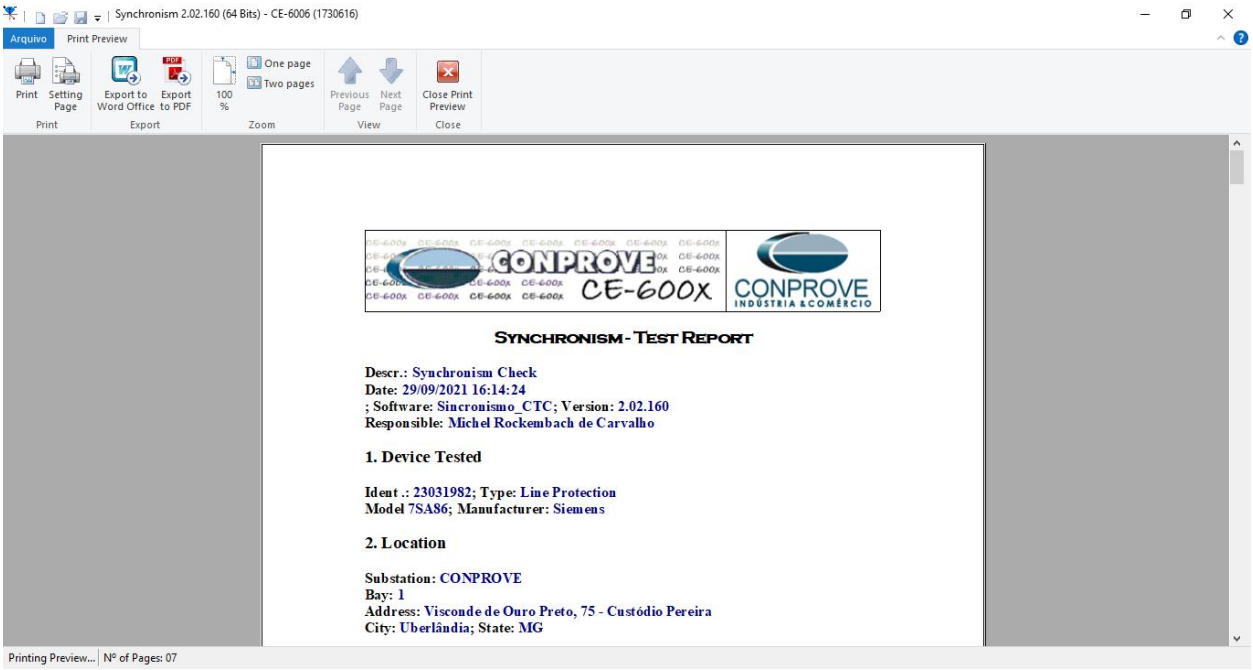
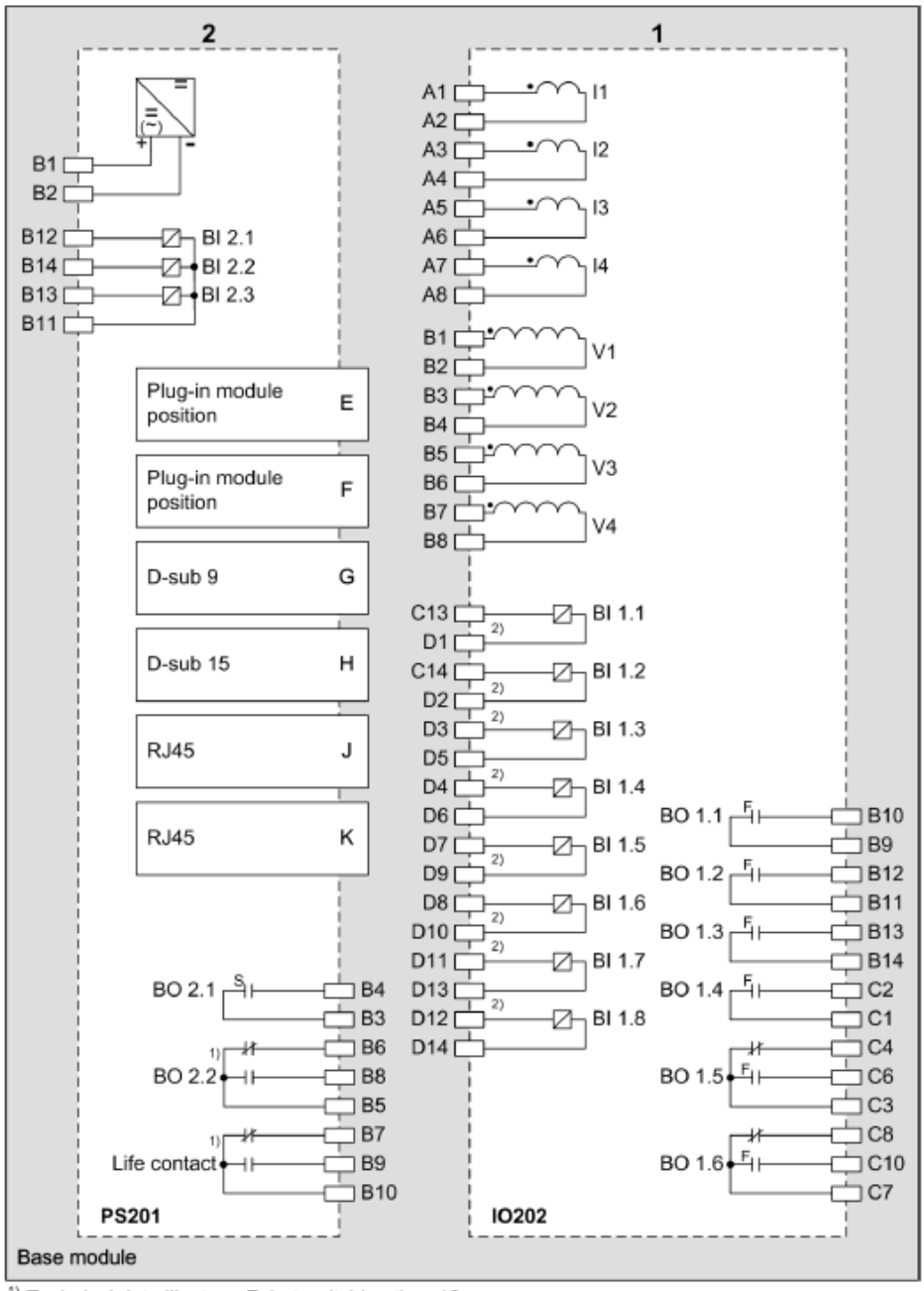


Figure 59

APPENDIX A

A.1 Terminal Designations



[svstyp02-161112-01.tif, 1, en_US]

Figure A-5 Standard Variant Type 2

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 60

A.2 Technical Data

Times

Measuring time, after switching on the variables	Approx. 80 ms

Operating Range

Voltage	20 V to 340 V
Frequency	f_{rated} -4 Hz ≤ f_{rated} ≤ f_{rated} +4 Hz

Tolerances

Tolerances of the voltage settings	2 % of the pickup value or 1 V
Voltage difference V2>V1; V2<V1	1 V
Frequency difference f2>f1; f2<f1	10 mHz
Angular difference α2>α1; α2<α1	1°
Tolerance of all time settings	10 ms
Max. phase displacement angle	5° for Δf ≤ 1 Hz 10° for Δf > 1 Hz

APPENDIX B

Equivalence of software parameters and the relay under test.

Table 1

Synchronism Software		Siemens 7SA86 Relay	
Parameter	**Figure**	**Parameter**	**Figure**
System 1		**Power System Data 1**	
Secondary Voltage (F-F)	41	Rated Secondary Voltage (Ph-Ph)	22
Ref	42	Meas. Point V-1ph1	18
Angle Transformer Ph. Shift	42	Angle adjust. (transform.)	28
System 2		**Power System Data 2**	
Secondary Voltage (Ph-Ph)	42	Rated Secondary Voltage (Ph-Ph)	25
Ref	42	Meas. Point V-1ph1	18
(dVMax+) / $\sqrt{3}$	43	Max. Voltage diff. V2>V1	29
(dVMax-) / $\sqrt{3}$	43	Max. Voltage diff. V2<V1	29
dFMax+	43	Max. frequency diff. f2>f1	29
dFMax-	43	Max. frequency diff. f2<f1	29
dAngMax	43	Max. Angle diff.	29
Max Time Sync.	43	Max. durat. Sync process	28