

INSTRUMENTOS PARA TESTES ELÉTRICOS Test Tutorial

Equipment Type: Protection Relay

Brand: SIEMENS

Model: 7SA611

Function: <u>25 or RSYN – Synchronism Check</u>

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

Objective: <u>Test when two systems can connect, respecting</u> 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



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A.1 Terminal Designations	
A.2 Technical Data	
APPENDIX B	



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 must always be consulted.



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 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.



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.



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.





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.



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.

🛃 DIGSI Manager - [Rockemba	ch C:\Siemens	Wigsi4W4PROJ\R	ockemba]
🛃 Eile Edit Insert Device View	v <u>O</u> ptions <u>W</u> indow	<u>H</u> elp	
		o Filter >	
E Brockembach	7SA611 V4.6	🏮 7SJ612 V4.6	♠ IEC61850 station
	T2-		

Figure 6



Open device	
Connection type	Connection properties
C Offline	No settings required for this connection type.
C Direct	
C USB	
C Modem connection	
C PROFIBUS FMS	
Ethernet	
Πκ	Cancel Help

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"*.

🎸 DIGSI - [Rockembach / Folder	/ 7SA611 V4.6/7SA611 V04.63.0)4]
🔄 Eile Edit Insert Device View	Options <u>W</u> indow <u>H</u> elp	
🖬 🎒 X 🖪 🖻 🖗 🎪 🎘	🏽 🎽 🔓 🔚 🏢 🔟	N?
Image: Settings Image: Seting Image: Seting <	Select function Device Configuration Masking I/O (Configuration Matrix) CFC Power System Data 1 Setting Group A Cocillographic Fault Records General Device Settings Time Synchronization Time Synchronization Time Synchronization Alternation Setting General Device Settings Comparison Setting General Device Settings Comparison Mathematical Settings Comparison Setting General Device Settings Comparison Setting General Device Settings Comparison Mathematical Settings Comparison Setting General Device Settings Comparison Setting General Device Settings Comparison Comparison Setting General Device Settings Comparison Setting General Device Settings Comparison Comparis	
	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"*.



No.	Function	Scope	1
0103	Setting Group Change Option	Disabled	-
0110	Trip mode	1-/3pole	
0114	21 Distance protection pickup program	Z< (quadrilateral)	
0120	68 Power Swing detection	Disabled	
0121	85-21 Pilot Protection for Distance prot	Disabled	
0122	DTT Direct Transfer Trip	Disabled	
0124	50HS Instantaneous SOTF	Disabled	
0125	Weak Infeed (Trip and/or Echo)	Disabled	
0126	50(N)/51(N) Backup OverCurrent	Disabled	
0131	50N/51N Ground OverCurrent	Disabled	
0132	85-67N Pilot Protection Gnd. OverCurrent	Disabled	
0133	79 Auto-Reclose Function	Disabled	
0134	Auto-Reclose control mode	with Trip and Action time	
0135	25 Synchronism and Voltage Check	Enabled	
0136	81 Over/Underfrequency Protection	Disabled	
0137	27, 59 Under/Overvoltage Protection	Disabled	
0138	Fault Locator	Disabled	1
		About	
		<u>About</u>	

Figure 9



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.



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.

🎸 DIGSI - Settings	- Masking I/C) (Configuration Mat	rix) -	Rocken	nba	ch /	Fo	lder	17	7SA	611	V4	. 6/	7SA	611	VO	4.6	3.04	}																						
<u>Eile Edit Insert D</u> e	vice ⊻iew <u>O</u> p	tions <u>W</u> indow <u>H</u> elp																																							
	1 🖬 📩 🎘	Tindication:	s and	comman	ds a	only	_		•	Co	nfig	ure	d to	BI,	BO,	or L	.ED				_			+] (D		Ö		Qué]()	R	?								
誹 Settings - Mask	ing I/O (Confi	guration Matrix) - H	Select I OCKET	Informatic	on Ty די	rpe Tuer	17	SAG	511	V4	.6/7	7SA	611	vo	4.6	3.0	4																					C			×
		Information											Sou	irce														_								Des	tinat	ion			
	Number	Display text		Туре								В	I							F	S	C				_	BO											LED	s		
			-		1	2 3	3 4	5	6	7 1	3 9	10	11 1	2 13	3 1 4	15 1	6 17	18 1	9 20)			1 :	2 3	4	5	6	7 8	8 9	9 10	11	12	1	2 :	3 4	5	6	7 5	8 9	10	11
Device, General																					×	×																			
P.System Data 1	0																																								
Osc. Fault Rec.																																									
P.System Data 2																																									
21 Dis.General																																									
21 Dis.ZoneQuad													2																												
Measurem.Superv			1.1			8 8		8												1										1	12				13						
	02905	>25 SynStart MC		SP	н	2 2	2	-				-	0 0	-			- 2		-	-	2	2			-				- 2	0	-		2		2	-	-			-	
	02941	25 Sy. running		OUT							~						~		-															J							
	02961	25 Sy. CloseCmd		OUT																			J										U								
25 Sync. Check	02978	25 Vsy2 > Vsy1		OUT						T													L					Т	Т					Т				l	J .		
	02979	25 Vsy2 < Vsy1		OUT																				U															U		
	02980	25 fsy2 > fsy1		OUT	1						1						1								U															U	
	02981	25 fsy2 < fsy1		OUT	-		- 3-	-	-		-	-	0-0	-	1	-			- 0-	-	1.0	-	-	-	-	U		- 0	- 2	-	-	-		-	-	-		-	-	-	U
EN100-Modul 1			2.2				1				1	8				1		8		8		8		1				1		1			8		S.	1			13	1	
Testing																																									
Cntrl Authority																														1.											
Control Device																					×	×																			
Process Data		0																																							
Measurement																																				-					
Set Points/MV1																						×														-					
Energy																																									
Statistics	1						18		8		13		8 8						10		8	8		1					18	13			8 8		18	10				1	
ThreshSwitch	4	2																																							
<							110	1																				J													>

Figure 11

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3.3 Tested System Configuration



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.





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).

Power Sy	stem Data 1	
Transform	ners Power System Breaker	
<u>S</u> ettings:		
No.	Settings	Value
0201	CT Starpoint	towards Line
0203	Rated Primary Voltage	13,8 kV
0204	Rated Secondary Voltage (Ph-Ph)	116 V
0205	CT Rated Primary Current	2000 A
0206	CT Rated Secondary Current	5A
0210	V4 voltage transformer is	Vsy2 transforme
0211	Matching ratio Phase-VT To Open-Delta-VT	1,73
0212	VT connection for Vsy2	A-G
0214A	Angle adjustment Vsy2-Vsy1	30°
0215	Matching ratio Vsy1 / Vsy2	1,16
0220	14 current transformer is	Neutral Current (of the protected line)
0221	Matching ratio 14/iph for C1's	1,000
☞ <u>D</u> ispl	ay additional settings	
	Egport	Graph <u>A</u> bout
ОК	Aplicar DIGSI -> Device	Cancelar Ajuda

Figure 14



3.5 Power System

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

No.	Settings	Value
0207	System Starpoint is	Solid Grounded
0230	Rated Frequency	60
0235	Phase Sequence	At Zero seg comp. fectors PC/PL and YC

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.

No.	Settings		Value	
0239	Closing (operating) time of 52 (CB)			0,06 se
0240A	Minimum TRIP Command Duration			0,10 se
0241A	Maximum Close Command Duration			0,10 se
0242	Dead Time for CB test-autoreclosure			0,10 se
Disp	ay additional settings	1		

Figure 16

3.7 Setting Group A



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



Double-click on the "Power System Data 2" option.

No.	Function	
0012 0013 0029 0035	21 Distance protection, general settings 21 Distance zones (quadrilateral) Measurement Supervision 25 Synchronism and Voltage Check	

Figure 18

3.8 Power System



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

1103 M 1104 M	Measurement: Full Scale Voltage (100%) Measurement: Full Scale Current (100%)	13,8 k
1104	Measurement: Full Scale Current (100%)	
1105 1		2000
1100 1	Line Angle	85
1211 /	Angle of inclination, distance charact.	85
1107 F	P,Q operational measured values sign	not revers
1116	Zero seq. comp. factor RG/RL for Z1	1,0
1117 2	Zero seq. comp. factor XG/XL for Z1	1,0
1118	Zero seq. comp.factor RG/RL for Z1BZ5	1,0
1119 2	Zero seq. comp.factor XG/XL for Z1BZ5	1,0
7 <u>D</u> ispla	ay additional settings	

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".

Power Sy	stem Data 2 - Settings Group A			
Power Sy	stem Line Status Trip 1-/3-pole			
<u>S</u> ettings:				
No.	Settings	Value		
1130A	Pole Open Current Threshold	0,50 A		
1131A	Pole Open Voltage Threshold	30 V		
1132A	Seal-in Time after ALL closures	0,05 sec		
1133A	minimal time for line open before SOTF	0,25 sec		
1134	Recognition of Line Closures with	Manual Close BI only		
1135	RESET of Trip Command	with Pole Open Current Threshold only		
1136	open pole detector	with measurement (V/I,trip, pickup, 52a		
1140A	CT Saturation Threshold	100,0 A		
1150A	Seal-in Time after MANUAL closures	0,30 sec		
1151	Manual CLOSE COMMAND generation	with Synchronism-check		
1152	MANUAL Closure Impulse after CONTROL	52Breaker		
<mark>⊡</mark> ispl	ay additional settings	<u>G</u> raph <u>A</u> bout		
ОК	Aplicar DIGSI -> Device	Cancelar Ajuda		

Figure 20

3.9 Trip 1-/3 pole



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

No.	Settings	1	Value	9
1155	3 pole coupling		+ dide	with Trip
1156A	Trip type with 2phase faults			Зр
<u>Displ</u>	ay additional settings			
7 <u>D</u> ispl	ay additional settings	1		

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".

No.	Function
0011	Power System Data 2
0012	21 Distance protection, general settings
0013	21 Distance zones (quadrilateral)
0029	Measurement Supervision
0035	25 Synchronism and Voltage Check
Cus	stomize <u>A</u> bout

3.11 General



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"*.

25 Syncl	hronism and Voltage Check - Settings G	iroup A								
General	with AR Man.Close+CNTRL									
<u>S</u> ettings	κ.									
No.	No. Settings Value									
3501	25 Synchronism and Voltage Check			ON 🕶						
3502	Voltage threshold dead line / bus	4		5 V						
3503	Voltage threshold live line / bus				30 V					
3504	Maximum permissible voltage				110 V					
3507	Maximum duration of synchronism-check				13,00 sec					
3508	Synchronous condition stability timer		0,00 sec							
Disp	olay additional settings									
		Export	Gr	aph	About					
ОК	Aplicar DIGSI -> Device			Cancelar	Ajuda					

Figure 23

3.12 Man. Close +CNTRL



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.

25	25 Synchronism and Voltage Check - Setting Group A									
C	ieneral	with AR Man.Close+CNTRL								
	Settings:									
	No.	Settings	Value							
	3530	Operating mode with Man.Cl	with consideration of 52 closing time							
	3531	Maximum voltage difference	10,0 V							
	3532	Maximum frequency difference	0,20 Hz							
	3533	Maximum angle difference	30 °							
	3535A	Manual Close at Vsy2>, Vsy1>, and Synchr	YES							
	3536	Manual Close at Vsy1< and Vsy2>	NO							
	3537	Manual Close at Vsy1> and Vsy2<	NO							
	3538	Manual Close at Vsy1< and Vsy2<	NO							
	3539	Override of any check before Man.Cl	NO							
	I✓ Displi	ay additional settings								
-			Alaria							
			About							
	ОК	Aplicar DIGSI -> Device	Cancelar Ajuda							

Figure 24

4. Synchronism software adjustment



4.1 Opening the software

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



Click on the Synchronism software icon.





👯 👔 💕 🛃 🚽 Synchronism 2.02.163 (64 Bits)	- CE-6006 (1650116)	- 0 ×
Arquivo Home Display Software Options	s	~ 🕐
Arguiro Home Display Software Options Image: Search Searc	tettings	Legend: Derints not Tested Orints Tested Colors: NT OK Error 30.00* REF -300.00*
Remove Remove Al / Test Points Points Tested	Bay: V Address: V City: V State: V Name: V Sector: V	df: 0 Hz
System Setting No. V ΔV Freq Δ1	CE-6006 Series Num.: 16501166302101110011XXX	
 ≤ ✓ Syst. 2 Ø Brk Cmd Ø Brk Close Ø Reply Errors List Protection Status 	Default V Preferences OK Cancel 2H	z:[Hz] ;00
New	Aux Source: 0,00 V Heating: 0%	
	Figure 27	

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.

Channels Direc	Hrd Set Sync. Set Connection Hardware	e ^G o GOOSE Set ⁵ _V SV Set	Start	Stop	 Next Point Next Line Generation 	✓ Clear test ✓ Clear all	K Waveform Settings ↔ Phasors ↔ Sync. Options	Present Report Report	Δ% P3 ibs rel Units	Recreate Restore V Charts Layout Layout	/iew
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.



General Inform	 System 	lotes & Obs. Explana	tory Figures	Check List Other	rs Connections	
Test:						
sm Descr	Check Synchr	onism		Date:		
Tested device:						
	Identif:	23031982	~	Model	7SA611	~
	Type:	Line Protection	~	Manufacturer:	Siemens	~
Location:						
	Substation:	CONPROVE				~
	Bay:	1	~			
	Address:	Visconde de Ouro Pret	to, N°75 - Custód	io Pereira Neighbort	nood	~
	City:	Uberlândia		~	Sta	ite: MG 🗸
Responsible:						
	Name:	Michel Rockembach d	le Carvalho			~
	Sector:	Engineering	~	Registry:	00001	~
Tool Test:						
CE-6006			Series Num.:	16501166302101	110011XXX	

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.

₹ <u>D</u>	🧉 🛃 🗧	Synchronism	n 2.02.162	2 (64 Bits)	- CE-60	006 (0320711)	
Arquivo	Home	Display	Softwar	e Option	s		
Channels Direc	Hrd Se Sync. 9 Conne Hare	et €o GOC Set ⁵, SV S ection dware	OSE Set et	Start	Stop	 Next Point Next Line Generation 	✔ Clear test ∰ Clear all

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".



ster Slave	Binary Outputs: Auxilia	ar Source:-
	Initial State	- 250 V
lodel: CE-6006 ∨ Serial №: 03207116302101110011XXX	✓ BO1: NO ✓	200 .
nalog Outpute: Default Frage	BO2: NO 🗸	- 220 V
	BO3: NC 🗸	- 110 V
C 200 V/. 00 V/A	BO4: NC V	- 60 V
0 2 200 V 20 VA		40.1/
0 3 X 300 V; 90 VA		- 40 V
V1 V2 V3 V4 V5 V6	Currents Analog Input:	- 24 V
O 3x 600 V; 150 VA	Clamp Scale	- Other
O 2x 300 V; 200 VA	IA: 100mV/A (10A) ~	- Off
○ 1 x 300 V; 400 VA	IB: 100mV/A (10A) ~	
	IC: 100mV/A (10A) ~ 11	V 00,00
V1 V2 V3 V4 V5 V6		
	Binary Inputs:	
Connect VTs	Contact 5 Vpk 50	Vpk 100 Vp
Default - Currents:	BI1 & BI2:	
O 6 x 20 A; 90 VA		
○ 3 × 20 A; 90 VA ~	BI3 & BI4:	
O 3 x 20 A; 150 VA	BI5 & BI6:	
🔾 3 x 40 A; 150 VA		
O 2 x 60 A; 200 VA	DI/ & BI8:	
O 1 x 120 A; 400 VA		
Electromechanical:		
O 2 x 20 A; 400 VA		
O 1 x 30 A; 600 VA		
O 1 x 24 A; 1100 VA		
Not Used Connect CTs		

Figure 33

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

Cha	nnels Direct.			_		×
Local	Model Reset for Hard.	Basic		[Confirm	L. C.
- N	CE-6006 V Connected	Set O Advanced	Se GOOSE	[Cancel	
ote	Serial Number:		50			
Rem	03207116302101110011XXX	ON Line	^s _v S. Value	Import	Export	

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



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



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 ELÉT	RICOS
Settings		×
General	Systems Sync. Settings	
		Defined Values Based on Primary
Synchronism	dV's in % of VRef dVMax+: 10.00 V dVMax: -10.00 V dVMax: -10.00 V dFMax+: 0.20 Hz dFMax: -0.20 Hz FMax Sync. Route: 150.00 % dFMax: -0.20 Hz FMin Sync. Route: 50.00 % dAngMax: 30.00 * Voltage Tolerance: Ang Tolerance: Abs: 1.00 V Freq Tolerance: Rel: g3.00 %	Max Time Sync.: 13.00 s Min Time Sync.: 0.00 s Zona Morta dFMax Dead Zn: 0.00 Hz dFMin Dead Zn: 0.00 Hz
	Abs: 0,02 Hz Time Tolerance: Rel: 5.00 % Abs: 100.00 ms	
Default 🗸		Preferences <u>Q</u> K <u>C</u> ancel

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.



	INS'	RUMENTOS	S PARA TES	TES ELÉTRICOS	
I 🗋 📸 🚽 = Synchronism 2.02.163	(64 Bits) - CE-6006 (1650116)				- ¤ ×
Channels Connection Direc Hadware	Start Stop Generation	est Settings Y Sync. Options	Present Report Report Units	Recreate Restore View Charts Layout	
Trigger Search Trajectory Test Settin	ngs	Enable Pre-Simulation 2	Enable Post-Simul	ation	Inv. Phase VTs S1
Generation Channel I Va_S1 AO_V01 (Hrd. VI) V Vb_S1 AO_V02 (Hrd. V2) V Va_S2 AO_V03 (Hrd. V3) V Va_S2 AO_V04 (Hrd. V4) V Binary Outputs & Corpse - Simulation B BO 1: 0: 0: 0: 0 I GO V V	Mode Nominal - Not Sync. ▼ V1 66,97 V 0 * V2 66,97 V 120,0 * V3 66,97 V 120,0 * V4 57,74 V 150,0 * Time Pre-Simulation1: 100,00 ms inary Outputs & Goose - Pre-Simulation1 80 0 0, 0, 0, 0, 0 ▼ GO Server Server				☐ Inv. Phase VTs 52
Interf. V> BI02 (Hrd: BI2) Interf. V> BI02 (Hrd: BI2) Interf. V< BI03 (Hrd: BI3) Stop Interf. BI01 (Hrd: BI1) Trigger Interf. Software	Interf. f> BI04 (Hrd: BI4) v Interf. f< BI05 (Hrd: BI5) v Step Logic Initial NA v Trigger Logic				Search Test Intial step: Min. Resolution Absol. 10.00 mHz Absol. Volt.: 100.00 mV Rel. Freq: 11.00 % Rel. Volt.: 100 % Wat time for every Incrementation: 300.00 ms Multiple of Tolerance for Verification Test: 1.05 Reveal time 300.00 ms Based Only on Values Generated
Wait for PPS	Ingger Delay 0,00 s	Aux	Source: 110,00 V Heatin	nq: 0%	Cycle to Cycle Generation 🗹

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.



× 🗅 💕 🔙 – s	ynchronism 2.02.163	(64 Bits) - CE-6006 (1650)	16)						×
Arquivo Home	Display Software	Options							^ (?
Channels Direc Hrd Set	୍ଟ୍ରେ GOOSE Set ୨ _୦ SV Set ୦୩	Start Stop > Next	Point 🧹 Clear test Line 👹 Clear all	Image: Settings Image: Waveform Image: Sync. Image: Waveform	Present Report	 ▲% ▲% ▶% ▶% ▶% ▶% ▶ ▶	Recreate Restore View Charts Layout		
Hardwa	are	Generat	ion	Options	Report	Units	Layout		
Trigger Search Tra	jectory Test Setting	s							
Insert/Edit Points					•	Chart	Waveform Phasors Synchonism		-
Inset/Edt Edt Point New Point Sequence Bemove Remove All Test Points	General Options System 1 VF-N: 66.97 V f: 60.00 Hz Ø: 0.00 *	Sequence Sequence Step: Number of Point	30.00 * 5: 24	Capcel		10.00 - <u>∆v</u> i	M		Legend: Points not Tested Points Tested Caloss: NT OK Error 30.00 * REF -30.00 *
Points Tested									dF: 0 Hz
	System	n Settings		Breaker	Closing Co				
No. V	ΔV Freq	ΔFreq Ø	ΔØ \	ΔV Fre	q ΔFi				
 ✓ Syst. 2 ✓ Brk Cmd 	I 🗹 Brk Close 🗹 Re	sply			>	-10.00	-100,0m 0	ΔHz-[]	iz]-
Errors List Prote	ection Status								
🚯 ON Line	New			Aux	Source: 110,	00 V Heati	ng: 0%		

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:



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.



🕂 🗋 Arquivo	🚰 🛃 ∓ Home	Synchroni Display	sm 2.02.163 (Software	64 Bits) - CE Options	-6006 (16501	16)													- 0 × ^ (?
Channe Direc	Sync. S Sync. S Conne Harc	t 😵 Gi et 5, 5\ ction Iware	DOSE Set / Set	Start Stop	> Next	Point 🧹 Cle Line 🕳 Cle on	ar test ar all	Settings	sors c. Repo	ent ort		Recreat Charts	te Restore Vi Layout	ew					
Trigger	Search	Trajectory	Test Settings																
Ins	ert/Edit Poin	ts								•	Chart	Wave	form Phas	ors Synch	nonism				•
Insert/	Edit	General	Options	Custor	- 2							M						1	Legend:
Tes	Points									•		10	••••				• • • • • • • • • • • • • • • • • • • •		- Points not Tested
Points	ested									_	10,00			· • · · · · · ·					Points Tested
<u> </u>		Breake	r Closing							-									
No.	ΔV	Freq	ΔFreq	ø	۸Ø	Nominal	Reply Real	Sync.	Status	î		•						•	Colors: NT OK Error
18	-	-	-	-	-	Not Sync.	Not Sync		Passed				•					•	30,00 ° RÉF -30,00 °
19	-8,95 V	60.00 Hz	0 Hz	-360,0 °	-360,0 °	Sync.	Sync.	198,9 ms	Passed										
20	-	-	-	-	-	Not Sync.	Not Sync		Passed		0-	•	•					• •	_
21	-8,95 V	60,10 Hz	103,0 mHz	-2.13 °	-2,13 °	Sync.	Sync.	0,873 s	Passed										dF: 221,0 mHz
22	-	-	•	-	-	Not Sync.	Not Sync		Passed				•					•	
23	-5.17 V	60,18 Hz	179,0 mHz	-1,84 *	-1,84 °	Sync.	Sync.	0,524 s	Passed									•	
24	-	-	-	-	-	Not Sync.	Not Synd	;, -	Passed		-10,00		·	•	••••		•		
<										~ ~		i	•		····•		•		
Syst	2 🗹 Brk C	md 🗹 Brk	Close 🗹 Re	ply							1	-200	.0m -1	100,0m	0	100	.0m	∆Hz [H 200,0m	zj
Error	List Pr	otection Sta	tus																
63 0	l Line	Nev	v						Aux Source	: 110,0	0 V Heatin	p:	0%						



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° .

Arquivo	🚰 🔙 ∓ Home	Synchroni Display	sm 2.02.163 (Software	64 Bits) - CE Options	-6006 (16501	16)						^
Channels Direc	Hrd Se Sync. S t Conne Harc	t 🧐 Gi iet 🤋 Si iction Iware	OOSE Set / Set	Start Stop	> Next >> Next Generati	Point 🖌 Clea Line 👹 Clea	r test r all Set	ttings R Syr	aveform asors nc. F	resent Report Report		Recreate Restore View Charts Layout - Layout
	rt/Edit Poin	Its	Test Setung	•						•	Chart	Waveform Phasors Synchonism
- Insert/E	dit Line dit Line w Line quence emove move Al	General System V F-N: Ø: ☑ Chk Start Ar ④ ΔΩ ○ Ø:	Options 66.97 V 60.00 Hz 0.00 * Sync after Se ng Evaluation: 0.00 * 0.00 * 0.00 *	Seque Seque Nu	ence ence Step: mber of Lines	30.00 ° 12 <u>C</u> onfirm		Cancel			10.00 -∆V 0	M Legend: Points not Tested: Points not Tested: Points Found: Calors: NT OK Enor 30.00* REF -30.00
Test Points Te	Points ested									•	-	
			Nomin	al Value					Breaker Clo	osina Ca		dr: 0 Hz
No.	v	Δ٧	Freq	∆Freq	ø	ΔØ	v	Δ٧	Freq	ΔFi		
< Type: Errors	Points	V Nor	n Val 🗌 Rea	al Value 🗹	Brk Cmd 🗹	Brk Close 🔽	Reply			>	-10,00	ΔHz-[Hz]- -100.0m 0 100.0m
NON	Line	Nev	N						Aux Sou	urce: 110,	,00 V Heat	ing: 0%
									F	Tign	re 41	-

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



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.

annel Direc	Hrd Se Sync. S	t 😵 Gi iet s, s\ ction	OOSE Set / Set	Start Stop	> Next I >> Next I	Point 🧹 Cle Line 🕌 Cle	ar test ar all S	ttings २ Syn	sors c. Repo	ent ort	L ∧ Δ% P ³ / ₈ β <th>Reci</th> <th>eate Restore Vie</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th>	Reci	eate Restore Vie						
	Hard	iware Tesisetes	Test California		Generati	on		Options	Rep	ort	Units		Layout						
Inset /	rt/Edit Poin	ts General	Ontions						_	-	Chart	Wave	form Phasors	Synchonis	m				- legend:
[dit Line	V F-N:	66,97 V	Start F	Point V F-N: 4.62	v c) V F-N:	53,75 V		Ŷ	ΔV (10.00	М	•		•		•		· · Points not Tested · Points Found:
Test ints T	Points	Breake	r Closing							-								•	Colors: NT OK Er
lo.	Δ٧	Freq	ΔFreq	ø	ΔØ	Reply Nominal	Reply Real	Time Sync.	Status	^									30,00 REFD -30,
	-1,47 μV	59,82 Hz	-182,0 mHz	-359,3 °	-359,3 °	Sync.	Sync.	5,52 s	Passed										
	-5,89 V	59,82 Hz	-184,0 mHz	-359,4 °	-359,4 °	Sync.	Sync.	5,47 s	Passed		0	•							dV: -5,66 V
	-9,10 V	59,88 Hz	-117,0 mHz	-358,4 °	-358,4 °	Sync.	Sync.	8,55 s	Passed	-									dA: -2,02 ° dF: 176,0 mHz
	-9,00 V	60,00 Hz	0 Hz	-360.0*	-360,0 *	Sync.	Sync.	197,8 ms	Passed	-		•						0	
	-5,66 V	60,12 Hz	176,0 mHz	-2,22 -2,02 °	-2,22 -2,02 °	Sync.	Sync.	5,69 s	Passed										
pe:	Points	V V Nor	n Val 🗌 Rea	I Value 🖂	Brk Cmd 🖂	Brk Close 🔽	Reply		>	~	-10,00	200.0	• m -100.0	m	•	100	• Om	ДНz (H	z]
	List Pr	rotection Sta	itus								I	200,0			•	100.	un	200,011	

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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:

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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.

Hardware Ger Ingege Search Trajectory Test Settings Insert/Edit General Options Start System Test Points System 1 Start System Test Points Breaker Closing Start System No. ΔV Freq ΔFreq Ø 06 4.16 V 59.86 Hz -144.2 mHz -359.2* -356	il Reply Rep	Options	Report	Units Chart Wa ΔV [/] 10,00	Layout	n		Legend:
Open Search Trajectory Test Settings Insert/Edit Points General Options Start System Test Points System 1 Start System orists Tested Breaker Closing Breaker Closing No. ΔV Freq ΔFreq Ø 6 4.16 V 59.86 Hz -144.2 mHz -359.2 * -356	.0 Reply Rep		-	Chart Wa ΔV [V] 10,00	veform Y Phasors Y Synchonis			Legend:
Bits Cart Form General Options Start System Test Points	Ø Reply Rep			Δ∨ [V] 10.00				Legend:
Test Points Breaker Closing No. ΔV Freq ΔFreq Δ 6 4,16 V 59,86 Hz -144,2 mHz -359,2 * -359	Ø Reply Rep		-	10.00		1		
Breaker Closing No. ΔV Freq ΔFreq Ø Δ 5 4,16 V 59,86 Hz -144.2 mHz -359,2 * -359	Ø Reply Rep			10,00				Line not Tested:
Area Area Ø A 4.16 V 59.86 Hz -144.2 mHz -359.2 * -359.2 *	Ø Reply Rep				· · · · · · · · · · · · · · · · · · ·	•		- Line Tested
λο. ΔV Freq ΔFreq Ø Δ ia 4,16 V 59,86 Hz -144,2 mHz -359,2 * -359	Ø Reply Rep Nominal Rea							Colors: NT OK Er
4,16 V 59,86 Hz -144,2 mHz -359,2 ° -355	Nonina Net	al Sync.	Status		\searrow			30.00 ° REFD -30.
	9,2 * Sync. Sync	c. 5,23 s	Passed			0		
-1,47 μV 59,86 Hz -144,2 mHz -359,2 ° -359	9,2 ° Sync. Sync	c. 5,23 s	Passed					$ $ \forall
-4,17 V 59,86 Hz -144,4 mHz -358,7 * -358	8,7 * Sync. Sync	c. 5,22 s	Passed	0				dV: -4,17 V
· · · · ·	- Not Sync. Not Sy dAngMáx Not Sy	/nc	Passed					dA: -1,68 ° dF: 145,7 mHz
-9,95 V 60,00 Hz 0 Hz -360,0 ° -360	0,0 ° Sync. Sync	c. 1,96 s	Passed				\sim	
	- Not Sync. dAngMáx Not Sy	/nc	Passed					
-4,17 V 60,14 Hz 144,6 mHz -1,68 ° -1,6	68 ° Sync. Sync	c. 5,22 s	Passed	-10,00	1			
			>		-		∆Hz [Hz]	
Generator 🗹 Start Syst. 🗹 Final Syst. 🗹 Brk Cmd 🗹 Brk	Close 🗹 Reply				-200,0m -100,0m	0 100,0m	200,0m	

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.

Presentation Setting			×
Language Inglês En-US 🛛 🗸			
All General Data Test General Data Test General Data of Tested Data Genera Data of Tested Data General Data of Tested Data Genera	evice		
	ОК	Cancel	

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Printing Preview... Nº of Pages: 08

Figure 48

APPENDIX A

A.1 Terminal Designations

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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<)	

∆U 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

Δφ measurement	2° to 80°	Increments 1°
Tolerance	2°	
∆f 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.

Synchronism Soft	Nare	Siemens 7SA6 Relay	
	ir ai o		
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	35	[Rated Secondary Voltage (Ph-Ph)] /	14
(Ph-Ph)		[Matching ratio Vsy1/Vsy2]	
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	24
		(negative signal)	
dFMax+	36	Maximum frequency difference	24
dFMax-	36	Maximum frequency difference	24
		(negative signal)	
dAngMax	36	Maximum angle difference	24
Max Time Sync	36	Maximum duration of Synchronism-check	23