

INSTRUMENTOS PARA TESTES ELÉTRICOS Test Tutorial

Equipment Type: Protection Relay

Brand: SCHWEITZER (SEL)

Model: <u>311C</u>

Function: 21 or PDIS – Distance

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

Objective: <u>Search Test of zones with MHO and quadrilateral</u> <u>characteristics.</u>

Version Control:

Version	Descriptions	Date	Author	Reviewer
1.0	Initial Version	16/08/2021	M.R.C.	M.P.S



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. Final Result Fault AE			
. Two-Phase Loop			
. Final Result Fault BC			
. Three-Phase Loop			
. Final Result Fault ABC			
Report			
ENDIX A			
Ferminal Designations			
Fechnical Data			
APPENDIX B			
	 Final Result Fault AE Two-Phase Loop Final Result Fault BC Three-Phase Loop Final Result Fault ABC Report Report ENDIX A Ferminal Designations Fechnical Data ENDIX 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 contact 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 SEL 311C relay in Distance software

1. Connection with 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 the "*Power* +" pin (Z25) of the relay, connect the negative (black terminal) of the Vdc Aux. Source to the "*Power* -" pin (Z26) of the relay.



1.2 Voltage and Current Coils

To establish the voltage coil connection, connect V1, V2 and V3 voltage channels to pins Z09, Z10 and Z11 of the relay terminal and connect the commons of the voltage channels to pin Z12 of the relay. To establish the connection of the current coils, connect I4, I5 and I6 channels to pins Z01, Z03 and Z05 of the relay terminal and those common to pins Z02, Z04 and Z06. If these last three points are short circuited, connect all the common ones to that point.





1.3 Binary Input

Connect CE-6006 binary input to relay binary output.

• BI1 to pin B01 and its common to pin B02 of the relay.

The following figure shows the details of these connections



2. Communication with the 311C relay

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



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





Figure 5

In the next screen, the model and version of the tested relay are set. Check on the front panel by pressing the *"Status"* key.



Figure 6

Then the "*Part Number*" must be set. This number appears on a stamp pasted on the back of the relay.



)evice Part Number	
Part Number: 0311C 1 1 3 N	* C 5 * 2 1
Chassis 1 = 3U ~	
3 = Horizontal Panel Mount	
User Interface N = Standard Interface plus SafeLock Trip / Close Pushbutton v	
Communication Interface	
Secondary Input Current 5 = 5 Amp Phase and Neutral	
I/O Board Configuration 2 = Additional 12 Standard Outputs and 8 Inputs	
Communications Protocol	
)
<u>E</u> dit	<u>о</u> к

Figure 7

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



AcSELerator® QuickSet - [Settings Editor - New Settings 1 (SEL-311C-1 100 v6.10.1.0)]



Figure 8

3. Parameterization of the SEL 311C relay

3.1. General

After the connection has been established, click on "*Global*" and "*General*" and adjust the connection of the voltage channels, the frequency value and the phase sequence.



Figure 9



3.2. General Settings

Click on "Group1 > Set 1" then "General Settings". In this window, the identification of the relay and its terminal, the current and voltage transformation ratios are set. Set the nominal secondary phase voltage, activate the "EADVS" setting and disable the "EBBPT" setting.

🚰 File Edit View Communications Tools Window	s Help Language	- 8 :
Canadian Construction Cons	Relay Identifier Labels RR Relay Identifier (30 chars) SEL-311 TD Terminal Identifier (30 chars) STATICN A Current and Potential Transformer Ratios CTR. Phase (IA,IB,IC) CT Ratio 200 Range = 1 to 6000 CTR. Neutral (IN) CT Ratio 200 Range = 1 to 1000 PTR. Fhase (VA,VE)/C) PT Ratio 2000,00 Range = 1,00 to 10000,00 VNOM Phase Nominal Voltage (NS) PT Ratio 2000,00 Range = 25,00 to 10000,00 VNOM Phase Nominal Voltage L4N (Volts secondary)) 66,40 Range = 25,00 to 10000,00 VNOM Phase Nominal Voltage PT LOP Logic N Select: Y, N	
Part#: 0311C113N4C5421 Group 1 : General Settings		📑 SEL_311C.rdl
TXD RXD Open: Connected COM3: Prolific USE	-to-Serial Comm Port 57600 8-None-1 Terminal = EIA-232 Serial File transfer = YModem	

3.3. *Line Settings and Fault Locator*

Click on "*Line Settings and Fault Locator*" and adjust the module value and angle of the line impedance. Either positive-sequence or zero-sequence and adjust the line length. Disable the fault locator.



A the full cash field of the full control field of the full cost of field of the full co		- 6		311C-1 100 v6.10.1.0)]	ance (SEL-3) Windows	AcSELerator® QuickSet - [Settings Editor - Distance
▼ Global ● Global del Input Times ● Optobalited Input Times ● Protecting ● Font Hall LOB ● Global Hange ● Phase Distance Elements ● Mage Ve-Sequence Theredower Hange Hange ● Negative-Sequence Timedome						
Switch-Oto-Fall Logic Ornurectoria Associated Trip Schemes Mirrored Bit Traininit and Receive Zone Licturious Statistication Orner Stimps Orner Stimps Statistication Graphical Logic Linux Schemes Y			andary) andary) secondary)	Line Settings and Fault Locator Line Settings ZIMAG Rosseque line impedance Magnitude (Ohms secondary) Z80 Range = 0,10 to 255,00 ZIANG Rosseque line impedance Angle (degrees) 84,00 Range = 0,10 to 255,00 20MAG Zero-Seque line impedance Magnitude (Ohms secondary) 24,80 Range = 0,10 to 255,00 20MAG Zero-Seque line impedance Magnitude (Ohms secondary) 24,80 Range = 0,10 to 255,00 20MAG Zero-Seque line impedance Magnitude (Ohms secondary) 0,36 Range = 0,10 to 255,00 20SMAG Zero-Seq Source Impedance Magnitude (Ohms secondary) 0,36 Range = 0,10 to 255,00 20SMAG Zero-Seq Source Impedance Magnitude (Ohms secondary) 0,36 Range = 0,10 to 255,00 20SANG Zero-Seq Source Impedance Magnitude (Ohms secondary) 0,36 Range = 0,10 to 399,00 Fault Locator Enclo Fault Locator Enable V Select: Y, N	j j j j li j j j j j j j j j j j j j j j	Odobi O
Part#20311C113H4C5421 Group 1: Line Settings and Fault Locator	SEL_311C.rdb	🔮 S		ocator	nd Fault Lo	t#: 0311C113N4C5421 Group 1 : Line Settings and F

Figure 11

3.4. Phase Distance Elements

Click on *"Phase Distance Elements"* and activate a zone. In this case, this zone will be of the MHO type and is active for three-phase or two-phase faults.

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General	Phase Distance Elements	
Optoisolated Input Timers	when these Distances filmments	
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Time and Date Management Settings		
up 1	ECCVT_CCVT Transient Detection Enable	
Set 1	N Select: Y, N	
 General Settings 		
Line Settings and Fault Locator	Pino Phase Distance Element Reach Settings	
Phase Distance Elements	Z1P Zone 1 (Ohms secondary)	
Ground Distance Elements	6,24 Range = 0,05 to 64,00, OFF	
O Distance Element Time Delay Settings		
Phase Overcurrent Elements	Z2P Zone 2 (Ohms secondary)	
Residual Ground Overcurrent Elements	9,36 Range = 0,05 to 64,00, OFF	
Negative-Sequence Overcurrent Elements		
Phase Time-Overcurrent Elements	Z3P Zone 3 (Ohms secondary)	
Kesiddal Ground Time-Overcurrent Elements	1,87 Range = 0,05 to 64,00, OFF	
Out-of-Step Settings	TO THE (Observation)	
Load Encroadment Element	24P Zone 4 (Onms secondary)	
Directional Elements	OFF Range = 0,05 to 64,00, OFF	
Voltage Elements		
Synchronism Check Elements	Mho Phase Distance Overcurrent Fault Detector Settings	
Frequency Elements	50PP1. Zone 1 Phase-Phase Current FD (Amps secondary)	
Reclosing Relay	0.50 Range = 0.50 to 170.00	
Switch-Onto-Fault Logic		
Communications Assisted Trip Schemes	50PP2 Zone 2 Phase-Phase Current FD (Amps secondary)	
Mirrored Bit Transmit and Receive	0,50 Range = 0,50 to 170,00	
Zone 1 Extension Settings		
 Demand Elements 	50PP3 Zone 3 Phase-Phase Current FD (Amps secondary)	
Other Settings	0,50 Range = 0,50 to 170,00	
 SELogic Variable Timers 		
Logic 1	50PP4 Zone 4 Phase-Phase Current FD (Amps secondary)	
Graphical Logic 1	0,50 Range = 0,50 to 170,00	

3.5. *Ground Distance Elements*

Click on *"Ground Distance Elements"* and activate a zone. In this case, this zone will be of the quadrilateral type and is only active for a phase-to-ground fault.





Figure 13

The "*XGPOL*" setting is configured as "*I2*" (not shown) and the other settings are shown in the following figure.



3.6. Distance Element Time Delay Settings



Click on "Distance Element Time Delay Settings" and set the time delay to instantaneous for both phase and ground elements.



TXD RXD Open: Connected COM3: Prolific US8-to-Serial Comm Port 57600 8-None-1 Terminal = EIA-232 Serial File transfer = YModem
Figure 15

3.7. Load Encroachment Element

Click on "Load Encroachment Element" and disable this function.

Constraints Assets The Series Constraints Assets Constraints Assets Constraints Assets	AcSELerator® QuickSet - [Settings Editor - Distance (SEL File Edit View Communications Tools Windo	311C-1100 v6.10.1.0)) vs Help Language	- D ×
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C Back Status 1 C Status 2 Sta	C Gobal General G	Load Encroachment Elements Load Encroachment Elements R.DAD Enable Load Encroachment Elements N Select: Y, N ZLF. Forward Load Ange = 0,05 to 64,00 ZLR. Ferverse Load Impedance (Ohms secondary) 6,50 Range = 0,05 to 64,00 PLAF. Positive Forward Load Angle (degrees) 30,00 Range = -90,00 to 90,00 PLAF. Positive Forward Load Angle (degrees) 30,00 Range = -90,00 to 90,00 PLAR. Positive Reverse Load Angle (degrees) 150,00 Range = -90,00 to 220,00 NLAR. Registive Reverse Load Angle (degrees) 120,00 Range = 90,00 to 220,00 Graphical Settings Editor	
Part#: 0311C113N4C5421 Group 1: Load Encroachment Element SEL_311C.r	Graphical Looic 1		
	Part#: 0311C113N4C5421 Group 1 : Load Encroachment El	ment	I₽ SEL_311C.rdb

Figure 16



3.8. Directional Elements

Click on "Directional Element" and choose the "AUTO" option to have the relay perform the calculations of the directionality control elements automatically. Zones 1 and 2 always have "Forward" directionality and cannot be changed. For zones 3 and 4, it is possible to choose the directionality "F or Forward" or "R or Reverse". In this tutorial only zone 1 is configured and the other zones can be evaluated in an analogous way.



Figure 17

3.9. Other Settings

Click on "*Other Settings*" and configure the way the relay identifies the breaker's open pole, whether by contact signal or by undervoltage. Also set the "50LP" element to 0.25A.





Figure 18

4. Binary Output Adjustments

4.1. Output Contacts

Click on "Logic 1" and select the option "Output Contacts" and make the following adjustments.

Phase Overcurrent Elements Phase Overcurrent Elements Phase Covercurrent Elements Phase Time Overcurrent Elements Output Contact Equations Output Contact IOI Equation (SELogic) Time Overcurrent Elements Output Contact IOI Equation (SELogic) Ou	tor® QuickSet - [Settings Editor - Distance (SEL-311) dit View Communications Tools Windows	-1 100 v.6.10.1.0)] Help Language	- • ×
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Part#: 311C113Net421 Logic 1: Output Contacts	113N4C5421 Logic 1 : Output Contacts		🔮 SEL_311C.rd





4.2. Other Equations

Select the option "Other Equations" and make the following adjustment.

🚰 AcSELerator® QuickSet - [Settings Editor - Distance (SEL-3 🚰 File Edit View Communications Tools Windows 🚳 🍇 🖺 🥩 💭 🙀 💭 📾 🖷 🕐 🖓 🕱	111C-1100v6.10.10] 5 Help Inguage • • • • • • • • • • • • • • • • • • •	- Ø ×
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Part#: 0311C113N4C5421 Logic 1 : Other Equations		SEL_311C.rdb
TXD RXD Open: Connected COM3: Prolific USB-	-to-Serial Comm Port 57600 8-None-1 Terminal = EIA-232 Serial File transfer = YModem	

Figure 20

4.3. Submitting the Adjustments

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





5. Distance software adjustments

5.1. Opening Distance

Click on the "CTC" application manager icon.



Double-click on the "Distance" software icon.





INSTRUMENTOS PARA TESTES ELÉTRICOS

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OFF Line New	Aux Source: 0,00 V Heating: 0%	
	E' 25	

Figure 25

5.2. Configuring the Settings

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



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.



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	Tested device:						
		Identif:	23031982	~	Model	311C	~
		Type:	Line Protection	~	Manufacturer:	SEL	~
	Location:						
		Substation:	CONPROVE				~
		Bay:	1	~			
		Address:	Visconde de Ouro Perto 75 - Ne	ighborhoo	d Custódio Pereira	1	~
		City:	Uberlândia		~		State: MG 🗸
	Responsible:						
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	CE-6006		Serie	s Num.: [3207116302101	110011XXX	
it v In	port Export				Preferences	ОК	Cance

5.3. System

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

Settings	×
General	General Inform. System Notes & Obs. Explanatory Figures Check List Others Connections
Distance	Nominal Impedance Frequency: 60 Hz Phase Seq: ABC 3q power: 47.80 MVA 1q: 15.93 MVA Primary Votage (FF): 13.80 KV (FN): 7.97 KV Primary Current: 2.00 kA Secondary Votage (FF): 115.0 V
~	VIR Use of the secondary Current: 500 A VTR F: 120.0 Phase F Neutral N Ground E Displ. D VTR D / VTR F: 1,00 CTR F: 400.0 Immediate Immediat Immediat Immediat </th
Default 🗸 Im	port Export Preferences QK Cancel

Figure 28

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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 diagram with all the schematic of the connections between the test set and the test equipment.

6. Distance Adjustments

Note: The SEL 311C relay has peculiar characteristics for each type of fault. For the software to perform the test properly, 3 types of zones must be inserted, the first for phase-to-ground faults, the second phase-phase fault and the third for three -phase faults. This must be done because for each type of fault the characteristics of the zones are modified by the relay itself.

6.1. Distance screen > Adjust Prot. Distance

The first step is to adjust the length and angle of the line. Then adjust the ground compensation factor.



Figure 29



6.2. Entering the Zone (Phase-Ground)

The first zone to be entered will be zone-1 (LE). Click on the "Insert" field in the previous figure. In the settings screen, first choose the relay mask "SEL 311C / 321 - Quadr.". You must adjust the actuation time, choose the type of fault (loop) for "LE" and enter the characteristics of the zone. Change the name to "Zn01 LE" and after the settings click on "OK".



Figure 30

6.3. Entering the Zone (Phase-Phase)

Clicking "Insert" again selects the relay mask "SEL 311C/321- Mho". You must adjust the actuation time, choose the fault type (loop) for "FF only" and enter the zone characteristics. Change the name to "Zn01 FF" and after the settings click on "ОК".





Figure 31

6.4. *Entering the Zone (Phase-Phase-Phase)*

Clicking "Insert" again selects the relay mask "SEL 311C/321- Mho". You must adjust the actuation time, choose the type of fault (loop) for "ABC" and enter the characteristics of the zone. Change the name to "Zn01 FFF" and after the settings click on "OK".





Figure 32

7. Channel Targeting and Hardware Configurations

Click on the icon illustrated below.





Then click on the highlighted icon to configure the hardware.





Figure 34

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



Figure 35

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

Ch	annels Direct.				_		×
Local	Model Reset for Hard.	Basic				Confirm	
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Rer	03207116302101110011XXX	V 🗹 ON Line	s _v S. Value	Import	Ex	ort	

Figure 36

8. Test structure for the distance function

8.1. Test Settings

By clicking on the test settings tab, the user must enter a pre-fault in "*Nominal*" mode. Another important setting is the binary input used as a "*Stop Interf.*" which in this example is set to "*BI01*".

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-			Ξ.			Fault Start	Dee	4	_					Anal	yze Trajectory to High S	peed Zones		
inggel	Interr. Software	~	Tringge	er Logic		VEault And	nan	DC Off	set						Based Only on Value	Generated		
43	vvalt for Pr	-з Ц	Ingge	n Delay 0,00 s	,										Cycle to Cycle	Cieneration		
VIO 47	Line Ne	w						Aux So	urce: 110,00 V	Heating	j: 05	%						
]	Figure	37								



8.2.1. Single-phase Loop

Click on the "Search Test" tab and then on the "Insert/Edit Points" tab click on the "Sequence" button. Choose the fault types in this case only single-phase faults, i.e. "AE, BE and CE".



Point test Search Te	est Test Settings	
Insert/Edit Points		-
Insert/Edit Points	General Options	ength
<u>E</u> dit Line	Data Entry: Line Origin	X ative to: Line V
New Line	□ IZI Relative Fault Type: AB AB	ABC
<u>S</u> equence	Adopting t BE BC	
<u>R</u> emove		All 360,00 ° Nº of Points 36
Remove <u>A</u> ll	Characteristic:	Ca <u>n</u> cel

Figure 38

Choose a start point approximately in the middle of the zone, adjust a length value, and choose a start angle, end angle and step. In this way the search lines are drawn automatically.

X □ □ □ □ Distanc 2.02.152 (64 Bits) - CE-6006 (0320711) Arquivo Home View Software Options	× ^ @
Channels Ind Config Cook Start Stop Next Point Clear test Image: Channels Image: Channels	Present Report Image: Constraint of the sector of the se
Point test Search Test Settings	
Insert/Edit Points	Chart ZxT Trajectories Waveform Phasors 700 + (0) 700 + (0) 500 400 300 200 100 100 100 Carrent Point 200 Carren
AF BE CE AB BC CA ABC	
Ne Be Ce Ab Ne Home Home Home Home Comp. Ang Status	-1.00 -2.00 -3.00 -3.00 -5.00
Errors List Protection Status	
N Line New Aux Source: 110,00 V	Heating: 0%
Figure	39

By clicking on the "Confirm" button the following search lines are created.



🏋 🗈 🛛	🧉 🚽 🗃	Distanc 2.02	.152 (64 Bits)	- CE-6006 (0	320711)												- 0	×
Arquivo	Home	View S	oftware Opt	ions														~ ?
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	Hardware Generation Options Report Units Layout																	
Point test	Search T	est Test	Settings						(a)) (
Inser Insert /Er	rt/Edit Points	Ganaral Or	tions						Chart	ZxI I	ajectories Wa	evetorm P	hasors		1.1			•
New Sequ	It Line	Data Ent Line Origi IZI Re Adop IZI: 3 Ø: 7	In alative to ting the same .00 Ω 7.0 °	Z and Ø Line line angle R: 0,67 Ω X: 2,92 Ω		ength Relative to: ength: 5,00 Ω equence itial: 0,00 * inal: 360,00	Line Ang. : 330.0 ° Step: 30.00 °	-	8,00 7,00 6,00 5,00 4,00 3,00								Fault/ Legend: Search Po Found Poin Colors: Not Te Passed Fail	NE ints nts sted
Test	Point	Characteris	tic: 🔘 Sea	rch 🔾 Chec	k				2.00			A		A.			Information: Current Point:	
Tested P	oints								0								- Z :	
AE	BE CE	AB	BC CA	ABC					-1.00			XX	시자	A-A-	1-1		- 10. Di	
Nº	R Home	X Home	Z Home	Ø Home	Comp.	Ang	Status	^	-2,00	\mathbb{N}	NXX	X		W	1/1/	1/1	- X:	
10	0,675 Ω	2,92 Ω	3,00 Ω	77.00 °	5,00 Ω	270,0 °	Not Tested		-4.00	¥¥	1 A P	X	-13	Ð	Æ	K.		
11	0,675 Ω	2,92 Ω	3,00 Ω	77,00 °	5,00 Ω	300,0 °	Not Tested		-5.00		N A			K	14	ŔЙ		
12	0,675 Ω	2,92 Ω	3,00 Ω	77,00 °	5,00 Ω	330,0 *	Not Tested		-7,00		NXH			- 1				
Type:	Y Y Y Y Y NΩi Impe: Lines Y RX Z and Ø Z rel Length Length KΩi																	
Errors	List Pro	tection Statu	IS															
() ON	Line	New						Aux Source: 110,00 V	Heating	: 05	6							
								T 1	40									

Figure 40

Start the generation by clicking on the icon highlighted below or through the shortcut "Alt + G".



The final result is shown below showing the characteristics of the zones. To zoom in, left click and drag defining the region to be zoomed in, and then release the button.

8.2.2. Final Result Fault AE

By clicking on the "AE" tab, the final result is verified. It is observed that all points are within the tolerances given by the manufacturer so that the test is approved. Click on the "BE" or "CE" tabs if you want to see the results for these types of faults (not shown in this tutorial).



INSTRUMENTOS PARA TESTES ELÉTRICOS 🛣 | 🗋 🗃 🚽 = | Distanc 2.02.152 (64 Bits) - CE-6006 (0320711) ۵ rquivo Home View Software Options 🗲 😭 Hrd Config 🌸 GOOSE Config Next Point Clear test Start Stop >>> Next Fault Present Report 🗶 GPS Config 🖏 SV Config Start Stop >>> Next Fault Connection Hardware Generation Options Report Units Lavout Point test Search Test Test Settings Insert/Edit Points Chart ZxT Trajectories Waveform Phasors nsert/Edit Points 7.00 - \$ 101 - 🗆 FaultAE Z and Ø \sim \sim Data Entry: Relative to: Line < Legend 6,00 Search Points Length. 5.00 Ω Ang. : 330.0 ° New Line 🗸 |Z| Relative to ... Line 🗸 5,00 Found Points Adopting the same line angle Sequence ... 4,00 IZI: 3,00 Ω R: 0.67 Ω Ø: 77,0 ° X: 2,92 Ω Initial: 0,00 * Step: 30,00 * Colors: 3,00 Passed Fail Remove Final: 360,00 ° Nº of Points 12 2,00 Remove All Characte istic: Search Check Information: 1.00 Current Point: Test Point - |Z| - Ø: . Tested Po 0 BE CE AB BC CA ABC AE -1.00 - R: - X: R Nom. X Nom. R Real X Real Time Nominal Time Real N⁰ Zone Status -2,00 -3,00 Zn01_LE (To 0.675 Ω -40,96 mΩ 0,675 Ω -40,96 mΩ 0 s 23,18 ms 10 Passed -4,00 Zn01_LE (To 2,45 Ω -148,6 mΩ 2,45 Ω -150 7 mO 0 s 31,13 ms 11 Passed -5,00 Passed 12 Zn01 LE (To 2.69 Ω 1.76 Ω 32.70 ms 2.65 Ω 1.78 Ω 0 s -6.00 RIQ -7.00 Type: Points V Zone R-X Zrel Time V& -6.00 -5.00 -4.00 -3.00 -2.00 -1.00 0 1.00 2.00 3.00 4.00 5.00 6.00 Errors List Protection Status 🚯 ON Line New Aux Source: 110,00 V Heating: 0% Figure 42

8.2.3. Two-Phase Loop

Click on the "Search Test" tab in the previous figure and then, on the "Insert/Edit Points" tab, click on the "Sequence" button. Choose the fault types in this case only two-phase faults, i.e. "AB, BC and CA".

Point test Search Te	Test Settings							
Insert/Edit Points 🗸								
Insert/Edit Points	General Options							
Edit Line	Data Apply to X Relative to: Line V							
New Line 🗸	IZ AE AB ABC							
Sequence	Ac BE ✓ BC Sequence [Z]: CE ✓ CA All Initial: 0,00 ° Step: 10,00 °							
Remove	Ø: OK Cancel Final: 360,00 ° Nº of Points 36							
Remove All	Characteristic: Search Check							



Choose a start point approximately in the middle of the zone, adjust a length value, choose a start angle, end angle and step. In this way the search lines are drawn automatically.





Figure 44

By clicking on the "Confirm" button the following search lines are created.



Start the generation by clicking on the icon highlighted below or through the shortcut "Alt + G".





The final result is shown below showing the characteristics of the zones. To zoom in, left click and drag defining the region to be zoomed in and then release the button.

8.2.4. Final Result Fault BC

By clicking on the "BC" tab, the final result is checked. It is observed that all points are within the tolerances given by the manufacturer so that the test is approved.

X] □ <th>- o × ~ @</th>	- o × ~ @
Channels Config & GOOSE Config & Start Stop > Next Point & Start Stop > Next Point & Start Stop > Next Point & Start Stop > Next Line & Next Line & Next Line & Start Fault & Generation	Itear test Clear all Settings (C) Tajectory Options Report Units Settings (C) Tajectory Options Report Units Settings (C) Tajectory Settings (C
Point test Search lest lest Settings	- (hat VTvT V Triastories V Waveform V Davor
Inserv bit voints General Options Length Inserv bit voints General Options Length Bata Entry: Z and Ø Relative to Line Origin Ine Origin Relative to Line Origin Ine Origin Relative to Sequence IZ Relative to Image: Ine Origin Sequence Image: Image: Image: Remove Image: Image: Image: Image: Image: Image: Image: Image: Remove Image: Image: Image: Image: Image:	Chart CAI materians waverom Phases FaultBC Legent:
Nº Zone R X R X Time Nom. Nom. Real Real Nominal	Time Status
10 Zn01_FF (Τc 0.675 Ω 1.46 mΩ 0.675 Ω 14.62 mΩ 0 s	30.28 ms Passed -3.00
11 Zn01_FF (Τc 2.07 Ω 0.512 Ω 2.05 Ω 0.546 Ω 0 s	32.87 ms Passed 4.00
12 Zn01_FF (Tc 3.04Ω 1.56Ω 3.01Ω 1.58Ω 0.s	28.22 ms Passed
Type: Points V Zone V R-X Zrel V Time V&I	-6,00 -5,00 -4,00 -3,00 -2,00 -1,00 0 1,00 2,00 3,00 4,00 5,00 6,00
Errors List Protection Status	Aux Source: 110,00 V Heating: 0%

8.2.5. Three-Phase Loop

Click on the "Search Test" tab in the previous Figure and then, on the "Insert/Edit Points" tab, click on the "Sequence" button. Choose the fault types, in this case only three-phase faults, i.e. ABC.



Point test	Search Tes	t Test Settings					
/Insert/	'Edit Points						-
-Insert/Edit	Points	General Options				_	
Eda	Line	Data Entry:	Apply to		×		
Edit	LINE	Line Origin	- Fault Type	e:		to:	Line 🗸
New L	ine 🗸	Z Relative to .	AE	AB	ABC	Ω 00	Ang.: 0.0 °
Seque	nce	Adopting the sa	BE	BC			
ocque		Z : 0,00 Ω	CE	CA	All) *	Step: 10.00 °
Rem	ove	Ø: 0,0 °		ОК	Cancel	° 00.	№ of Points 36
Remo	ve All	Characteristic: 🔘 :	Search 🔾	Check		<u>.</u>	

Figure 48

Choose a start point as the origin, set a length value, choose a start angle, end angle, and step. In this way the search lines are drawn automatically.

X I Image: Second Sec	× ^ @
Image: Second	ατ Present Report Report Report Units Layout
Point test Search Test Settings	
Insert/Edit Points	Chart ZrT Trajectories Waveform Phasors Chart ZrT Trajectories Waveform Phasors Chart ZrT Trajectories Waveform Phasors Chart ZrT Trajectories Waveform Phasors Classified Phasors FaultABC Legend:
AE BE CE AB BC CA ABC Nº R X IZI Ø Comp. Ang Status Impe: Impe: Mome Home Home Comp. Ang Status Impe: Impe: Max Zand Ø Zand Ø Impe: Length Errors List Protection Status K Aux Source: 10,001	- 100 - 200 -
Figure	e 49

By clicking on the "Confirm" button the following search lines are created.



🌋 🛅 📸 🚽 = Distanc 2.02.152 (64 Bits) - CE-6006 (0320711)	— 🗇 🗙
Arquivo Home View Software Options	^ (2)
Channels Channels	Waveform LP Chart ZAT Phasors ID SEL Trajectory Present Report
Hardware Generation	Options Report Units Layout
Point test Search Test Test Settings	
Inser/Call Points General Options Inser/Call Points General Options Inser/Call Points General Options Inser/Call Points General Options Isel Line Data Entry: Isel Line Diata Entry: Isel Line Diata Entry: Ise Bedave to Line Isequence Isequence It Relative to : Isemove 0: Isemove 0: Onaracteristic: Isearch Otheck	Chart CAT indectories were offer indexes Second Priorits Construction Con
Tested Points	0
AE BE CE AB BC CA ABC	- R-3.396 Ω - Χ-7.405 Ω - Χ-7.405 Ω
10 0,675 Ω 2.92 Ω 3.00 Ω 77,00 ° 5.00 Ω 270,0 ° Not Tested	
11 0,675 Ω 2,92 Ω 3,00 Ω 77,00 ° 5,00 Ω 300,0 ° Not Tested	-3.00
12 0.675 Ω 2.92 Ω 3.00 Ω 77.00 * 5.00 Ω 330.0 * Not Tested	-7.00
Type: Lines V R-X Z and Ø Zrel V Length Length	-8,00 -6,00 -4,00 -2,00 0 2,00 4,00 6,00 8,00
Errors List Protection Status	
🚯 ON Line New	Aux Source: 110,00 V Heating: 0%

Figure 50

Start the generation by clicking on the icon highlighted below or through the shortcut "Alt + G".



Figure 51

The final result is shown below with the characteristics of the zones. To zoom in, left click and drag defining the region to be zoomed in and then release the button.

8.2.6. Final Result Fault ABC

By clicking on the "*ABC*" tab, the final result is verified. It is observed that all points are within the tolerances given by the manufacturer so that the test is approved.





9. Report

After finishing the test, click on the icon "*Present Report*" 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	\times	
	Language Inglês En-US 🗸 🗸		
	All General Data Test General Data of Tested Device General Data of Selected Settings General Data of Selected Simulation General Data of Selected Simulation General Data of Selected Settings General Data of Settings Gene	~	
	OK Cancel		
	Figure 53		
X I Image: Second sec	3its) - CE-6006 (0320711)		- 0 × ^ (?
Print Setting Page Word Office to PDF	Image: Drep age Image: Drep age Image: Drep age Image: Drep age Image: Drep age Previous Next Cose Print Previous Previous Preview		
Print Export	Zom View Close		

Figure 54



APPENDIX A A.1 Terminal Designations





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



A.2 Technical D)ata
-----------------	------

Mho Phase Distance Elements

Zones 1-4 Impedance Re	ach	
Setting Range:	OFF, 0.05 to 64 Ω sec, 0.01 Ω steps (5 A nominal) OFF, 0.25 to 320 Ω sec, 0.01 Ω steps (1 A nominal)	
	Minimum sensitivity is controlled by the pickup of the supervising phase-to-phase overcurrent elements for each zone.	
Accuracy:	±5% of setting at line angle for 30 ≤ SIR ≤ 60 ±3% of setting at line angle for SIR ≤ 30	
Transient Overreach:	<5% of setting plus steady-state accuracy	
Zones 1-4 Phase-to-Pha	ase Current Fault Detectors (FD)	
Setting Range:	0.5-170.00 A _{P-P} secondary, 0.01 A steps (5 A nominal)	
	0.1-34.00 A _{P-P} secondary, 0.01 A steps (1 A nominal)	
Accuracy:	± 0.05 A and $\pm 3\%$ of setting	
	± 0.01 A and $\pm 3\%$ of setting (1 A nominal)	
Transient Overreach:	<5% of pickup	
Max. Operating Time:	See Figure 3.13–Figure 3.16.	
Mho and Quadrilateral Gro	und Distance Element	
Zones 1-4 Impedance Re	ach	
Mho Element Reach:	OFF, 0.05 to 64 Ω sec, 0.01 Ω steps	
	OFF, 0.25 to 320 Ω sec, 0.01 Ω steps (1 A nominal)	
Quadrilateral Reactance Reach:	OFF, 0.05 to 64 Ω sec, 0.01 Ω steps (5 A nominal) OFF, 0.25 to 320 Ω sec, 0.01 Ω steps (1 A nominal)	
Quadrilateral Resistance Reach:	OFF, 0.05 to 50Ω sec, 0.01 Ω steps (5 A nominal) OFE 0.25 to 250 Ω sec, 0.01 Ω steps	
	(1 A nominal) Minimum sensitivity is controlled by the pickup of the supervising phase and residual overcurrent elements for each zone.	
Accuracy:	±5% of setting at line angle for 30 ≤ SIR ≤ 60 ±3% of setting at line angle for SIR < 30	
Line Angle:	≥45° (Quadrilateral)	
Transient Overreach:	<5% of setting plus steady-state accuracy	
Zones 1-4 Phase and Res	idual Current Fault Detectors (FD)	
Setting Range:	0.5–100.00 A secondary, 0.01 A steps (5 A nominal) 0.1–20.00 A secondary, 0.01 A steps (1 A nominal)	
Accuracy:	±0.05 A and ±3% of setting (5 A nominal) ±0.01 A and ±3% of setting (1 A nominal)	
Transient Overreach:	<5% of pickup	
Max Operating Time:	See Figure 3 17-Figure 3 20	

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APPENDIX B

Equivalence of software parameters and the relay under test.

Table 1							
Distance Software		SEL 311C Relay					
	-		-				
Parameter	Figure	Parameter	Figure				
Secondary Current	28	Secondary Input Current	07				
Frequency	28	NFREQ	09				
Phase Seq.	28	PHROT	09				
Line Length	29	Z1MAG	11				
Line Ang	29	Z1ANG	11				
Znp	31	Z1P	12				
Xgn	30	XG1	13				
RĞn	30	RG1	13				
TANG	30	TANG	14				
Mod K0	29	K0M1	14				
Ang K0	29	K0A1	14				
Trigger Time	31	Z1PD	15				
Trigger Time	30	Z1GD	15				