

INSTRUMENTOS PARA TESTES ELÉTRICOS Test Tutorial

Equipment Type: Protection Relay

Brand: SIEMENS

Model: <u>7SA611</u>

Functions: 21 or PDIS – Distance

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

**Objective:** <u>Search and Point Test of Zones with Quadrilateral</u> <u>Characteristics</u>

Version Control:

Version	Descriptions	Date	Author	Reviewer
1.0	Initial Version	06/08/2021	M.R.C.	M.P.S



Su	nmary
1.	Relay connection to CE-6006
1.1	Auxiliary Source
1.2	Current and Voltage Coils5
1.3	Binary Inputs
2.	Communication with 7SA6 relay
3.	Parameterization of the 7SA6 relay7
3.1	Device Configurations7
3.2	Masking I/O8
3.3	Power System Data 19
3.4	Transformers
3.5	Power System
3.6	Setting Group A11
3.7	Power System Data 212
3.8	21 Distance Protection/General settings12
3.9	21 Impedance Distance Zones (Quadrilateral)
<i>4</i> .	Distance software adjustments
4.1	Opening Distance
4.2	Configuring the Settings
4.3	<i>System</i>
4.4	Distance Adjustments
4.5	Distance Screen > Adjust Prot. Distance
4.6	Inserting Phase Zones
4.7	Inserting the Zones (Line-Earth)
5.	Hardware Settings
6.	Channels Direc
7.	Restore Layout
8.	Function 21 test structure
8.1	Test Settings
8.2	Point Test for Zones 1,2,3 and 4
8.2.	1 Two-Phase and Three-Phase Loop
8.2.	2 Final Result A-B-C faults
8.2.	3 Single-phase Loop
8.2.	4 Final Result AE Fault
_	Rua Visconde de Ouro Preto. 77 - Bairro Custódio Pereira - Uberlândia – MG - CEP 38405-202.



8.3	Search Test for Zones 1,2,3 and 4	
8.3.1	Two-Phase and Three-Phase Loop	
8.3.2	Final Result A-B-C Fault	
8.3.3	Single-phase Loop	
8.3.4	Final Result AE Fault	
9. 1	Report	
APP	ENDIX A	
A.1 7	<b>Ferminal Designations</b>	
A.2 7	Fechnical Data	40
APP	ENDIX B	41



## **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 contacting 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.



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

Copyright © CONPROVE. All rights reserved. The dissemination, total or partial reproduction of its content is not authorized, unless expressly permitted. Violations are punishable by law.



## INSTRUMENTOS PARA TESTES ELÉTRICOS Sequence for testing the 7SA6 relay in the Distance 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 F1 pin (UH+) of the relay and the negative (black terminal) of the Vdc Aux. Source to F2 pin (UH-) of the relay.



## **1.2** Current and Voltage Coils

To establish the voltage coil connection, connect V1, V2 and V3 channels with the relay terminal pins R15, R17 and R18 and the common ones to pin R16. To establish the connection of the current coils, connect I4, I5 and I6 channels with pins Q1, Q3 and Q5 of the relay terminal and make a short circuit between pins Q2, Q4 and Q6, finally connect pin Q6 to Q8 and connect the current channel commons to pin Q7.





## **1.3** Binary Inputs

Connect the CE-6006 binary input to the relay binary output, BI1 to pin R1 and its common to R5 in this way, the trip signal sent by the relay is monitored.



## 2. Communication with 7SA6 relay

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



When opening the program, the substation that contains the relay (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.





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

Figure 6

### 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 Configuration"*.

🌛 DIGSI - [Carvalho / Folder / 7S	A611 V4.6/7SA611 V04.68.03]
📴 File Edit Insert Device View 🤇	Options <u>W</u> indow <u>H</u> elp
🖬 🧉 🖞 🕹 🖏 🛛	蓬 🌋 🐁 🌫 🏥 🗰 💵 🛺 📢
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 Interfaces Passwords Set-Language
Fig	gure 7

In the *"Functional Scope"* screen, disable all functions leaving only the *"21 Distance protection pickup program"* and *"Trip mode"* functions enabled. This prevents trips from other functions interfering with the test. After the adjustments click *"OK"*.



Functio	nal Scope		X
A <u>v</u> ailable	e functions:		
No.	Function	Scope	^
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	Disabled	
0136	81 Over/Underfrequency Protection	Disabled	1
0137	27, 59 Under/Overvoltage Protection	Disabled	
0138	Fault Locator	Disabled	~
		About	
	K <u>D</u> IGSI -> device	Cancel Help	

Figure 8

### 3.2 Masking I/O

The next step is to adjust the relay output. To access these parameters, double-click with the left button on "Masking I/O (Configuration Matrix)" as illustrated in the next figure.





Binary output BO1 is designated for sending the trip of zones 1, 2, 3 and 4. In order to aid the test, LED 1 is used to signal the trip sending of zone 1, LED 2 to signal the zone 2 trip send, LED 3 to signal zone 3 trip send and LED 4 to signal zone 4 trip send.

🇱 Settings - Maski	ing I/O (Confi	guration Matrix) -	Carv	alho / Fol	der	17	5A6	11	V4.	6/7	SAG	511	VO	4.6	58.	03																			-		×
		Information				Sour	се														[	Dest	inat	ion													
	Number	Display text		. Туре		F	S C					В	0					Т						LED	)s						В	uffer	. [	S	XI	) C	м
					BI			1	2	3 4	1 5	6	7	8	9	10	11 1	2 1	1 2	: 3	4	5	6	7	8	9 1	01	11	2 13	14	0	S	Т				
Device, General						3	< ×																								×			×	×		
P.System Data 1																																					
Osc. Fault Rec.																															×			×			
P.System Data 2																															×		×	×	×		
	03801	21 TRIP		OUT				U										U																Х			
	03811	21 TRIP 1p. Z1		OUT															U															Х			
21 Dis Consul	03823	21 TRIP3p. Z1sf		OUT															U															Х			
21 Dis.deneral	03824	21 TRIP3p. Z1mf		OUT															U															Х			
	03816	21 TRIP 1p. Z2		OUT																U				Т		Т								Х			
	03817	21 TRIP 3p. Z2		OUT															Τ	U				Т		Т								Х			
21 Dis.ZoneQuad																																					
Measurem.Superv																															×			×			
EN100-Modul 1																Т			Т	Г				Т		Т					×						
Testing																															×						
Cntrl Authority																															×			ж			
Control Device						3	( ×													T											×			×	×	×	
Process Data																															×				×		
Measurement																																					
Set Points(MV)							×																								×						
Energy																																					
Statistics																																		×			
ThreshSwitch																															×					×	

#### Figure 10

## 3.3 Power System Data 1

Double-click on "Power System Data 1" to access the system settings.



Those settings highlighted in red need special attention. Firstly, the VT and CT data are shown, then the system data and finally the breaker data.



## **3.4** *Transformers*

In the "Transformers" tab, the CT and VT ratio of the system is configured.

Pov	ver Sy	stem Data 1	X
Tr	ansform	ners Power System Breaker	
9	ettings:		
Γ	No.	Settings	Value
	0201	CT Starpoint	towards Line 💌
	0203	Rated Primary Voltage	400,0 k∨
	0204	Rated Secondary Voltage (Ph-Ph)	115 V
	0205	CT Rated Primary Current	1000 A
	0206	CT Rated Secondary Current	5A
	0210	V4 voltage transformer is	Vsy2 transformer
	0211	Matching ratio Phase-VT To Open-Detta-VT	1,73
	0215	Matching ratio Vsy1 / Vsy2	1,00
	0220	I4 current transformer is	Neutral Current (of the protected line)
	0221	Matching ratio I4/lph for CT's	1,000
г	Dien	au additional settings	
· '		ay additional sectings	
		Expo	t <u>G</u> raph <u>About</u>
	OK	Aplicar DIGSI -> Device	Cancelar Ajuda

Figure 12

## 3.5 Power System

In the "*Power System*" tab, the nominal frequency, the phase sequence, whether the system is grounded and how the ground compensation for ground faults will be set up.

Po	wer Sy	stem Data 1			X
T	ransform	ners Power System Breaker			
	Settings:				
	No.	Settings		Value	
	0207	System Starpoint is		So	lid Grounded 💌
	0230	Rated Frequency			60 Hz
	0235	Phase Sequence			ABC
	0237	Setting format for zero seq.comp. format		Zero seq. comp. factor K	0 and angle(K0)
]	Disp	lay additional settings			
			E <u>x</u> port	<u>G</u> raph	About
	OK	Apjicar DIGSI -> Device		Cancelar	Ajuda

Figure 13



## 3.6 Setting Group A

This option sets important data about the protected transmission line and the parameters of the impedance function, whose calculations will be shown later.



Figure 14

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

Setting	Group A	×
<u>F</u> unctio	ns:	
No.	Function	
0011	Power System Data 2	
0012	21 Distance protection, general settings 21 Distance zones (guadrilateral)	
0029	Measurement Supervision	
	stomize Reset A	bout
		bout
<u></u> lo	ose	Help

Figure 15



### 3.7 Power System Data 2

In the "*Power System*" tab, important data such as: measurement full scale voltage and current, line angle, slope angle of the distance characteristic and the compensation factors for ground faults are parameterized.

Po	wer Sy	stem Data 2 - Settings Group A	×
F	<sup>p</sup> ower Sy	stem Line Status Trip 1-/3-pole	
	<u>S</u> ettings:		
	No.	Settings	Value
	1103	Measurement: Full Scale Voltage (100%)	400,0 kV
	1104	Measurement: Full Scale Current (100%)	1000 A
	1105	Line Angle	60 °
	1211	Angle of inclination, distance charact.	60 °
	1107	P,Q operational measured values sign	not reversed
	1120	Zero seq. comp. factor K0 for zone Z1	0,880
	1121	Zero seq. comp. angle for zone Z1	0,00 *
	1122	Zero seq.comp.factor K0,higher zones >Z1	0,880
	1123	Zero seq. comp. angle, higher zones >Z1	0,00 *
	🗹 <u>D</u> isp	ay additional settings	
		Export	<u>G</u> raph <u>About</u>
	OK	Apjicar DIGSI -> Device	Cancelar Ajuda

Figure 16

### 3.8 21 Distance Protection/General settings

The next step in the "General" tab is to activate function 21, disable the series compensation line and adjust the load compensation, which in this case will be infinite.

No	Settings	Value
4.004	24 Distance exclusion in	Valac
1201	21 Distance protection is Reaso Curvent threshold for dist, mass	0.50 4
1202	Angle of inclination, distance abarest	0,50 A en *
1211	Series companyed line	00 NO
1200	Instantaneous trin after SwitchOnToFault	Inactive
1232	R load minimum Load Impedance (nh-d)	oo Obra
1241	PHiload maximum Load Angle (ph-g)	45 °
1242	R load minimum Load Impedance (ph-ph)	oo Obra
1244	PHiload maximum Load Angle (ph-ph)	45 °
1317A	Single pole trip for faults in 72	YES
1357	71B enabled before 1st AR (int_or ext.)	NO
	1 182 1 22	
	lay additional settings	

#### Figure 17



In the *"Time Delays"* tab, the time delays for each zone are adjusted, both for three-phase faults and for ground faults.

21 Distar	nce protection, general settings - Setting	gs Group A 🛛 🔰		
General Settings	Ground faults Time Delays			
No.	Settings	Value		
1210	21 Condition for zone timer start	with distance pickup 💌		
1305	T1-1phase, delay for single phase faults	0,00 sec		
1306	T1multi-ph, delay for multi phase faults	0,00 sec		
1315	T2-1phase, delay for single phase faults	0,30 sec		
1316	T2multi-ph, delay for multi phase faults	0,30 sec		
1325 T3 delay 0,6				
1335 T4 delay 0,90				
1345	T5 delay	00 sec		
1355	T1B-1phase, delay for single ph. faults	0,00 sec		
1356	T1B-multi-ph. delay for multi ph. faults	0.00 sec		
🖵 Disp	lay additional settings			
		Export Graph About		
OK	Aplicar DIGSI -> Device	CancelarAjuda		

Figure 18

## 3.9 21 Impedance Distance Zones (Quadrilateral)

Set the impedance values of zones 1, 2, 3 and 4 for three-phase/single-phase faults and their respective delays. In this test the Z1B zone will not be used.



21 Distan	21 Distance zones (quadrilateral) - Setting Group A X							
Zone Z1	Zone Z1B-exten. Zone Z2 Zone Z3 Zone Z4 Zone Z5							
Setting	3:							
No. Settings Value								
1301	Operating mode Z1	Forward						
1302	R(Z1), Resistance for ph-ph-faults	0,250 Ohm						
1303	X(Z1), Reactance	0,500 Ohm						
1304	RG(Z1), Resistance for ph-gnd faults	0,500 Ohm						
1305	T1-1phase, delay for single phase faults	0,00 sec						
1306	T1multi-ph, delay for multi phase faults	0,00 sec						
1307	Zone Reduction Angle (load compensation)	0°						
🔽 Dis	play additional settings							
	Export	Graph About						
ОК	Aplicar DIGSI -> Device	Cancelar Ajuda						

Figure 19

21 Distan	ce zones (quadrilateral) - Setting Group A	×								
Zone Z	Zone Z1 Zone Z1B-exten. Zone Z2 Zone Z3 Zone Z4 Zone Z5									
Setting	IS:									
No.	No. Settings Value									
131	Operating mode Z2	Forward 💌								
131	2 R(Z2), Resistance for ph-ph-faults	0,500 Ohm								
131	3 X(Z2), Reactance	1,000 Ohm								
131	4 RG(Z2), Resistance for ph-gnd faults	1,000 Ohm								
131	5 T2-1phase, delay for single phase faults	0,30 sec								
131	6 T2multi-ph, delay for multi phase faults	0,30 sec								
1317	A Single pole trip for faults in Z2	NO								
<b>I</b> Dis	play additional settings									
	Export	Graph About								
ОК	Aplicar DIGSI -> Device	Cancelar Ajuda								

Figure 20



	Sattinga	 Value	
4224	Operating mode 72	 value	Dovoro -
1321	D(73) Desistance for ph.ph.faulte		1.000 Obm
1323	X(Z3) Reactance		2 000 Ohm
1324	RG(Z3), Resistance for ph-ond faults		2,000 Ohm
1325	T3 delay		0,60 sec
] Disp	lay additional settings		

Figure 21

21 Distan	ce zones (quadrilateral) - Setting Group A	×							
Zone Z1	Zone Z1B-exten. Zone Z2 Zone Z3 Zone Z4 Zone Z5								
Setting	3:								
No.	Settings	Value							
1331	Operating mode Z4	Non-Directiona 💌							
1332	R(Z4), Resistance for ph-ph-faults	2,400 Ohm							
1333	X(Z4), Reactance	2,400 Ohm							
1334	RG(Z4), Resistance for ph-gnd faults	2,400 Ohm							
1335	T4 delay	0,90 sec							
Dis	play additional settings								
	Export Graph About								
ОК	OK Aplicar DIGSL-> Device Cancelar Ajuda								

Figure 22



## 4. Distance software adjustments

## 4.1 Opening Distance

Click on the CTC application manager icon.



Click on the "Distance" software icon.



Figure 24



🏋   🗋 🗃 🚽   Distanc 2.02.152 (64 Bits) - CE-6006 (0320711)		$-$ 0 $\times$
Arquivo Home View Software Options		~ <b>(</b> )
Channelis & Connection Store S	set Point ext Fourt ext Fault ext Fa	
Hardware Settings	X	
Point test Search Test Test Settings		
Insert/Edit Points General	General Inform. System Notes & Obs. Explanatory Figures Check List Others Connections	
Insert/Edit Points General Options		FaultAE
Edit Point	Desor: Date: Date: Desor: Deso	Legend:
New Point	Tested device:	- Points Not Tested
Z  Relative to	Identif: V Model V	Points Tested
Sequence	Type: V Manufacturer: V	Colors: Not Tested
IZ: 0.00 Ω		Passed
Ø: 0.0 *	Location:	Fail
Remove All	Substation:	Information:
Tart Point	Bay:	Current Point
Tested Points	Address:	-  Z :
AF BE CE AB BC CA	City: V State: V	- Ø:
	Responsible:	- R:
No. Zone Operated R		
		7
	Sector: V Registry: V	
	Tool Test:	
	CE-6006 Series Num.: 03207116302101110011XXX	
<		
☑ Zone ☑ R-X ☑ Z and Ø ☑ Z rel ☑		1.00
Errors List Protection Status		
New	rieterices UN Cancel	

Figure 25

## 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.

🛣   🗋 🗃 🛃 🚽   Distanc 2.02.152 (64 Bits)	) - CE-6006 (0320711)							
Arquivo Home View Software Opt	tions							
Channels Direc Hrd Config 😵 GOOSE Config @ GPS Config 5, SV Config the Connection	Start Stop Stop Next Point Clear test	Image: Waveform         Image: Wa	Present Report	Recreate Charts Layout				
Hardware	Generation	Options	Report Units	Layout				
Figure 26								

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



INSTRUMENTOS	PARA	TESTES	ELÉTRICOS

General General Inf	orm. System N	lotes & Obs. Expl	anatory Figures C	Check List Other	rs Connection	IS	
Distance	eor: Distance Fund	tion		Date:			
	aur. j Distance i unc			Date.	1		
Tested dev	ice:						
	Identif:	23031982	~	Model	7SA611		$\sim$
	Туре:	Line Protection	~	Manufacturer:	Siemens		$\sim$
Location:							
	Substation:	CONPROVE					~
	Bay:	1	~				
	Address:	Visconde de Ouro	Perto 75 - Neighborhoo	od Custódio Pereira	i		~
	City:	Uberlândia		~		State: MG	$\sim$
Responsible	ə:						
	Name:	Eng° Michel Rock	embach de Carvalho				~
	Sector:	Engenharia	~	Registry:	00001		~
Tool Test:							
CE-600	6		Series Num.:	03207116302101	110011XXX		
~ · · · · · · · · · · · · · · · · · · ·							

Figure 27

### 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 PTs and CTs are configured. There are also two sub-tabs "*Impedance*" and "*Source*" whose data is not relevant for this test.

Settings					>
General	General Inform. Syste	Motes & Obs.	Explanatory Figures	Check List Others Co	nnections
Distance	Nominal Impedance Frequency: Phase Seq.: 3φ power: 1φ: Primary Voltage (FF): (FN): Primary Current: Secondary Voltage (FF): ((N): Secondary Current:	Source 60 Hz ABC 47.80 MVA 15.93 MVA 13.80 KV 7.97 KV 2.00 kA 115.0 V 66.40 V 5.00 A			
	VTR F: CTR F:	120.0	Phase F Ne	eutral N Ground E	Displ. D
	VTR D / VTR F: CTR E / CTR F: Invert Polarity: VT's F VT's F VT D	1,00 1,00 CT's F CT E	Voltage           FN         1         Va           2         Vb         3           3         Vc         Vc           D         4         VD	S         Ia           F         6         Ib           7         Ic           E         8         IE           EP         9         IEP	k to V0: 1.00 k to V2: 1.00 k to I0: 1.00 k to I2: 1.00
Default V Imp	port Export			Preferences	<u>O</u> K <u>C</u> ancel





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.

## 4.4 Distance Adjustments

**Note:** The relay will be parameterized differently for phase-to-ground faults compared to two-phase and three-phase faults. For the software to perform the test properly, 8 types of zones must be inserted, the first four for two-phase and three-phase faults and the last four for phase-to-ground faults.

## **4.5** *Distance Screen* > *Adjust Prot. Distance*

The first step is to adjust the ground compensation factor.



Figure 29



### 4.6 Inserting Phase Zones

The first zone to be entered will be zone-1 (LL+ABC). Click on the "*Insert*" field highlighted in green in the previous figure. In the settings screen, first select the relay mask "*SIEMENS 7SA6/7SA8/7SL8 - Quad.*". You must adjust the actuation time, choose the type of fault (loop) enter the zone characteristics and directionality. Adjust the tolerance values and finally click on "OK".



Figure 30

Clicking "Insert" again adjusts the values for zone 2.





By clicking on "Insert" the values for zone 3 are adjusted.





By clicking on "Insert" the values for zone 4 are adjusted.





Figure 33

## 4.7 Inserting the Zones (Line-Earth)

The first FT zone to be entered will be zone-5 (LE). Change the name of zone 5 to "*Zn01\_LE*".Click on the "*Insert*" field highlighted in green in the Figure 29. In the settings screen, first select the relay mask "*SIEMENS 7SA6/7SA8/7SL8 - Quad*.".





Figure 34



Figure 35





Figure 36





### 5. Hardware Settings

In the "*Home*" menu click on the "*Hrd Config*" button to configure the power supply, stipulate the configuration of the generation channels and the stopping method of the input binaries.



Figure 38

## 6. Channels Direc

After performing the hardware configuration, click on the highlighted icon to automatically associate the created channels with the nodes. Choose the *"Basic"* option for this.



1 🗋	🍟 🛃 🚽   Dis	stanc 2	Cha	annels Direct.				- <b>D</b> X
Arquivo	Home V	ïew	-					
G	🚍 Hrd Config	, 😵 e	Loci	Model Reset for Hard.	(Control of the second	Basic		Confirm
	🖉 GPS Config	j 5 <sub>0</sub> S	~	CE-6006 V Connected	Set	Advanced	Se GOOSE	Cancel
Channels Direc	Connection	n	note	Serial Number:			50 00002	
	Hardw	are	Ren	03207116302101110011XXX	~	ON Line	<sup>s</sup> <sub>o</sub> S. Value	Import Export
Point tes	Search Test	Te						
	Figure 39							

### 7. Restore Layout

Due to the great flexibility that the software presents allowing the user to choose which windows are displayed and in which position, the Restore Layout command is used to restore the default settings. Click on the "Layout" button and then on "Recreate Charts" repeat the process by clicking on "Layout" and "Restore Layout". During the test, windows that are not relevant are excluded.

🛣   🗋 📸 🚽   Distanc 2.02.152 (64 Bits)	) - CE-6006 (0320711)							
Arquivo Home View Software Opt	tions							
Channels Direc Channels	Start Stop * Next Point & Clear test * Next Line & Clear all * Next Fault	K Waveform ↓ Chart ZxT → Phasors Ⅲ SEL G Trajectory	Present Report	Recreate Restore Charts Layout				
Hardware	Generation	Options	Report Units	Layout				
Figure 40								

# 8. Function 21 test structure

## 8.1 Test Settings

By clicking on the Test Settings tab set the test mode to "*Intelligent*" and use binary input 1 for stop interface. Insert a pre-fault with nominal voltage and current equal to zero.

🗋 隘	F → Distanc 2.02.15 Home View Sof	i2 (64 twar	Bits) - CE Options	-6006 (032071	11)										-	٥
nnels t	Hrd Config 😵 GOOS GPS Config 🍕 SV Col Connection	E Coi nfig	nfig St	art Stop	<ul> <li>Next Point</li> <li>Next Line</li> <li>Next Fault</li> </ul>	🖌 Clear test 🚰 Clear all	5ettings	₩ Waveform → Phasors 6 Trajector	m 🛃 Chart ZxT	Present Report	○ ~ P <sup>3</sup> [S abs rel	Recreate Rest Charts Layo	ore View			
	Hardware				Generation			Option	s	Report	Units	Layo	ut			
test	Search Test Test Se	tting	s													
eration	of Channels Direc.		Enable	e Pre-Fault 1		Enable P	re-Fault 2		Enable F	ost-Fault					VTRNeu	tral/VTRPhase
	Generation Channel		Mode	Vs = VNe	om, ls = 0 🔻										1,	00
	Va (Hrd: V1)	-	V1	66,40 V	0 °	T									CTRGrou	ind/CTRPhase
	Vb (Hrd: V2)	•	V2	66,40 V	240,0 °	1									1/	00
	Vc (Hrd: V3)	•	V3	66,40 V	120,0 *	1										Dia
)		•														v Neutral VT
	la (Hrd: 14)	•	14	0 A 0	0 *											e er
	lb (Hrd: 15)	•	15	0 A	240,0 °											Phase CTs
	lc (Hrd: 16)	•	16	0 A 0	120,0 °											V. Earth CT
		•														
PII		•	L			4										
Кеер р	ore-fault in healthy phases			Time Pre-Faul	t 1: 100,00 ms											
y Out	puts & Goose - Fault		Binary Out	tputs & Goose -	Pre-Fault1											nfigure in All
	0; 0; 1; 1; 0; 0	•	BO	0; 0; 1;	1; 0; 0 🔹										L Ge	enerations
		-	GO			-										
aration	and Pickup Limite	_	Test Mode		alde Enoi									Search Test		
av Cl	annel Gener 15.00 A		Mode	- Intelliz	nent 🔻	1								Initial step: A	bsolute Resolution: 10	Ωm 00,0
lse F	landware Limit		mode	intenity	join									Min. Resolution $$	Relative Resolution: 0,	10 %
t V M	ax. Fault (L-1 2.00 Vfn													M.A. Television		10 0
lin. Pi	ckup (L-N) 1,00 V													Mult. Tolefance i	or venication rest. 1,	
n Piz	100.0 mA	~													Reset Time: 10	10,00 ms
Stop Ir	nterf. BI01 (Hrd: BI1)	-	Stop	p Logic	Initial NA $\sim$									Verify Possible Intervent	Overtime Waiting: 10, ons of Other Loops for F	00 s ¥ FFault ⊠
						Fault Start								Analyze 1	rajectory to High Speed	Zones 🗹
gger Ir	nterf. Software	1	Trigge	r Logic		Mode	R	andom	•					Ba	sed Only on Values Ger	nerated 🗹
	Wait for PPS		Trigger	r Delay 0,00 s		VFault Ang		DC Of	fset						Cycle to Cycle Gen	eration 🗹
ON Li	ne New							Aux S	ource: 110,00 V	Heating	p: 09	5				
									Figure	41						
-							_									



## 8.2 Point Test for Zones 1,2,3 and 4

## 8.2.1 Two-Phase and Three-Phase Loop

Click on the *"Point Test"* tab and then *"Sequence"* and choose the types of faults, in this case only three-phase and two-phase faults, that is, ABC, AB, BC and CA.

Point test Search Tes	st Test Settings								
Insert/Edit Points									
Insert/Edit Points	General Options								
<u>E</u> dit Point	Test Point Fault Type: nale: -45.00 °								
New <u>P</u> oint	IZI Rel AE AB ABC								
Sequence	Adopti □ CE □ CA □ All al: 0.00 ° Step: 45.00 °								
<u>R</u> emove	Ø: _45 <u>O</u> K Ca <u>n</u> cel al: 360,00 ° № of Points 8								
Remove <u>A</u> ll									

Figure 42

Choose a starting angle, ending angle and pitch. In this way the points are determined automatically.

	×
Image: Second	
Point test Search Test Test Settings	
Insert/Edit Points   Chart ZxT Trajectories Waveform Phasors	•
Insert Field Points     Descriptions        Descriptions	
Zone         RX         Zand Ø         Zml         Tme         VBI           Errors List         Protection Status         -2.00         -1.00         0         1.00         2.00         -3.00           Errors List         Protection Status         -2.00         -1.00         0         1.00         2.00         3.00	
rigure 45	



By clicking on the "Confirm" button the following points are created.



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



Figure 45

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.



## 8.2.2 Final Result A-B-C faults

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



## 8.2.3 Single-phase Loop

Click on the "*Point Test*" tab and then "*Sequence*" and choose the fault types, in this case only single-phase faults, that is, AE, BE and CE.

Point test Search Tes	st Test Settings
Insert/Edit Points	
Insert/Edit Points	General Options
<u>E</u> dit Point	Data Entry: Apply to X reck
	Test Point Fault Type: le: 45,00 °
New Point	IZI Relati 🔽 AB 🔲 ABC
Sequence	Adopting BE BC
	IZ: 2,29 ✓ CE CA AII 0.00° Step: 45,00°
Remove	Ø: -45,0 360,00 ° № of Points 8
Remove <u>A</u> ll	OK Cancel
	Figure 47



Choose a starting angle, ending angle and pitch. In this way the points are determined automatically.





Image: Solution of the second sec	s) - CE-6006 (0320711) bions Start Stop > Next Point & Clear test >> Next Line & Clear all >>> Next Fault	₩ Waveform ₩ Chart ZxT + Phasors ■ SEL Settings ⑤ Trajectory	- O	×
Hardware	Generation	Options	Report Units Layout	
Point test Search Test Test Settings				
Insert/Edit Points			Chart ZXT ZTAJectories Z Waveform Z Phasors	-
Bett Point     General Options       Edit Point     Test Point       New Epint     IZ Relative to       Sequence     Adopting the sam       Remove     45.0 °       Remove All     45.0 °       Test Point     Test Point       Test Point     AB	Z and Ø         Check ',           Ine         Angle: 45.00 *           Ine angle         Sequence           Intal: 0.00 *         Step           X: -1.62Ω         Final: 360.00 *           ABC         ABC	: [45.00 * Point 8	4.00 XEQ 3.00 2.00 1.00 0 0 0 0 0 0 0 0 0 0 0 0	
No. Zone Operated R	X IZI Ø Time Nomin	e Time Status	-1.00	
56 Zn04_LE - 311,1 mΩ	-311,1 mΩ 440,0 mΩ -45,00 ° 0,900	s - Not Tester	200	
57 Zn04_LE - 1.42 Ω	-1,42 Ω 2,01 Ω -45,00 ° 0,900	s - Not Tester	300	
58 External - 1,62 Ω	-1,62 Ω 2,29 Ω -45,00 ° -	- Not Tester		
Zone R-X Z and Ø Z rel	] Time 🔲 V8I		4.00 -3.00 -2.00 -1.00 0 1.00 2.00 3.00 4.00	
12 ON Line New		Aux Source: 110.00 V	Heating: 0%	
		Figure	49	

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



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



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.

## 8.2.4 Final Result AE Fault

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.





8.3 Search Test for Zones 1,2,3 and 4

## 8.3.1 Two-Phase and Three-Phase Loop

Click on the "Search Test" tab highlighted in green 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 and two-phase faults, or ABC, AB, BC and CA.

Point test	Search Te	est Test Settings						
Insert	/Edit Points							-
-Insert/Edit	Points	General Options				_		
		Data Entry:	Apply to			×		
Edit	dit Line	Line Origin	-Fault Type			<b>p</b> :	Line $\vee$	
New I	ine 🗸	IZI Relative to	AE	🗹 AB	🖂 ABC	Ω	) Ang. : 0,0 °	
Segur	1	Adopting the sam	BE	⊠ BC	_			
Seque	ance	Z : 0.00 Ω	CE	<mark>∠ C</mark> A	🗌 Ali		Step: 45,00 °	
Ren	nove	Ø: 0,0 °		ОК	Cance	el 0 '	° № of Points 8	
Remo	ove All	Characteristic: 🔘 Se	earch 🔾 Ch	neck				

Figure 52

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



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



rquivo	22	vistanc 2.02	152 (64 Bits) ioftware Opt	- CE-6006 (0	)320711)							- 0 ×
E.	GPS Conf	ig sociality of the second	OSE Config		> Nei	ct Point 🧃 C	lear test	No Waveform	ZXI	- <u>-</u>		
hannels	(Connecti	ng -, sv (	oning	Start St	top >>> Net	d Fault	Setting	Trajectory	Present	ahs rel	Recreate Restore View	
Direc	Hard	ware		•	Genera	ation		Ontions	Report	Units	Lavout	
oint test	Search Te	est Test :	Settinas					options				
Inse	t/Edit Points	]						-	Chart	ZxT	Trajectories Waveform Phasors	-
Insert/E	dit Points	General Op	otions									E-ukAD
Ec	lit Line	Data Ent	iry:	Z and Ø	~	ength	Ling		6,00 - ^		KITSKN.	FaultAb
_		Line Origi	n			Relative to.		_	5,00 🗸		+ $+$ $+$ $+$ $+$ $+$ $+$ $+$ $+$ $+$	ann Canada Dainta
New	Line 🗸	📃 IZI Re	elative to	Line	~	.ength. 15,50 Ω	2 Ang.: 315,0	•	100			Search Foints
Seq	uence	Adop	ting the same	line angle	-9	Sequence			4,00			<ul> <li>Found Points</li> </ul>
		IZI: 0	Ω 00.	R: 0.00 Ω	h	nitial: 0,00 *	Step: 45,00	*	3,00	<u> </u>		Colors: Not Tested Passed
B	<u>Remove</u> Ø: 0.0 ° X: 0.00 Ω Final: 360.00 ° Nº of Points 8									13		Fail
Ren	nove <u>A</u> ll	Characteris	tic: 💿 Sea	rch 🔿 Chec	*				2,00	/ //		nformation:
Tort	Point								1,00	i¥		urrent Point:
Fested P	oints							•	0			-  Z :
AE	BE CE	AB	BC CA	ABC								- Ø:
Nº	R Home	X Home	IZI Home	Ø Home	Comp.	Ang	Status	^	-1,00			- R: - X:
06	0Ω	0Ω	0 Ω	0°	5,50 Ω	225.0 °	Not Tested		-3.00	XP		
07	0Ω	0Ω	0 Q	0 °	5,50 Ω	270.0 °	Not Tested		-4.00		AA-AAA	
08	0Ω	0Ω	0Ω	0 *	5,50 Ω	315,0 °	Not Tested		-5,00			
Type:	Lines 🗸 🗹	] R-X 🔽	Zand Ø	Zrel 🗹 Le	ngth 🗌 Le	ngth		¥	-6,00	-5.00	-400 -300 -200 -100 0 100 200 300 400 500	
Errors	List Prote	ection Statu	IS							5,00		
) ON	Line	New						Aux Source: 110,0	0 V Heatin	q: 0	1%	
								T:	no 54			

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



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.

## 8.3.2 Final Result A-B-C Fault

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.



🕅 🗋 💕	🔛 👳   🕻	Distanc 2.02	.152 (64 Bits	) - CE-6006 (0	320711)											-	o ×
Arquivo	Home	View 9	Software Op	tions													~ 🕜
Channels Direc	Hrd Conf GPS Conf Connecti	ig ∲gGO ig ⁵gSV( on	OSE Config Config	Start Sta	> Ne > Ne > Ne	xt Point 🧹 CI xt Line 🛛 🚰 CI xt Fault	ear test ear all	ettings	form LChart ZxT ors I SEL ctory	Present Report	Pillis sts rel	Recreate Restore View Charts Layout					
Point test	Search Te	ware Teet	Settings		Gener	ation		Op	tions	кероп	Units	Layout					
Insert/E	dit Points		ootango						-	Chart	ZxT / T	rajectories Waveform	Phasors				•
Insert/Edit F	Points ine	General O Data En Line Orig	ptions try: in elative to	Z and Ø Line	~ [	length Relative to: length: 5,50 Ω	Line Ang. :	> 315.0 °		4.00 × [	ρ]			X		Fault Legend: Search	ABC
<u>S</u> equen <u>R</u> emov	ice ove re <u>A</u> I	Adop IZI: 0 Ø: 0 Characteris	ting the same 1,00 Ω 1,0 ° stic: () Sea	line angle R: 0,00 Ω X: 0,00 Ω arch O Checl	k s	Sequence nitial: 0,00 ° Final: 360,00 °	Step: Nº of Po	45.00 * ints 8		2,00	X					Found     Colors: Not     Pass     Fail     Informatio	Points Tested sed <u>n:</u>
Test Poi Tested Point AE BI	int ts E CE	AB	BC CA	ABC					-	0 —						Current Point -  Z : - Ø: - R:	i.
Nº	Zone	R Nom.	X Nom.	R Real	X Real	Time Nominal	Time Real	Status	^	-1,00					4-/-	- X:	
07-01 Zr	n03 (Tol.)	0Ω	-1,73 Ω	Ω 000000,0	-1,74 Ω	0,600 s	0,619 s	Passed		-2,00	X			7.4	¥4-		
07-02 Zr	n04 (Tol.)	0Ω	-2.40 Ω	0.000000 Ω	-2,40 Ω	0,900 s	0.944 s	Passed		-3.00				X.,	XZ		
08 Zr	n04 (Tol.)	1,52 Ω	-1,52 Ω	1,50 Ω	-1,50 Ω	0,900 s	0,949 s	Passed	<b>,</b>	-4.00				X			
Type: Point	nts 🗸 🗠	Zone 🔽	R-X 🗌 Z	rel 🗹 Time	V&I					-4	00 -3.	00 -2,00 -1,00	0 1.00	2,00	3,00 4,00		
Errors List	t Prot	ection Statu	IS														
🚯 ON Lin	ne	New						Au	ix Source: 110,00 V	Heatin	g: 0	%					
									1.1.	= (							



## 8.3.3 Single-phase Loop

Click on the "*Point Test*" tab and then "*Sequence*" chooses the fault types in this case only single-phase faults, or AE, BE and CE.

Point test	Search Te	st Test Settings					
/Insert,	/Edit Points						-
Insert/Edit	Points	General Options			length -		
Edit Line		<u>Data Entry:</u>	Apply to		×	ve to:	Line V
		Line Origin	Fault Typ	e:			
New <u>I</u>	Line 🔽	Z  Relative to	🗹 AE	AB	ABC	5,50 Ω	Ang. :  315,0 °
Seque	ence	Adopting the	🗹 BE	BC		9	
		Z : 0,00 Ω	CE	CA	All	° 00.	Step: 45,00 °
<u>R</u> en	nove	Ø: 0,0 °		ОК	Cancel	60,00 °	Nº of Points <mark>8</mark>
Remo	ove <u>A</u> ll	Characteristic:	Search (	) Check			

Figure 57

Choose a initial angle, final angle and step. In this way the points are determined automatically.





Figure 58





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





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.

## 8.3.4 Final Result AE Fault

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.





### 9. Report

After finishing the test, click on the icon highlighted 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 of Tested Device   Installation Location   Reference Values   Hardware Settings   Test Settings   Distance Protection Settings   O Test Results   Points Details of Selected Fault   Oharts of Selected Simulation   Notes and Observations   Explanatory Figures   OK	~	
_	Figure 62		
1   ] 📑 💭 🚽   Distanc 2.02.152 (64 Bit	s) - CE-6006 (0320711)		- 0 ×
Print Setting Page Word Office to PDF	Two pages Two pages Previous Next Page Page Previous Next Preview		
Print Export	Zoom View Close		
	DISTANCE - TEST REPORT		
	Descr.: Distance Fuction Date: 10/08/2021 09:28:30 ; Software: Distancia_CTC; Version: 2.02.152 Responsible: Eng® Michel Rockembach de Carvalho <b>1. Device Tested</b> Ident .: 23031982; Type: Model 7SA611; Manufacturer: Siemens <b>2. Location</b> Substation: CONPROVE Bay: 1 Address: Ray Visconde de Ouro Preto. Nº75 - Bairro Custódio Pereira		
Printing Preview Nº of Pages: 24	City: Uberlândia; State: MG		~

Figure 63



## APPENDIX A

### **A.1 Terminal Designations**



Figure 64



Table 1

## A.2 Technical Data

α = Threshold angle for the increased resis ance	tance toler-	10° to 90°		Increments1°		
Determination of Direction		1	I			
For all types of faults		With phase-true, mem	orized or cross-pol	arized voltages		
Directional sensitivity		Dynamically unlimited				
		Stationary approx. 1 V	1			
Each zone can be set to operate in forward	d or reverse di	rection, non-directional	or ineffective.			
Load trapezoid:						
R <sub>load</sub> = minimum load resistance	for $I_N = 1 A$	0.100 Ω to 600.000 Ω	;∞	Increments0.001 Ω		
	for $I_N = 5 A$	0.020 Ω to 120.000 Ω	;∞			
$\phi_{load}$ = maximum load angle		20° to 60°		Increments1°		
Dropout to pickup ratio						
- Currents		Approx. 0.95				
- Impedances		Approx. 1.06				
Measured value correction		Mutual impedance ma	tching for parallel	lines (ordering option)		
Measuring tolerances for sinusoidal measu	red values	$\left \frac{\Delta X}{X}\right  \le 5 \%$ for 30	$^{\circ} \leq \phi_k \leq 90^{\circ}$			
		$\left \frac{\Delta R}{R}\right  \le 5 \%$ for 0	$0^\circ \le \phi_K \le 60^\circ$			
		$\left \frac{\Delta Z}{Z}\right  \le 5 \%$ for 0	$^{\circ} \leq \phi_k \leq 90^{\circ}$			

#### Table 2

Shortest trip time	Approx. 17 ms (50 Hz) /15 ms (	50 Hz) with fast relay and				
	Approx. 12 ms (50 Hz) /10 ms (60 Hz) with high-speed relay					
Dropout time	Approx. 30 ms					
Stage timers	0.00 s to 30.00 s; ∞	Increments 0.01 s				
	for all zones; separate time setting possibilities for single- phase and multiphase faults for the zones Z1, Z2, and Z1B					
Time expiry tolerances	1 % of setting value or 10 ms	1 % of setting value or 10 ms				

The set times are pure delay times.

Times

The interval from fault inception to trip command is made up of the set delay time plus the measuring time. The minimum measuring time is 10 ms, for faults close to the set zone boundary the maximum measuring time is approximately 40 ms.



## **APPENDIX B**

## Equivalence of software parameters and the relay under test.

Table 3				
Distance Software		Siemens 7SA611 Relay		
	-			
Parameter	Figure	Parameter	Figure	
Mod Z0/Z1	29	Zero seq. comp. K0 for Z1	16	
Ang Z0/Z1	29	Zero seq. comp. Angle for Z1	16	
Zn1		Phase Distance Z1		
Distance Angle	30	Angle of inclination, distance charact.	16	
Forward/Reverse/Non-	30	Operating mode Z1	19	
Directional				
R	30	R(Z1), Resistance for ph-ph faults	19	
Х	30	X(Z1), Reactance	19	
Trigger Time	30	T1 multi-ph, delay for multiphase faults	19	
Zone Reduction	30	Zone Reduction Angle	19	
Zn2		Phase Distance Z2		
Distance Angle	31	Angle of inclination, distance charact.	16	
Forward/Reverse/Non-	31	Operating mode Z2	20	
Directional				
R	31	R(Z2), Resistance for ph-ph faults	20	
Х	31	X(Z2), Reactance	20	
Trigger Time	31	T2 multi-ph, delay for multiphase faults	20	
Zone Reduction	31	Zone Reduction Angle	20	
Zn3		Phase Distance Z3		
Distance Angle	32	Angle of inclination, distance charact.	16	
Forward/Reverse/Non-	32	Operating mode Z3	21	
Directional				
R	32	R(Z3), Resistance for ph-ph faults	21	
Х	32	X(Z3), Reactance	21	
Trigger Time	32	T3 multi-ph, delay for multiphase faults	21	
Zone Reduction	32	Zone Reduction Angle	21	
Zn4		Phase Distance Z4		
Distance Angle	33	Angle of inclination, distance charact.	16	
Forward/Reverse/Non-	33	Operating mode Z4	22	
Directional				
R	33	R(Z4), Resistance for ph-ph faults	22	
Х	33	X(Z4), Reactance	22	
Trigger Time	33	T4 multi-ph, delay for multiphase faults	22	
Zone Reduction	33	Zone Reduction Angle	22	



Software Distance		Siemens 7SA611 Relay	
Parameter	Figure	Parameter	Figure
Zn1_LE		Ground Distance Z1	
Distance Angle	34	Angle of inclination, distance charact.	16
Forward/Reverse/Non-	34	Operating mode Z1	19
Directional		-	
RE	34	RG(Z1), Resistance for ph-gnd faults	19
X	34	X(Z1), Reactance	19
Trigger Time	34	T1 1-ph, delay for multiphase faults	19
Zone Reduction	34	Zone Reduction Angle	19
Zn2_Terra		Ground Distance Z2	
Distance Angle	35	Angle of inclination, distance charact.	16
Forward/Reverse/Non-	35	Operating mode Z2	20
Directional			
RE	35	RG(Z2), Resistance for ph-gnd faults	20
X	35	X(Z2), Reactance	20
Trigger Time	35	T2 1-ph, delay for multiphase faults	20
Zone Reduction	35	Zone Reduction Angle	20
Zn3_LE		Ground Distance Z3	
Distance Angle	36	Angle of inclination, distance charact.	16
Forward/Reverse/Non-	36	Operating mode Z3	21
Directional			
RE	36	RG(Z3), Resistance for ph-gnd faults	21
X	36	X(Z3), Reactance	21
Trigger Time	36	T3 1-ph, delay for multiphase faults	21
Zone Reduction	36	Zone Reduction Angle	21
Zn4_LE	-	Ground Distance Z4	
Distance Angle	37	Angle of inclination, distance charact.	16
Forward/Reverse/Non-	37	Operating mode Z4	22
Directional			
RE	37	RG(Z4), Resistance for ph-gnd faults	22
X	37	X(Z4), Reactance	22
Trigger Time	37	T4 1-ph, delay for multiphase faults	22
Zone Reduction	37	Zone Reduction Angle	22