

# INSTRUMENTOS PARA TESTES ELÉTRICOS Test Tutorial

Equipment Type: Protection Relay

Brand: GE

Model: <u>D60</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 MHO</u> <u>Characteristics</u>

Version Control:

Version	Descriptions	Date	Author	Reviewer
1.0	Initial Version	15/09/2021	M.R.C.	M.P.S



#### **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 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.

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Sul	mmary Delay compaction to CE 6006
1.	Relay connection to CE-6006
1.1	Auxiliary Source
1.2	Current and Voltage Coils
1.3	Binary Inputs
2.	Communication with D60 relay
3.	Parameterization of the D60 relay7
3.1	Current7
3.2	Voltage
3.3	Power system
3.4	Signal Source
3.5	Distance9
3.6	Phase Distance9
3.7	Ground Distance9
4.	Binary Output Adjustments
4.1	FlexLogic Equation Editor10
4.2	Contact Outputs11
5.	Distance software adjustments12
5.1	Opening the Distance
5.2	Configuring the Settings13
5.3	<i>System</i> 14
6.	Distance Adjustments
6.1	Distance Screen > Distance Prot. Settings
6.2	Inserting Phase Zones15
6.3	Inserting Zones (Phase-Earth)17
7.	Channel Direction and Hardware Configurations
8.	Test structure for function 21
8.1	Test Settings
8.2	<i>Two-Phase and Three-Phase Loop</i> 21
8.3	Final Result Fault AB23
8.4	Single-phase Loop
9.	Report
API	PENDIX A
A.1	Terminal Designations



	INSTRUMENTOS PARA TESTES ELÉTRICOS	
APPENDIX B		



#### INSTRUMENTOS PARA TESTES ELÉTRICOS Sequence for testing the D60 relay in the Distance software

#### 1. Relay connection to CE-6006

#### **1.1** Auxiliary Source

Connect the positive (red terminal) of the Vdc Aux. Source to pin B5b of the relay and the negative (black terminal) of the Vdc Aux. Source to pin B6a of the relay.



## **1.2** Current and Voltage Coils

To establish the voltage coil connection, connect the V1, V2 and V3 voltage channels to the relay pins F5a, F6a and F7a and connect the common voltage channels to the relay pins F5b, F6b and F7b: Connect the I1, I2 and I3 current channels of CE-6006 to pins F1a, F2a and F3a of the relay respectively, connect the three commons of CE-6006 to pins F1b, F2b and F3b for relay completing a connection.



Figure 2



#### **1.3** Binary Inputs

Connect the binary input of the CE-6006 to the binary output relay.

- BI1 to pin P1b and its common to pin P1c.
- BI2 to pin P2b and its common to pin P2c.



## 2. Communication with D60 relay

Before starting the D60 relay test, open the *"EnerVista"* software and download the UR series software, if you already have, click directly on:



Check the relay IP and set this value in "Device Setup" after inserting a new system. Then read the relay code by clicking "Read Order Code" and finish by clicking "OK".

🚖 Discover 🛛 🛓 Add Site 🛛 🛓 Add Devic	e Device Name: D60
⊡ New Site 1 D60	Description:
	IP Address: 10 . 0 . 11
	Slave address: 254 📫 Modbus Port 502 Connected via Ethernet / Serial Gateway: No 💌
	Order Code: D60-N07-HCH-F8L-P6T
🍵 Deleti	e Version: 5.7x ▼ Read Order Code



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Then click on "*New Site 1*" and on "*D60*" to access the relay configuration and close the "*Offline Window*" by clicking on the button highlighted in green.





# 3. Parameterization of the D60 relay

#### 3.1 Current

After the connection has been established, click on the "+" signs near "Settings > System Setup > AC Input" and double-click on "Current", in it adjust the primary and secondary current values of the current transformer.



Figure 7



#### 3.2 Voltage

Click on "Voltage" and adjust the primary and secondary voltage values of the potential transformer.

Bave Besto	e 🔛 Default 💾 Reset 🛛 🖽
PARAMETER	VT F5
Phase VT Connection	Wye
Phase VT Secondary	66.4 V
Phase VT Ratio	120.00:1
Auxiliary VT Connection	Vag
Auxiliary VT Secondary	66.4 V
Auxiliary VT Ratio	1.00 :1

Figure 8

#### 3.3 Power system

In this field, the nominal frequency, the phase sequence and the side used as reference are set.

Power System // New S	ite 1: D60: Settings 🔳 🗖 🔀	
Save Bestore	🛱 Default 🔤 Reset 🛛 VIEW	
SETTING	PARAMETER	
Nominal Frequency	60 Hz	
Phase Rotation	ABC	
Frequency And Phase Referenc	sRC1 (SRC1)	
Frequency Tracking Function	Enabled	
D60 Settings: System Setup	Screen ID: 161	



#### 3.4 Signal Source

Set the current transformer as "F1" and the voltage transformer as "F5" in "Source 1".

Bave Bes	tore 🔛 Default 🔛 Reset VIEV	N ALL mode
PARAMETER	SOURCE 1	SOURCE 2
Name	SRC 1	SRC 2
Phase CT	F1	None
Ground CT	F1	None
Phase VT	F5	None
Aux VT	None	None

Figure 10



#### 3.5 Distance

Click on the "+" sign near to "Grouped Elements > Group1 > Distance" and double-click on "Distance". In this option the "Source" is defined with "SRC1".

Save Bre	store 🔡 Defau	It 💾 Reset	
SETTING		PARAME	TER
Source		SRC 1 (SRC 1)	
Memory Duration		10 cycles	
Force Self-Polar		OFF	
Force Mem-Polar		OFF	

#### Figure 11

#### **3.6** *Phase Distance*

Click on the "+" sign near to "Grouped Elements > Group1 > Distance" and double-click on "Phase Distance". This option defines the zone settings, directionality and operating time of the phase elements.

📼 Phase Distance // New Site 1: D60: Settings: Grouped Elements: Group 1: Distance					
Save Bestore Default B Reset VIEW ALL mode					
PARAMETER	PHASE DISTANCE Z1	PHASE DISTANCE Z2	PHASE DISTANCE Z3		
Distance Shape Graph	View	View	View		
Function	Enabled	Enabled	Enabled		
Direction	Forward	Forward	Non-directional		
Shape	Mho	Mho	Mho		
Xfmr Vol Connection	None	None	None		
Xfmr Curr Connection	None	None	None		
Reach	1.00 ohms	2.00 ohms	3.00 ohms		
RCA	85 deg	85 deg	85 deg		
Rev Reach	2.00 ohms	3.00 ohms	4.00 ohms		
Rev Reach RCA	85 deg	85 deg	85 deg		
Comp Limit	90 deg	90 deg	90 deg		
DIR RCA	30 deg	30 deg	30 deg		
DIR Comp Limit	90 deg	90 deg	90 deg		
Quad Right Blinder	2.00 ohms	4.00 ohms	6.00 ohms		
Quad Right Blinder RCA	85 deg	85 deg	85 deg		
Quad Left Blinder	2.00 ohms	4.00 ohms	6.00 ohms		
Quad Left Blinder RCA	85 deg	85 deg	85 deg		
Supervision	0.050 pu	0.050 pu	0.050 pu		
Volt Level	0.000 pu	0.000 pu	0.000 pu		
Delay	0.030 s	0.300 s	0.600 s		
Block	OFF	OFF	OFF		
Target	Self-reset	Self-reset	Self-reset		
Events	Disabled	Disabled	Disabled		
<	107			>	
D60 Settings: Grouped Elements: G	iroup 1: Distance	Screen ID: 13		1	

#### Figure 12

#### **3.7** Ground Distance

Click on the "+" sign near to "Grouped Elements > Group1 > Distance" and double-click on "Ground Distance". In this option the zone, directionality and operating time settings of the ground elements.



Ground Distance // New Site 1: D60: Settings: Grouped Elements: Group 1: Distance					
Bestore Default 型 Reset VIEW ALL mode					
PARAMETER	GROUND DISTANCE Z1	GROUND DISTANCE Z2	GROUND DISTANCE Z3	1 1	
Distance Shape Graph	View	View	View		
Function	Enabled	Enabled	Enabled		
Direction	Forward	Forward	Non-directional		
Shape	Mho	Mho	Mho		
Z0/Z1 Mag	2.70	2.70	2.70		
Z0/Z1 Ang	0 deg	0 deg	0 deg		
ZOM Z1 Mag	0.00	0.00	0.00		
ZOM Z1 Ang	0 deg	0 deg	0 deg		
Reach	2.00 ohms	3.00 ohms	4.00 ohms		
RCA	85 deg	85 deg	85 deg		
Rev Reach	2.00 ohms	3.00 ohms	4.00 ohms		
Rev Reach RCA	85 deg	85 deg	85 deg		
POL Current	Zero-seq	Zero-seq	Zero-seq		
Non-Homogen Ang	0.0 deg	0.0 deg	0.0 deg		
Comp Limit	90 deg	90 deg	90 deg		
DIR RCA	30 deg	30 deg	30 deg		
DIR Comp Limit	90 deg	90 deg	90 deg		
Quad Right Blinder	10.00 ohms	10.00 ohms	10.00 ohms		
Quad Right Blinder RCA	85 deg	85 deg	85 deg		
Quad Left Blinder	10.00 ohms	10.00 ohms	10.00 ohms		
Quad Left Blinder RCA	85 deg	85 deg	85 deg		
Supervision	0.200 pu	0.200 pu	0.200 pu		
Volt Level	0.000 pu	0.000 pu	0.000 pu		
Delay	0.060 s	0.400 s	0.700 s		
Block	OFF	OFF	OFF		
Target	Self-reset	Self-reset	Self-reset		
Events	Disabled	Disabled	Disabled		
<	ille.			>	
D60 Settings: Grouped Elements: Gr	roup 1: Distance	Screen ID: 11		- 1	

Figure 13

#### 4. Binary Output Adjustments

#### 4.1 FlexLogic Equation Editor

Click on the "+" sign near to "*FlexLogic*" and double-click on "*FlexLogic Equation Editor*". On this screen, two logics are programmed. The first creates an "OR" logic between the phase distance elements associating to virtual output 1. The second is also an "OR" logic associating the ground distance elements to virtual output 2.



FlexLogic Equation Ed	litor // New Site 1: D60: Settings: Fle	xLogic	×
Save Restore	Default 🗄 Reset VIEW A	IL mode	
FLEXLOGIC ENTRY	ТҮРЕ	SYNTAX	~
View Graphic	View	View	
FlexLogic Entry 1	Protection Element	PH DIST Z1 OP	
FlexLogic Entry 2	Protection Element	PH DIST Z2 OP	
FlexLogic Entry 3	Protection Element	PH DIST Z3 OP	
FlexLogic Entry 4	OR	3 Input	
FlexLogic Entry 5	Assign Virtual Output	= Virt Op 1 (VO1)	
FlexLogic Entry 6	Protection Element	GND DIST Z1 OP	
FlexLogic Entry 7	Protection Element	GND DIST Z2 OP	
FlexLogic Entry 8	Protection Element	GND DIST Z3 OP	
FlexLogic Entry 9	OR	3 Input	
FlexLogic Entry 10	Assign Virtual Output	= Virt Op 2 (VO2)	
FlexLogic Entry 11	End of List		
FlexLogic Entry 12	End of List		
FlexLogic Entry 13	End of List		
FlexLogic Entry 14	End of List		
FlexLogic Entry 15	End of List		
FlexLogic Entry 16	End of List		
FlexLogic Entry 17	End of List		
FlexLogic Entry 18	End of List		0.000
FlexLoaic Entry 19	End of List		~
D60 Settings: FlexLogic	S	creen ID: 171	1

Figure 14

#### **4.2** Contact Outputs

Click on the "+" sign near to "*Inputs/Outputs*" and double-click on "*Contact Outputs*". In this screen, the trips of the virtual outputs are designated as the binary outputs of the relay.

🚥 Contact Outputs // New Site 1: D60: Settings: In 📃 🗖 🔯		
Save Bestore	Default 🗄 Reset VIEW ALL	
SETTING	PARAMETER	
[P1] Contact Output 1 ID	Cont Op 1	
[P1] Contact Output 1 Operate	Virt Op 1 On (VO1)	
[P1] Contact Output 1 Seal-In	OFF	
[P1] Contact Output 1 Events	Enabled	
IP21 Contact Output 2 ID	Cont On 2	
[P2] Contact Output 2 Operate	Virt Op 2 On (VO2)	
[P2] Contact Output 2 Seal-In	OFF	
[P2] Contact Output 2 Events	Enabled	
[P3] Contact Output 3 ID	Cont Op 3	
[P3] Contact Output 3 Operate	PH DIST Z3 OP	
[P3] Contact Output 3 Seal-In	OFF	
[P3] Contact Output 3 Events	Enabled	
[P4] Contact Output 4 ID	Cont Op 4	
[P4] Contact Output 4 Operate	PH DIST Z4 OP	
[P4] Contact Output 4 Seal-In	OFF	
[P4] Contact Output 4 Events	Enabled	
D60 Settings: Inputs/Outputs	Screen ID: 232	
	Figure 15	

In Appendix B the user finds a table of equivalence between the software settings of the relay and the test set.



## 5. Distance software adjustments

#### 5.1 Opening the Distance

Click on the CTC application manager icon.



Make a click on the software icon "Distance".





🏋   🗋 📂 🛃 🚽   Distance 2.02.160 (64 Bits) - C	E-6006 (1730616)	- 0 ×
Arquivo Home View Software Options		~ <b>?</b>
Channels	Settings X	
Direc Connection	General General Inform. System Notes & Obs. Explanatory Figures Check List Others Connections	
Point test Search Test Test Settings	Distance Descr. Distance function Date:	
Insert/Edit Points	Tated to in	•
Insert/Edit Points General Options Edit Point Data Entry: Z an	Identif: V Model V	FaultAE
Test Point	Type: V Manufacturer: V	Dirite Net Testad
New Point V IZI Relative to Line Adopting the same line	Location:	Points Tested
IZ: 0.00 Q R:	Substation:	Colors: Not Tested
Remove Ø: 0.0 ° X:	Bay:	Fail
Remove All	Address:	Information:
TONOTO TH	City: V State: V	
Test Point	Presentile	Current Point
Tested Points		- 0:
AE BE CE AB BC CA	Name:	-R:
No. Zone Operated R	Sector: V Registry: V	//////
	Tool Test:	
	CE-6006 Series Num.: 17306166302101110011XXX	
	· · · · · · · · · · · · · · · · · · ·	
<	Default V Import Export Preferences OK Cancel	
Zone R-X Z and Ø Z rel J Time	-4.00 -3.00 -2.00 -1.00 0 1.00 2.00	3.00 4.00
Errors List Protection Status		
📢 OFF Line New	Aux Source: 0,00 V Heating: 0%	

Figure 18

#### 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.



			,
	PARA	TESTES	FIFTRICOS
INSTRUMENTOS		ILJILJ	LELINICOJ

General	General Inform.	System N	otes & Obs. Explanatory Figur	es (	Check List Other	rs Connections	
	Test:						
Distance	Descr: D	istance funct	ion		Date:		
	Tested device:						
		Identif:	23031982	~	Model	D60	~
		Type	Line Protection	_	Manufacturer	GE	~
		.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		-			-
	Location:						
		Substation:	CONPROVE				~
		Bay:	1	$\sim$			
		Address:	Visconde de Ouro Preto, 75 - Cu	istódio F	Pereira		~
		City:	Uberlândia		~	State	: MG 🗸
	Responsible:						
		Name:	Michel Rockembach de Carvalh	0			~
		Sector:	Engineering	~	Registry:	00001	~
	Tool Test:						
	CE-6006		Series	Num.:	173061663021011	110011XXX	
	Import 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 is not relevant for this test.



Figure 21



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 GE D60 relay will be parameterized differently for phase-ground faults in relation to two-phase and three-phase faults. For the software to perform the test properly, 6 types of zones must be inserted, the first three for two-phase and threephase faults and the last three for phase-ground faults.

#### 6.1 Distance Screen > Distance Prot. Settings

The first step is to adjust the ground compensation factor.



Figure 22

#### **6.2** Inserting Phase Zones

The first zone to be entered will be zone-1 (Phase). Click on the "Insert" field highlighted in green in the previous figure. In the settings screen, first select the relay mask "GE D60-Mho". You must adjust the actuation time, choose the type of fault (loop), and enter the zone characteristics and directionality. Adjust the tolerance values and finally click on "OK".







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



Clicking "Insert" again adjusts the values for zone 3.





#### Figure 25

#### 6.3 Inserting Zones (Phase-Earth)

Zone 4 entered in the software is equivalent to zone 1 phase-ground of the relay, zone 5 is equivalent to zone 2 phase-ground and zone 6 is equivalent to zone 3 phaseground set in the relay. Change the name of each zone and make the following adjustments for each of the zones.



Figure 26





Figure 27







#### **INSTRUMENTOS PARA TESTES ELÉTRICOS** 7. Channel Direction and Hardware Configurations

Click on the icon illustrated below.



Figure 29

Then click on the highlighted icon to configure the hardware.

Channels Direct.												_		×
Bool         Model         R           CE-6006         V         Serial Number:         1730616630210111001	Reset for Hard. Connected	¢ k S	Set ○ ●	Basic Advanced ON Line	e <sup>6</sup> o G <sup>s</sup> ∨ S.	OOSE Value	Hard.:	Adapt I/Os Autoassociate Clean	• •	Nodes:	oassociate Clean ▼	Import	Confir Cance Export	m el
Outputs: Analog. and SV	Inputs: Analog.	and SV	/ Output	s: Binary, GOO	SE and	Analog	DC	Inputs: Binary, GO	OSE a	and Analog. D	C Logical			<i>//</i> >>
< NO01 >	N 🕂 🗕 -	-	_m_	405	orwar					Voltage Char	nnels		⊥ ▼  ♣ ▼	
Nominal Line Source	e				orward					Descr.	Hardware	Node	Point	
			ന്നപ്പ							AO_V01	V1	NO01	👻 Va	-
Frequency:	60 Hz ~	L		-			શ્રદ્ધ			AO_V02	V2	▼ NO01	▼ Vb	•
Phase Seq.:	ABC ~		<del>ہ</del> ۲	в овј		0	8 ≥			AO_V03	V3	▼ NO01	▼ Vc	-
3φ power:	47,80 MVA				٦L									
1φ: [	15,93 MVA					⊘ ∃								
Primary Voltage (FF):	13,80 KV					·								
(FN):	7,97 KV					a† =								
Primary Current:	2,00 kA					~	SIZ.							
Secondary Voltage (EE):	115.0 V						-							
(ENI)-	66 40 V									Current Chan	inels	Y	•   <b>•</b> •	
	5 00 0		Voltage	Channe		С	urrents	Channel		Descr.	Hardware	Node	Point	
Secondary Current:	5,00 A		1 Va	AO_V01	~	5	la	AO_101 ~	Σ	AO_I01	14	NO01	👻 la	-
VTR F:	120,0	FN	2 Vb	AO_V02	$\sim$	F e	i lb	AO_102 ~	Σ	AO_102	15	<ul> <li>NO01</li> </ul>	▼ Ib	-
CTR F:	400,0		3 Vc	AO_V03	~	7	/ lc	AO_103 ~	Σ	AO_103	16	▼ NO01	▼ lc	•
VTR D / VTR F:	1,00		Vab		~	E 8	IE		~					
CTR E / CTR F:	1,00	FF	Vbc	_	~	EP 9	IEP		$\sim$					
Reverse Polarity:			Vca	-	<u> </u>									
VT's F	CT's F	-	4 VD		Ť		k 10		~					
	CTE	Calc.	k.V2		~	Calc.	k.12		~					
Equal Parameters An	mong Nodes	k	to V0 1,00	to V2 1.00		k i	to I0 1,00	to I2 1,00						

Figure 30

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





Figure 31

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

Char	nels Direct.			— 🗆 X
Local	Model Reset for Hard.	Basic		Confirm
5	CE-6006 V Connected	O Advanced	Se GOOSE	Cancel
ote	Serial Number:		50	
Rem	03207116302101110011XXX	V V ON Line	<sup>s</sup> <sub>o</sub> S. Value	Import Export

Figure 32

#### 8. Test structure for function 21

#### 8.1 Test Settings

By clicking on the 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.



1 🗋	🗃 层 🤿   Distance 2.02.160 (	(64 Bits) - C	E-6006 (173061	6)											- 6	×
Arquivo	Home View Softwa	re Options														~ 🕐
Channels Direc	Hrd Config 😵 GOOSE Co GOSE Config 5, SV Config Connection Hardware	onfig St	art Stop >>	Next Point	Clear test	Settings	₩Waveform Phasors Trajectory	Chart ZxT	Present Report	C ∿ P3 S abs rel Upits	Recreate Resto Charts Layo	ore View ut •				
Point test	Search Test Test Settin	as	0	eneration			options		Report	onics	cayor					
Generat	ion of Channels Direc.	Enable	e Pre-Fault 1		Enable F	Pre-Fault 2		Enable Po	ost-Fault					VTR	Neutral/VTF	Phase:
	Generation Channel	Mode	Vs = VNon	n, ls = 0 🔻											1,00	_
Va	AO_V01 (Hrd: V1) -	V1	66.40 V	0 *										CTR	Ground/CTF	RPhase:
Vb	AO_V02 (Hrd: V2) -	V2	66,40 V	240,0 °											1,00	
Vc VD	AO_V03 (Hrd: V3)	V3	66,40 V	120,0 °											Inv. Phase	VTs
la	AO_I01 (Hrd: I4) -	14	0 A 0	0*										L	_ Inv. Neutr	al VT
lb	AO_I02 (Hrd: I5) -	15	0 A	240,0 °											Inv. Phase	CTs
lc	AO_I03 (Hrd: I6) -	16	0 A 0	120,0 °										L	j inv. cann	CI
IE IE PII	•															
Kee	p pre-fault in healthy phases		Time Pre-Fault	1: 100,00 ms												
Binary C	Outputs & Goose - Fault	Binary Out	puts & Goose - P	Pre-Fault1										F	Configure i	in All
BO	0; 0; 0; 0; 0; 0 🔫	BO	0; 0; 0; 0;	: 0: 0 🔻										L	- Generation	15
GU Sin		GU Simu														
Generat	ion and Pickup Limits	Test Mode	•		1								Search Test			_
I Max.	Channel Gener 15,00 A	Mode	Intellige	ent 🔻									Initial step:	Absolute Resolution:	100,00 m2	2
Us	e Hardware Limit												Min. Resolution V	Relative Resolution:	0,10 %	
Mult V	Max. Fault (L-M2,00 Vfn												Mult. Tolera	nce for Verification Test:	1,10	^
L Min	Pickup 100.0 mA													Reset Time:	100,00 ms	•
Stop	o Interf. BI01 (Hrd: BI1) 🗸 🗸	Stop	o Logic 🔐 🗼	nitial NA $\sim$									Verify Possible Inter	Overtime Waiting:	50,00 ms	× ×
					Fault Start								Anal	yze Trajectory to High Sp	beed Zones	
Trigge	r Interf. Software 🗸 🗸	Trigge	r Logic		Mode	Ran	dom 🔻							Based Only on Values	Generated	
	Wait for PPS	Trigger	r Delay 0,00 s		VFault Ang	4	DC Offset							Cycle to Cycle	Generation	
NO (	Line New						Aux Source	110,00 V	Heating	r: 09	%					
							1.1		12							

Figure 33

#### 8.2 Two-Phase and Three-Phase Loop

Click on the "Search Test" 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: ABC, AB, BC and CA.

Point test	Search Te	st Test Settings						
Insert/	Edit Points							-
Insert/Edit	Points	General Options	Annhata					
Edit L	Line	Data Entry:	Apply to			<u>^ .</u>	Line V	
		Line Origin	Fault Type			<b>1</b>		
New Li	ne 🔽	Z Relative to			M ABC	Ω	2 Ang.: 0,0 °	
Comme		Adopting the sam	E BE	⊡ BC				
Sequer	ice	171: 0.00.0	CE	CA 🗹	🗌 Ali	-	Step: 45.00 °	
Remo	ove	0,00 \$2		OK	C			
		Ø: 0,0 °		OK	Cance	el O	<sup>™</sup> Nº of Points 8	
Remov	ve All	Characteristic: 🔘 Se	arch 🔿 Cł	neck				



Enter a new sequence whose starting point is |Z| equal to  $0.6\Omega$  and  $\theta$  equal to  $70^{\circ}$ . The search line length is  $6.0\Omega$  and the angle ranges from 0 to  $360^{\circ}$  with a  $60^{\circ}$  step.





Figure 35







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







#### 8.3 Final Result Fault AB

By clicking on the tab "AB" 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.

Arquivo	ie de la Home	Distance 2.0 View	)2.160 (64 Bit: Software Opt	s) - CE-6006 tions	(1730616)											- 0	× ^ <b>?</b>
Channels Direc	Hrd Cor GPS Cor Connect Harr	nfig ္ရွိေGO nfig ၈၂ SV tion dware	OSE Config Config	Start S	> Nex >> Nex >> Nex Genera	t Point 🧹 Clear tes t Line 👑 Clear all t Fault tion	t 🖌 🖗 Waveform 🔐 Settings 🖗 Trajectory Options	Chart ZxT SEL	Present Report Report	Pilis dbs rel Units	Recreate F Charts	Restore View ayout	,				
Point test	Search 1	Test Test	Settings						1	TT							
Insei Inseit/E New Sequ Rer Tested P AF	tt/Edit Points dt Points dt Points v Line v	General O Data En Line Orig IZI R Adop IZI: [C Ø: ]: Characteri	ptions           try:           jin           elative to           oting the same           0.60 Ω           70.0 °           stic:         • Sea           BC         CA	Z and Ø Line line angle R: [205,21 X: [0,56 Ω rch ] Cherc ABC	μ μ μ μ μ μ μ μ μ μ μ μ μ μ μ μ μ μ μ	ength Relative to: Lin equence dital: 0.00 ° Ste 360.00 ° №	ng.: 300,0 * pp: 60,00 * of Ponta 6	<ul> <li>C</li> <li>4,</li> <li>3,</li> <li>2,</li> <li>1,</li> </ul>	, hart Δ × [Ω] ,00 ,00 ,00 ,00 ,00 0		ectories	Waveform P	Phasors			FaultAB Legend: Search Points Colors: Not Teste Passed Fail Information: Current Point - [Z]: - Q:	
N⁰	Zone	R Nom.	X Nom.	R Real	X Real	Status		▲ -1.	.00		H	$\langle \uparrow \rangle$		X	4117	- H: - X:	
06-01	Zn01_LL (To	428,3 mΩ	177,5 mΩ	425,1 mΩ	183,0 mΩ	Passed		-2,	.00	H		X		X			
06-02	Zn02_LL (To	485,7 mΩ	78,02 mΩ	484,2 mΩ	80,57 mΩ	Passed		-3									
06-03	Zn03_LL (To	2,31 Ω	-3,09 Ω	2,31 Ω	-3,08 Ω	Passed		-4.	.00	$\sum$							
Type:	Points ~ [	Zone 🗹	] R-X 🗌 Z	rel 🗌 Time	Vål				-4	.00 -3.	.00 -2.00	-1.00	0 1.00	2,00	3,00 4,00		
Errors	List Pro	tection State	us														
<ul><li>ON</li></ul>	Line	New					Aux Source:	110,00 V	Heating	j: 0'	%						
							Fig	gure (	38								

The other fault types can be visualized, for this click on the corresponding tab. Save the test and remove the tests in order to test the phase-ground characteristics. In this test, you should change the stop interface to BI2 in the option *"Test Settings"*.



🛣   🗋 🛾	→ Distance 2.02.160 Home View Software	(64 Bits) - are Option	CE-6006 (17306 s	i16)									-	٥	× ^ 🕜
Channels Direc	Hrd Config 😵 GOOSE C GPS Config 5, SV Config Connection Hardware	onfig	Start Stop	> Next Point >> Next Line >>> Next Fault Generation	🖌 Clear test	Settings	form L Chart ZxT ors I SEL tory ions	Present Report Report	Pill S abs rel Units	Recreate Charts Layout	View				
Point test	Search Test Test Settin	gs													
Generat	ion of Channels Direc.	🗹 Enat	ole Pre-Fault 1		Enable P	re-Fault 2	Enable	Post-Fault					VTRNeu	tral/VTRPhas	se:
	Generation Channel	Mode	Vs = VNc	om, ls = 0 🔻									1,	00	
Va Vb	AO_V01 (Hrd: V1)	V1 V2	66,40 V 66,40 V	0 ° 240,0 °									CTRGrou	und/CTRPhas	se:
Vc	AO_V03 (Hrd: V3)	V3	66,40 V	120,0 °										. Phase VTs	
la	AO_I01 (Hrd: I4)	14	0 A	0*									in	v. Neutral VT	
lc	AO_102 (Hrd: 15)	15	0 A	120,0 °									In	v. Earth CT	
IE PII	-														
Kee	p pre-fault in healthy phases		Time Pre-Fault	t 1: 100,00 ms											
Binary C BO GO	utputs & Goose - Fault 0; 0; 0; 0; 0; 0; 0	Binary O BO GO	utputs & Goose - 0; 0; 0;	Pre-Fault1 0; 0; 0 -									G	onfigure in All enerations	
Sin	nulate Sampled Value Error	Sim	ulate Sampled \ -	/alue Error								Sourch Test			
L Max	Channel Gener 15 00 A	Mode	lotellic	ent 🔻								Initial step:	Absolute Resolution: 10	Ωm 00,00	
🔳 Use	e Hardware Limit		-									Min. Resolution ${\scriptstyle\checkmark}$	Relative Resolution: 0,	10 %	
Mult V	Max. Fault (L-1 2,00 Vfn	11										Mult. Tolera	nce for Verification Test: 1,	10 /	^
V Min.	Pickup (L-N) 1,00 V	.											Reset Time: 10	00,00 ms	
Stop	b Interf. BI02 (Hrd: BI2) ∨	Ste	op Logic	Initial NA $\sim$								Verify Possible Inter	Overtime Waiting: 50 ventions of Other Loops for F	0,00 ms	~
-					Fault Start							Anal	yze Trajectory to High Speed	Zones 🗹	
Irigge	Wait for PPS	Trigg	er Logic er Delay 0,00 s		VFault Ang	Random	Offset						Based Only on Values Ger Cycle to Cycle Ger	nerated 🗹 neration 🗹	
to ON	Line New					Au	x Source: 110,00 V	Heating	j: 05	%					

Figure 39

# 8.4 Single-phase Loop

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

Point test Search Te	est Test Settings
Insert/Edit Points	
Insert/Edit Points	General Options
<u>E</u> dit Line	Data Entry:     Apply to     ×       Line Origin     Fault Type:
New <u>L</u> ine 🗸	IZI Relative to         AE         AB         ABC         5.50 Ω         Ang. : 315,0 °
<u>S</u> equence	Adopting the BE BC
<u>R</u> emove	Ø:         0,0 °         OK         Cancel         60,00 °         Nº of Points         8
Remove <u>A</u> ll	Characteristic: Search O Check

Figure 40

Enter a new sequence whose starting point is |Z| equal to  $1.2\Omega$  and  $\theta$  equal to  $70^{\circ}$ . The search line length is  $6.0\Omega$  and the angle ranges from 0 to  $360^{\circ}$  with a  $60^{\circ}$  step.





Figure 41

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



Start the generation and the final result is shown below.





Figure 43

It is verified in both searches that the values found are within the tolerance provided by the manufacturer.

#### 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	×
Languag∉ Inglês En-US ∨	
All     General Data Test     General Data of Tested Device     Jinstallation Location     Reference Values     Jest Settings     Test Settings     Distance Protection Settings     Jest Results     Points Details of Selected Fault     Charts of Selected Simulation     Notes and Observations     Explanatory Figures     Check List	~
OK Cancel	

Figure 44





Figure 45



## APPENDIX A

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



Figure 46



#### A.2 Technical data

PHASE DISTANCE	
Characteristic:	mho (memory polarized or offset) or quad (memory polarized or non-direc- tional), selectable individually per zone
Number of zones:	5
Directionality:	forward, reverse, or non-directional per zone
Reach (secondary Ω):	0.02 to 500.00 Ω in steps of 0.01
Reach accuracy:	±5% including the effect of CVT tran- sients up to an SIR of 30
Distance:	
Characteristic angle:	30 to 90° in steps of 1
Comparator limit angle	e: 30 to 90° in steps of 1
Directional supervision:	
Characteristic angle:	30 to 90° in steps of 1
Limit angle:	30 to 90° in steps of 1
Right blinder (Quad only	y):
Reach:	0.02 to 500 Ω in steps of 0.01
Characteristic angle:	60 to 90° in steps of 1
Left Blinder (Quad only)	
Reach:	0.02 to 500 Ω in steps of 0.01
Characteristic angle:	60 to 90° in steps of 1
Time delay:	0.000 to 65.535 s in steps of 0.001
Timing accuracy:	±3% or 4 ms, whichever is greater
Current supervision:	
Level:	line-to-line current
Pickup:	0.050 to 30.000 pu in steps of 0.001
Dropout:	97 to 98%
Memory duration:	5 to 25 cycles in steps of 1
VT location:	all delta-wye and wye-delta transformers
CT location:	all delta-wye and wye-delta transformers
Voltage supervision pick	kup (series compensation applications): 0 to 5.000 pu in steps of 0.001

#### PHASE DISTANCE OPERATING TIME CURVES

The operating times are response times of a microprocessor part of the relay. See output contacts specifications for estimation of the total response time for a particular application. The operating times are average times including variables such as fault inception angle or type of a voltage source (magnetic VTs and CVTs).



#### GROUND DISTANCE

Characteristic:	Mho (memory polarized or offset) or Quad (memory polarized or non-direc- tional), selectable individually per zone			
Reactance polarization:	negative-sequence or zero-sequence current			
Non-homogeneity angle:	-40 to 40° in steps of 1			
Number of zones:	5			
Directionality:	forward, reverse, or non-directional per zone			
Reach (secondary Ω):	0.02 to 500.00 Ω in steps of 0.01			
Reach accuracy:	±5% including the effect of CVT tran- sients up to an SIR of 30			
Distance characteristic a	ngle: 30 to 90° in steps of 1			
Distance comparator limi	t angle: 30 to 90° in steps of 1			
Directional supervision:				
Characteristic angle:	30 to 90° in steps of 1			
Limit angle:	30 to 90° in steps of 1			
Zero-sequence compens	ation			
Z0/Z1 magnitude:	0.00 to 10.00 in steps of 0.01			
Z0/Z1 angle:	-90 to 90° in steps of 1			
Zero-sequence mutual c	ompensation			
Z0M/Z1 magnitude:	0.00 to 7.00 in steps of 0.01			
ZOM/Z1 angle:	-90 to 90° in steps of 1			
Right blinder (Quad only)	)r			
Reach:	0.02 to 500 Ω in steps of 0.01			
Characteristic angle:	60 to 90° in steps of 1			
Left blinder (Quad only):				
Reach:	0.02 to 500 Ω in steps of 0.01			
Characteristic angle:	60 to 90° in steps of 1			
Time delay:	0.000 to 65.535 s in steps of 0.001			
Timing accuracy:	±3% or 4 ms, whichever is greater			
Current supervision:				
Level:	neutral current (3I_0)			
Pickup:	0.050 to 30.000 pu in steps of 0.001			
Dropout:	97 to 98%			
Memory duration:	5 to 25 cycles in steps of 1			
Voltage supervision pick	up (series compensation applications): 0 to 5 000 pu in steps of 0 001			

#### GROUND DISTANCE OPERATING TIME CURVES

The operating times are response times of a microprocessor part of the relay. See output contacts specifications for estimation of the total response time for a particular application. The operating times are average times including variables such as fault inception angle or type of a voltage source (magnetic VTs and CVTs).





#### **APPENDIX B**

Software parameter equivalence and the relay under test

Table 1							
Distance Software		D60 Relay					
Parameter	Figure	Parameter	Screen ID	Figure			
Mod Z0/Z1	22	Z0/Z1 Mag	11	13			
Ang Z0/Z1	22	Z0/Z1 Ang	11	13			
Zn1 Fase		Phase Distance Z1					
Reach phs	23	Reach	13	12			
Reach RCA phs	23	RCA	13	12			
Rev Reach phs	23	Rev Reach	13	12			
Rev Reach RCA phs	23	<b>Rev Reach RCA</b>	13	12			
Comp Limit phs	23	Comp Limit	13	12			
Dir RCA	23	Dir RCA	13	12			
Dir Comp	23	Dir Comp Limit	13	12			
Zn2_Fase		Phase Distance Z2					
Reach phs	24	Reach	13	12			
Reach RCA phs	24	RCA	13	12			
Rev Reach phs	24	Rev Reach	13	12			
Rev Reach RCA phs	24	<b>Rev Reach RCA</b>	13	12			
Comp Limit phs	24	Comp Limit	13	12			
Dir RCA	24	Dir RCA	13	12			
Dir Comp	24	Dir Comp Limit	13	12			
Zn3_Fase		Phase Distance Z3					
Reach phs	25	Reach	13	12			
Reach RCA phs	25	RCA	13	12			
Rev Reach phs	25	Rev Reach	13	12			
<b>Rev Reach RCA phs</b>	25	<b>Rev Reach RCA</b>	13	12			
Comp Limit phs	25	Comp Limit	13	12			
Dir RCA	25	Dir RCA	13	12			
Dir Comp	25	Dir Comp Limit	13	12			
Zn1_Terra		Ground Distance Z1					
Reach gnd	26	Reach	11	13			
Reach RCA gnd	26	RCA	11	13			
Rev Reach gnd	26	Rev Reach	11	13			
<b>Rev Reach RCA gnd</b>	26	<b>Rev Reach RCA</b>	11	13			
Comp Limit gnd	26	Comp Limit	11	13			
Dir RCA	26	Dir RCA	11	13			
Dir Comp	26	Dir Comp Limit	11	13			



Distance Software		D60 Relay			
Parameters	Figure	Parameter	Screen ID	Figure	
Zn2_Terra		Ground Distance Z2			
Reach gnd	27	Reach	11	13	
Reach RCA gnd	27	RCA	11	13	
Rev Reach gnd	27	Rev Reach	11	13	
Rev Reach RCA gnd	27	<b>Rev Reach RCA</b>	11	13	
Comp Limit gnd	27	Comp Limit	11	13	
Dir RCA	27	Dir RCA	11	13	
Dir Comp	27	Dir Comp Limit	11	13	
Zn3_Terra		Ground Distance Z3			
Reach gnd	28	Reach	11	13	
Reach RCA gnd	28	RCA	11	13	
Rev Reach gnd	28	Rev Reach	11	13	
Rev Reach RCA gnd	28	<b>Rev Reach RCA</b>	11	13	
Comp Limit gnd	28	Comp Limit	11	13	
Dir RCA	28	Dir RCA	11	13	
Dir Comp	28	Dir Comp Limit	11	13	