

INSTRUMENTOS PARA TESTES ELÉTRICOS Test Tutorial

Equipment Type: Protection Relay

Brand: GE

Model: <u>D60</u>

Function: <u>68 or RPSB - Power Swing Blocking (PSB) & 78 or</u> <u>PPAM - Out of step (OoS)</u>

Tool Used: CE-6006; CE6707; CE-6710; CE-7012 or CE-7024

Objective: <u>Test of PSB and OoS in Conditions of Synchronous</u> and Asynchronous Power Oscillations

Version Control:

Version	Descriptions	Date	Author	Reviewer
1.0	Initial Version	28/03/2022	M.R.C.	G.C.D.P



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Statement of responsibility

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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 test 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 test and also be aware of safety standards and regulations.

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INSTRUMENTOS PARA TESTES ELÉTRICOS D60 Relay Power Swing Blocking and Out-of-Step Protection Philosophy

Power swing detection has both blocking and tripping functions. The impedance vector is measured according to 2 or 3 user-parameterized boundary characteristics.

1. Detection of Power Swing Blocking:

<u>Three-step operation</u>: Power swing time is measured when the impedance vector is between the outermost zones to the central zone. If the impedance enters the external zone and remains outside the central characteristic for a time longer than the time parameterized in POWER SWING PICKUP DELAY 1, the power swing blocking is performed. The release will be commanded when the impedance leaves the outermost characteristic, but not before the parameterized time.

<u>Two-step operation</u>: for the two-step mode, the sequence is identical, but it is the external and internal characteristics that will be used to measure the time.

2. Detection of Power Swing (TRIP):

<u>Three-step operation</u>: unstable power oscillations are identified by checking if the impedance has remained between the external and central characteristic for a finite time and between the central and internal characteristic also for a finite time. The first step is identical to detecting power swing. After the POWER SWING PICKUP DELAY 1 time is exceeded, lock 1 is adjusted over the period the impedance remains in the outer zone.

If then, at any time, the impedance stays between the external zone and the switch for a period longer than POWER SWING PICKUP DELAY 2, a lock 2 is set while the impedance remains inside the external zone.

If then, at any time, the impedance remains within the inner zone for a period longer than POWER SWING PICKUP DELAY 3, a lock 3 is set while the impedance remains within the outer zone. The element is therefore ready for tripping.

If fast TRIP mode is selected, power swing trip is commanded immediately and is locked for a time set in POWER SWING SEAL-IN DELAY. If "delayed" trip mode is selected, the element waits until the impedance leaves the internal characteristic and the POWER SWING PICKUP DELAY 4 time expires, thus setting a latch of 4, making the element ready to trip. The trip will only be commanded later when the impedance leaves the external characteristic.

<u>Two-Step Operation</u>: Two-Step Mode is similar to Three-Step with two exceptions. First, the initial stage monitors the time spent by the impedance vector between the outer and inner zones. Second, the stage involving the POWER SWING PICKUP DELAY 2 is skipped.

The element can be adjusted to use either mho or quadrilateral features as shown below. When set to Mho, the element also applies blinders (left and right). If blinders are not required, their settings must be parameterized high enough to effectively disable them.



INSTRUMENTOS PARA TESTES ELÉTRICOS Sequence for testing relay D60 in PSB_OoS software

1. Relay Connection to CE-6710

1.1 Auxiliary Source

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



1.2 Current and Voltage Coils

To establish the connection of voltage coils, connect voltage channels V1, V2 and V3 to pins F5a, F6a and F7a of the relay and connect the commons of voltage channels to pins F5b, F6b and F7b of the relay: current I1, I2 and I3 of the CE-6710 to pins F1a, F2a and F3a of the relay respectively, connect the three commons of the CE-6710 to the pins F1b, F2b and F3b of the relay completing the connection.



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1.3 Binary Inputs

Connect the binary inputs of the CE-6710 to the binary outputs of the relay.

- BI1 to pin P1b and its common to pin P1c.
- BI2 to pin P2b and its common to pin P2c.
- BI3 to pin P3b and its common to pin P3c.



Figure 3

2. Communication with relay D60

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



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



▲ Discover ↓ ★ Add Site ↓ ★ Add Device	
	Device Name: D60
Ler New Site 1	Description:
	Color:
	Interface: Ethernet
	IP Address: 10 . 0 . 11
	Slave address: 254 🛨 Modbus Port: 502
	Connected via Ethernet / Serial Gateway: No 💌
	Order Code: D50-N07-HCH-F81-P6T
<u> Delete</u>	Version: 5.7x Version: 5.7x
	🗹 Ok 🛛 🗙 Cancel

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



Figure 6

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3. Parameterization of relay D60

3.1 Current

After the connection has been established, click on the "+" signs next to "Settings" > "System Setup" > "AC Inputs" and double-click on "Current", in which you will be able to adjust the primary and secondary current values of the current transformer.



Figure 7

3.2 Voltage

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

Save Restor	🛛 🛱 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
D60 Settings: System Setup	AC Inputs Screen ID: 168



3.3 Power system

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

Save Restore	🗑 Default 🛛 🖽 Reset 🛛 💴		
SETTING	PARAMETER		
Nominal Frequency	60 Hz		
Phase Rotation	ABC		
Frequency And Phase Reference	SRC 1 (SRC 1)		
Frequency Tracking Function	Enabled		



3.4 Signal Source

Set the current transformer to "F1" and the potential transformer to "F5" in "Source 1".

말 Save 말 Restore 말	Default 🖭 Reset VIEV	V 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 the "+" sign next to "Grouped Elements" > "Group1" > "Distance" and double-click "Distance" (not shown). In this window, the "Source" is defined with "SRC1".

Save	Restore	🔛 Default	Reset	VIEW ALL
S	ETTING		PARAMET	ER
Source			SRC 1 (SRC 1	1)
Memory Duratio	n		10 cycles	
Force Self-Pole	ar		OFF	
Force Mem-Pol	ar		OFF	

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3.6 *Phase Distance*

Click the "+" sign next to "Grouped Elements" > "Group1" > "Distance" and double-click "Phase Distance" (not shown). In this window, the zone settings, directionality and operating time of the phase elements are defined. Although the relay allows the registration of up to 5 zones, in this test only zone 1 will be used.

Bestore Bestore Bestore Best VIEW ALL mode				
PARAMETER	PHASE DISTANCE Z1	PHASE DISTANCE Z2	PHASE DISTANCE	
Distance Shape Graph	View	View	View	
Function	Enabled	Disabled	Disabled	
Direction	Forward	Forward	Forward	
Shape	Quad	Mho	Mho	
Xfmr Vol Connection	None	None	None	
Xfmr Curr Connection	None	None	None	
Reach	4.00 ohms	2.00 ohms	2.00 ohms	
RCA	85 deg	85 deg	85 deg	
Rev Reach	4.00 ohms	2.00 ohms	2.00 ohms	
Rev Reach RCA	85 deg	85 deg	85 deg	
Comp Limit	90 deg	90 deg	90 deg	
DIR RCA	90 deg	85 deg	85 deg	
DIR Comp Limit	90 deg	90 deg	90 deg	
Quad Right Blinder	2.00 ohms	10.00 ohms	10.00 ohms	
Quad Right Blinder RCA	60 deg	85 deg	85 deg	
Quad Left Blinder	2.00 ohms	10.00 ohms	10.00 ohms	
Quad Left Blinder RCA	60 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	0.030 s	0.000 s	0.000 s	
Block	OFF	OFF	OFF	
Target	Self-reset	Self-reset	Self-reset	
Events	Disabled	Disabled	Disabled	
<	ut)		>	
D60 Settings: Grouped Elements: G	roup 1: Distance	Screen ID: 13	1	



3.7 *Power Swing Detect*

Double-click on "*Power Swing Detect*". In this option, you define the values for power swing or out-of-step detection. You must choose the zone type (Mho or Quadrilateral) and the number of zones (two or three). In this tutorial the fits are quadrilateral with two zones. To test the mho characteristic with 3 zones, the user just has to make an analogy to this tutorial.



Power Swing Detect // New	v Site 1: D60: Settings: Group 🔳 🗖	X
Save BRestore	Default Reset VIEW ALL mode	
SETTING	PARAMETER	~
Power Swing Detect Graph	View	
Function	Enabled	1
Source	SRC 1 (SRC 1)	1
Shape	Quad Shape	1
Mode	Two Step	
Supv	0.600 pu	
Fwd Reach	4.00 ohms	1
Quad Fwd Mid	4.00 ohms	
Quad Fwd Out	8.00 ohms	
Fwd Rca	90 deg	
Rev Reach	4.00 ohms	
Quad Rev Mid	4.00 ohms	
Quad Rev Out	8.00 ohms	
Rev Rca	90 deg	
Outer Limit Angle	90 deg	=
Middle Limit Angle	90 deg	
Inner Limit Angle	90 deg	
Outer Rgt Bld	8.00 ohms	
Outer Lft Bld	8.00 ohms	
Midle Rgt Bld	8.00 ohms	
Midle Lft Bld	8.00 ohms	
Inner Rgt Bld	4.00 ohms	
Inner Lft Bld	4.00 ohms	
Delay 1 Pickup	0.040 s	
Delay 1 Reset	0.050 s	
Delay 2 Pickup	0.017 s	
Delay 3 Pickup	0.020 s	
Delay 4 Pickup	0.050 s	
Seal-In Delay	0.100 s	
Trip Mode	Delayed	
Block	OFF	
Target	Self-reset	~
D60 Settings: Grouped Elements: Gr	oup 1 Screen ID: 218	1

Figure 13

4. Binary Output Adjustments

4.1 Contact Outputs

Click on the "+" sign next to "*Inputs/Outputs*" and double-click on "*Contact Outputs*" (not shown). On this screen, the trips of the functions with the binary outputs of the relay are designated.



Contact Outputs // Nev	w Site 1: D60:Settings: Inputs/ 💶 🗖 🚺		
Save Restore	Default Beset VIEW ALL mode		
SETTING	PARAMETER		
[P1] Contact Output 1 ID	Cont Op 1		
[P1] Contact Output 1 Operate	PH DIST Z1 OP		
[P1] Contact Output 1 Seal-In	OFF		
[P1] Contact Output 1 Events	Enabled		
[P2] Contact Output 2 ID	Cont Op 2		
[P2] Contact Output 2 Operate	POWER SWING BLOCK		
[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	POWER SWING TRIP		
[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	OFF		
[P4] Contact Output 4 Seal-In	OFF		
[P4] Contact Output 4 Events	Enabled		
D60 Settings: Inputs/Outputs	Screen ID: 232		

Figure 14

In appendix B the user finds an equivalence table between the relay software settings and the test case.

5. PSB OoS software adjustments

5.1 Opening the PSB OoS

Click on the CTC application manager icon.



Click the "PSB OoS" software icon.



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0817)				

🏪 🗋 📴 🛃 🖛 🗠	SB OoS 2.02.171 (64 Bits) -	5710 (0110817)		- 0 ×
Arquivo Home	Display Software Optic			^ (
Hrd Set	୍ରତି GOOSE Set ୭୦ SV Set	tings	x	
Channels Direc () Connection Hardwa	on Start	General Inform. System Note Test:	s & Obs. Explanatory Figures Check List Others Connections	
System Simulation	Trajectories Simulation	Distance Descr:	Date:	
Insert/Edit Points]			-
Insert/Edit	General Options	Tested device:		
Edit Oscillation	Oscillation Type:	ldentif: Type:	Model Manufacturer:	_
New Oscillation	- Synchronous Oscillation -	Location:	3	~
	Slip Angle:	Substation:	~	Mod. KS 1,00
Sequence	Time:	Bay:	~	Ang KS 0 °
Barraua		Address:		
nemove		City:	✓ State: ✓	
Remove All		Responsible:		
		Name:	✓	
		Sector:	V Registry:	
Test Points				
Points Tested		Tool Test:		
Nº Type of Oscillation O	Time of Interface Op No	CE-6710	Series Num.: 01108177CCM33222211U5HVRGLGLGL2Z0RXX	
			Preferences OK Cannal	
🗹 General Info. 🗹 O	peration 🔽 Time			
Errors List Prote	ection Status			
ON Line	New	A	Aux Source: 0,00 V Heating: 0%	
			Figure 17	

Figure 17

5.2 Configuring the Settings

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



Figure 18

Inside the "Settings" screen, fill in the "General Inform." with details of the tested device, installation location and the person responsible. This makes reporting easier, as this tab will be the first to be shown in it.



ieneral	General Inform.	System N	lotes & Obs.	Explanatory Figures	Check List Oth	ners Connectio	ons	
	lest:				_			
starice	Descr:	Power Swing I	Block and Out	t of Step	Date	e		
	Tested device:							
		Identif:	23031982		 Mode 	I D60		~
		Type:	Line Protect	tion	Manufacturer	GE		~
	Location:							
		Substation:	Conprove					~
		Bay:	1		~			
		Address:	Visconde de	e Ouro Preto 75, Custó	dio Pereira			\sim
		City:	Uberlândia		~		State: MG	~
	Responsible:							
		Name:	Michel Rock	kembach de Carvalho				\sim
		Sector:	Engineering	1	 Registry 	: 0001		~
	Tool Test:							
	CE-6710			Series N	um.: 01108177CCM3	3222211U5HVR	GLGLGL2Z0RXX	
	-							

Figure 19

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 Infor	m. System Notes & Obs.	Explanatory Figures Check List Others Connections
Distance Nominal Primary V Primary V Secondary V	Impedance Source Frequency: 60 Hz 9hase Seq.: ABC 3φ power: 119,5 MVA 1φ: 39,84 MVA Voltage (FF): 138,0 KV (FN): 79,67 KV nary Current: 0,500 kA Voltage (FF): 115,0 V (FN): 66,40 V day Current: 50,0 A	
VTR CTR Invert Pole UVTs VT b	VTR F: 1.20k CTR F: 100.0 RD / VTR F: 1.00 RE / CTR F: 1.00 F CT's F CT's F CT's F CT's F	Voltage Currents 1 Va 5 Ia FN 2 3 Vc E 8 D 4 VD EP 9 IEP kto 10: 1,00 kto 12: 1,00
Default V Import	Export	Preferences <u>O</u> K <u>C</u> ancel

Figure 20

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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. Channel Targeting and Hardware Configuration

Click on the icon pointed out below.





Channels Direct. × Local Hard.: Nodes O Basic Adapt I/Os -Confirm Model Reset for Hard Connected CE-6710 Advanced 🗐 GOOSE. Autoassociate -Cance Autoassociate emotes Serial Number 03010187CCM33222211U5HVRGLGLGL2Z0RX0 V ON Line 50 S. Value. Clean Ŧ Clear ŝ Import Export Outputs: Analog. and SV Inputs: Analog. and SV Outputs: Binary, GOOSE and Analog DC Inputs: Binary, GOOSE and Analog. DC Logical Analog Outputs **«** » Sampled Value Outputs NO01 + - m Voltage Channels 🖓 + | 🔶 + | 🗕 -1/1 <hr>
 Forward O m Descr. Hardware Node Point Nominal Line Source 60 Hz AO V02 V2 • NO01 VЬ ABC ₀t ₹ NO01 Seq.: AO V03 V3 ▼ Vc OB ▼ UD • AO_V04 V4 NO01 3q power: 119,5 MVA 1φ: 39,84 MVA R Primary Voltage (FF): 138.0 KV (FN): 79.67 KV Primary Current: 0.500 kA Secondary Voltage (FF): 115,0 V 7 - + -Current Channels (FN): 66.40 V Voltage Channel Currents Channel Descr Hardwa Node Point 5.00 A ndary Current: AO_V01 AO_I01 1 Va 5 la VTR F: 1,20 k FN Vb AO_V02 F lb AO_102 AO_102 NO01 2 6 12 lb CTR F: 100,0 ▼ lc 7 AO 103 ▼ NO01 3 Vc AO V03 lc AO_103 13 VTR D / VTR F: 1,00 Vab Е 8 IE AO_104 14 NO01 ▼ UD • NO01 ▼ UD • FF Vbc AO_105 15 IEP CTR E / CTR F: 1.00 EP 9 ▼ UD • NO01 AO 106 16 Vca Reverse Polarity D VD 4 VT's F CT's F k.V0 k.10 🗌 VT D CT E Calc Calc k.V2 k.l2 Equal Parameters Among Nodes k to V0 1,00 to V2 1,00 k to I0 1,00 to I2 1,00

Then click on the highlighted icon to configure the hardware.

Figure 22

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

tings	
laster Slave 1 Slave 2	Main Sampled Value Others
Model CE-6710 Serial Number 03010187CCM33222211U5HVRGLGLGL2Z0 Analog Outputs: Standard - Voltages: 4 x 300 V; 100 VA 2 x 600 V; 180 VA 2 x 600 V; 180 VA V1 2 x 300 V; 150 VA V2 N1 1 x 600 V; 350 VA V3 V3 1 x 300 V; 250 VA V4 N4	Binary Outputs: Auxiliar Source: Initial State Initial State B01: NO B02: NO B03: NC B04: NC B05 and B06 type: - 60 V Conventional B05: NO B06: NO - 24 V IRIG (B05) /Clock (B06) - 0ff
Customized Assoc.	Transistor TTL 110.00 V Binary / Analog Inputs: BI1: BI - Contact
• 6 x 32 A; 220 VA	BI2: BI - Contact BI3: BI3: BI3: BI3: BI3: BI3: BI3: BI3:
	BI4: BI - Contact 👻
	BI5: BI - Contact 💌
	BI6: BI - Contact
	BI7: BI - Contact
14 O - N4	BI8: BI - Contact
I5 C - N5	BI- Contact
16 9 9 1 6	BI11: BI - Contact
	BI12: BI - Contact
0 1x 50 A; 700 VA	Considers absolute values to Voltage-BI AI 1-6 : 2V; 20V; 600V AI 7-12 : 200mV; 2V; 60
Customized Assoc.	1,25 A OK Cancel

Figure 23

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

Cha	nnels Direct.			- 0	\times
Local	Model Reset for Hard.	Basic Set		Confirm	
emotes	Serial Number: 03010187CCM33222211U5HVRGL0	ilgl2Z0RX0 V V ON Line	⁵ ↓ S. Value	Cancel	
∝				Import Export	





7. Distance Adjustments

7.1 Distance screen > Distance Prot. Settings



Figure 25

7.2 Entering the Phase Zone

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





Figure 26

7.3 Inserting the blinders

By clicking on "*Insert*" again, set the values of two zones with quadrilateral characteristics to represent the blinders being an internal and an external one. Depending on the time the impedance path takes to pass between the two blinders, the relay decides which action to take.





By clicking on "Insert" once again, set the values for Outer zone.





Figure 28

8. Test structure for PSB_OoS functions

8.1 Test Settings

By clicking on the *"Test Settings"* tab, the user must direct the channels and adjust the binary inputs as follows:

- BI01 = "*Dist Trip*";
- BI02 = "*PSB Alarm*";
- BI03 = "OoS Trip".



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4 🗋 🗃 🚽 PSB OoS 2.02.171 (64 Bits) - CE-6710 (01	10817)	- 0 ×
Arquivo Home Display Software Options		~ 😢
Channels Direc Channels Hardware	 Next Point ✓ Clear test Next group ✓ Clear all Settings ✓ Trajectory Generation 	
System Simulation Trajectories Simulation Test Setting	z	
Generation Channels Direc: Enable Pre-Smula Generation Channel Va AO_V01 (Hrd: V1) V Vb AO_V02 (Hrd: V2) V Vo AO_V02 (Hrd: V3) V Ia AO_I01 (Hrd: 11) V Ib AO_I02 (Hrd: 12) V IE V V	tion 1	VTRNestral/VTRPhase: 1.00 CTRGcund/CTRPhase: 1.00 Inv. Phase VTs Inv. Phase VTs Inv. Nestral VT Inv. Restral VT Inv. Ground CT
PSB Alam Bl02 (Hd: Bl2) V Diet. Trip Bl01 (Hd: Bl1) V		Continuous Generation Among Trajectories in Reset Time: 100,00 ms No. of repetitions in case of generation error: 2 ~
OoS Trip BI03 (Hrd: BI3)		Stan the test at the first failure
Trigger Interf. Software Trigger Logic Wait for PPS Trigger Delay 0.0	0 s	Based Only on Values Generated Cycle to Cycle Generation
New	Aux Source: 110,00 V Heating: 0%	

Figure 29

8.2 System Simulation

For the "System Simulation" test, a study must be carried out in order to simplify the system to two voltage sources with a line between them so that the power oscillations will occur according to these parameters. As we do not have this study, we chose the option "Trajectories Simulation".

8.3 Trajectories Simulation

The Trajectory Simulation test makes it possible to create the same tests as the System Simulation, however it has the great advantage of not being tied to the real system settings, so that the user has complete freedom to control the impedance trajectory (dZ/dt). The key factor in detecting the types of oscillation is in the time settings of the "Delay Pickup (from 1 to 4)" parameters inserted into the relay. Depending on the time the trajectory takes to pass from the external to the internal blinder, the following situations arise:

- 1. Time greater than "*Delay 1 Pickup*" set to 0.03 seconds to cross the two blinders regardless of the side (right or left). Power Swing Block tripping.
- 2. The time set in *"Delay 2 Pickup"* is not used in this case. This parameter must be considered when using 3 blinders.
- 3. When the "*Trip mode*" option is set to "*Early*", a time greater than the "*Delay 3 Pickup*" set to 0.02 seconds to cross the inner zone causes the relay to perform the Out-of-Step trip..



- 4. When the "*Trip mode*" option is set to "*Delay*", a time greater than the "*Delay 4 Pickup*" set to 0.05 seconds to cross the two blinders on both sides causes the Out-of-Step trip to be triggered. That happens if the trajectory leaves the outer zone.
- 5. Time shorter than "Delay 1 Pickup", longer than the distance setting, the Distance function trips.

Note: The difference between the external and internal blinder is 4 Ω , provided that a trajectory parallel to the abscissa axis is adopted.

8.4 Synchronous Oscillation Trajectory Simulation

In the following test, a synchronous oscillation is simulated, where the activation of the Power Swing Alarm is expected. To perform the test click on "*New Trajectory*" then choose the number of points, impedance and angle values. The next step is to enter the rate of change of the impedance which must be different from "0". Choose the value of dZ/dt equal to 50.00Ω/s this ensures that the time to cross the two blinders is 0.08 seconds, sufficiently greater than the one set.



The next step is to configure the "System" tab.



Insert/Edit Points	
Insert/Edit	General Options
Edit Trajectory	Trajectory System Fault Evaluation
N <u>e</u> w Trajectory	Source E : 115,0 V 0 °
Trajectories <u>G</u> roups	Set Z by: ZS; KS ✓ Mod. ZS 4,00 Ω Mod. KS 1,00
<u>R</u> emove	Ang ZS 80.00 ° Ang KS 0 °
Remove <u>A</u> ll	
	<u>C</u> onfirm Ca <u>n</u> cel

Figure 31

It is not necessary to make any adjustments in the "Fault" tab. The next step in the "Evaluation" tab is to set the "Operation" field to "Yes" and the "Interface" to "PSB Alarm" then click on "Confirm".

System Simulation T	Trajectories Simulation Test Settings	
Insert/Edit Points		
nsert/Edit	General Options	
Edit Trajectory	Trajectory System Fault Evaluation	
New	Operation:) No Yes Interface: PSB Alarm ~	
Trajectory	Evaluation Time	
Trajectories Groups	Reference for Start Time Count: \$Pre-Simulation 1\$	
	Nominal Time: 50,00 ms	
<u>R</u> emove	Positive Time Tolerance: 30,00 ms	
Remove <u>A</u> ll	Negative Time Tolerance: 30,00 ms	
	<u>C</u> onfirm Ca <u>n</u> cel	

Figure 32

Start the generation by clicking on the icon highlighted below or using the command "Alt + G".



Arquivo	Home	Display	Softwa	re Option	IS		
Channel Direc	Hrd Se Sync. S Conne	et ç ⁶ o GC Set ⁵v SV ection	OSE Set Set	Start	Stop	 Next Point Next group 	✓ Clear test ✓ Clear all
	Hardware			Generation			
E ¹ 22							



After the end of the test, it is possible to visualize the waveforms, actuation of the binary inputs and the impedance and power trajectories.



8.5 Asynchronous Oscillation Trajectory Simulation (Delay Mode)

To verify the performance of the OoS trip, the following trajectory is used. To do so, click on the "*New Oscillation*" icon, use the highlighted points and keep the impedance variation of the previous test.



🍄 🛅 🥁 🚽 = PSB OoS 2.02.171 (64 Bits) - CE-6710 (0110817)	×
Arquivo Home Display Software Options	· · · · · · · · · · · · · · · · · · ·
Channels Next Point ✓ Clear test With Weith Connection Start Stop	Waveform Image: Constraint of the second s
Hardware Generation Option	ions Report Units Layout
System Simulation Trajectories Simulation Test Settings	
/ Insert/Edit Points	Chart Waveform Phasors Trajectory
Insert/Edit General Options Edit Trajectory Trajectory Namber of Points: 2 Remove 2 Bemove 3.00 Ω/s	Xipp Legend 8.00
Tert Deinte	
Points Tested	
No. Nº of Points Enabled Trime of Trajectory Fault Trajectory Fault Trajectory Fault Trajectory Fault Trajectory Fault Trajectory Fault Fa	
01 4 No 0,510 s PSB Alarm Operation Yes Passed	
Type: Individual Image: Comparison Errors List Protection Status Image: Comparison New	-8.00 -4.00 -2.00 0 2.00 4.00 6.00 8.00 Aux Source: 110.00 V Heating: 0%
	Figure 35



Insert/Edit Points	
Insert/Edit	General Options
Edit Trajectory	Trajectory System Fault Evaluation
N <u>e</u> w Trajectory ✔	Source E : 115.0 V 0 °
Trajectories <u>G</u> roups	Set Z by: ZS; KS ✓ Mod. ZS 4,00 Ω Mod. KS 1,00
<u>R</u> emove	Ang ZS 80.00 ° Ang KS 0 °
Remove <u>A</u> ll	
	<u>C</u> onfirm Ca <u>n</u> cel
	F: 36

Figure 36

The next adjustment is in the "Evaluation" field, where the "Operation" should be set to "Yes" and the "Interface" to "Trip OoS".



System Simulation	Trajectories Simulation Test Settings		
Insert/Edit Point	ts		
Insert/Edit	General Options		
Edit Trajectory	Trajectory System Fault Evaluation		
N <u>e</u> w v	Operation: O No O Yes	Interface: Trip OoS	~
Trajectory	Evaluation Time		
Trajectories Groups	Reference for Start Time Count:	Pre-Simulation 1	~
	Nominal Time: 50,00 ms		
<u>R</u> emove	Positive Time Tolerance: 30,00 ms]	
Remove <u>A</u> I	Negative Time Tolerance: 30,00 ms		
		<u>C</u> onfirm	Ca <u>n</u> cel

Figure 37

After generating the signals, check the waveforms, the performance of the binary, the impedance trajectory and the time between the blinders following the final result.

Image: Weight of the state	Á I D 🥁 🛃 ∓ Arquivo Home	PSB OoS 2 Display	.02.171 (64 B Software	its) - CE-6710 Options	0 (0110817)															- 0 ×
System Trajectories Simulation Text Setting Image: Control Image: Contro Ima	Channels Direc Hrd S Sync. Channels Ha	et €oG Set ⁵∪S\ ection dware	OOSE Set / Set	Start Stop	> Next P > Next g	roint 🧹 Clear Iroup C lear on	test all Settings	Waveform Phasors Frajectory Frajectory	resent Report Report	P) S abs rel Units	Recreate Charts Layout Layout	View								
Insert/Edit Points Chart Waveform Phases Trajectory Legend: Legend: Trajectory Dial Dial <thdial< th=""> Dial Dial<th>System Simulation</th><th>Trajectori</th><th>ies Simulatio</th><th>n Test Set</th><th>ttings</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></thdial<>	System Simulation	Trajectori	ies Simulatio	n Test Set	ttings															
Served Options Trajectory System Fack Evaluation Operation: No Yes Heffer: Top OcS Bemove General Options No Bemove Stratectores Stratectores Bemove Stratectores Stratectores Positive Time: Tolerance: Stratectores Stratectores Trajectory Fack Trajectores Stratectores Positive Time: Tolerance: Stratectores Stratectores Stratectores Positive Time: Tolerance: Stratectores Stratectores Stratectores Trajectory Fack Trajectores Stratectores Stratectores Positive Time: Tolerance: Stratectores Stratectores No No 10 4 No Stratectores Stratectores No 10 4 No Stratectores Strat	Insert/Edit Poi	nts							•	Chart	Waveform	Phasors	Traject	ory						•
Yest Points	Insert/Edit Edit Trajectory Trajectory Trajectories Groups Remove Remove All	General Trajec Oper Rel Nor Por Ne	Options extory Systemation: O No Evaluation Time ference for Statematical minal Time: sative Time Tol gative Time Tol	m Fault Ves ves art Time Count: 50,00 ms erance: olerance:	Evaluation 30,00 ms 30,00 ms	Interface: Tr	tp OoS v			2 8,00 7,00 4 6,00 5,00 2 4,00 3,00 4 2,00 1,00 0 -1,00										Legend: Traj. Not Tested Traj. Tested Colors; Not Test. Passed Fail Information: Atual Point. - [Z]: - Ø: - R: - X:
No. No Operating Ope	Points Tested								•	-2,00		T D	X K		1X	145	t7	1717	17	
01 4 No 0.510 s PSB Alarm Operation Yes Passed 02 2 No 0.500 s Oos Trip Operation Yes Passed Image: Individual Concentration Time -6.00 -4.00 -2.00 0 2.00 4.00 6.00 8.00/ Errors List Protection Status	No. Nº of Poin Trajector	ts Enabled / Fault	Time of Trajectory	Interface	Operating Nominal	Operated	Status			-3,00 -4,00 -5,00			X		R	A	Ž.	K	¥.	
Image: Individual	01 4	No	0,510 s	PSB Alarm	Operation	Yes	Passed			-6,00 -7,00		Ŋ		11 ham		X		4	A	
	Type: Individual Errors List N ON Line	V Gen	eral Info.	Operation (Time			Aux Sour	rce: 110,	-8.00	-8,00 -6,00	0 -4,0	0 -2,00	0	2,00	4,00	6	.00 8	R (Q)	



9. Report

After finishing the test, click on the icon highlighted in the previous figure or using the "Ctrl + R" command to call up 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 Gener		
	ок	Cancel

Figure 39



Figure 40



APPENDIX A

A.1 Terminal Designations



Figure 41

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



A.2 Technical data

POWER SWING DETECT

Functions:	Power swing block, Out-of-step trip					
Characteristic:	Mho or Quad					
Measured impedance:	Positive-sequence					
Blocking / tripping mode	es: 2-step or 3-step					
Tripping mode:	Early or Delayed					
Current supervision:						
Pickup level:	0.050 to 30.000 pu in steps of 0.001					
Dropout level:	97 to 98% of pickup					
Fwd / reverse reach (se	c. Ω): 0.10 to 500.00 Ω in steps of 0.01					
Left and right blinders (sec. Ω): 0.10 to 500.00 Ω in steps of 0.01					
Impedance accuracy:	±5%					
Fwd / reverse angle imp	pedances: 40 to 90° in steps of 1					
Angle accuracy:	±2°					
Characteristic limit angl	es: 40 to 140° in steps of 1					
Timers:	0.000 to 65.535 s in steps of 0.001					
Timing accuracy:	±3% or 4 ms, whichever is greater					



APPENDIX B

Equivalence of software parameters and the relay under test.

Software PSB_0	oS	D60 Relay					
Parameter	Figure	Parameter	Screen ID	Figure			
	riguic	Phase Distance 71					
Rat Bld nhs	26	Quad Right Blinder 13					
Rat Bld RCA nhs	20	Quad Right Blinder RCA	13	12			
I ft Bld nhs	26	Quad Left Blinder	13	12			
I ft Bld BCA phs	26	Quad Left Blinder RCA	13	12			
Reach nhs	26	Reach	13	12			
Reach RCA nhs	26	RCA	13	12			
Rev Reach nhs	26	Rev Reach	13	12			
Rev Reach RCA nhs	26	Rev Reach RCA	13	12			
Comp Limit phs	26	Comp L imit	13	12			
Dir RCA	26	Dir RCA	13	12			
Dir Comp	26	Dir Comp Limit	13	12			
Inner		Power Swing	Detect	. –			
Rat Bld phs	27	Inner Rat Bld	218	13			
Rat Bld RCA phs	27	Fwd RCA	218	13			
Lft Bld phs	27	Inner Lft Bld	218	13			
Lft Bld RCA phs	27	Fwd RCA	218	13			
Reach phs	27	Fwd Reach	218	13			
Reach RCA phs	27	Fwd RCA	218	13			
Rev Reach phs	27	Rev Reach	218	13			
Rev Reach RCA phs	27	Rev Rca	218	13			
Comp Limit phs	27	Fwd RCA	218	13			
Dir RCA	27	Fwd RCA	218	13			
Dir Comp	27	Fwd RCA	218	13			
Outer	•	Power Swing Detect					
Rgt Bld phs	28	Outer Rgt Bld	218	13			
Rgt Bld RCA phs	28	Fwd RCA	218	13			
Lft Bld phs	28	Outer Lft Bld	218	13			
Lft Bld RCA phs	28	Fwd RCA	218	13			
Reach phs	28	Quad Fwd Out	218	13			
Reach RCA phs	28	Fwd RCA	218	13			
Rev Reach phs	28	Quad Rev Out	218	13			
Rev Reach RCA phs	28	Rev Rca	218	13			
Comp Limit phs	28	Fwd RCA	218	13			
Dir RCA	28	Fwd RCA	218	13			
Dir Comp	28	Fwd RCA	218	13			

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