

INSTRUMENTOS PARA TESTES ELÉTRICOS Test Tutorial

Equipment Type: Protection Relay

Brand: <u>ABB</u>

Model: <u>REL650</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>PSB Test in Synchronous Power Oscillation</u> <u>Conditions</u>

Version Control:

Version	Descriptions	Date	Author	Reviewer
1.0	Initial Version	17/03/2022	M.R.C.	G.C.D.P.



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Suggestions for improvement of this material are welcome, just user contacts us via email suporte@conprove.com.br.

The tutorial contains knowledge gained from the resources and technical data at the time was writing. Therefore, CONPROVE reserves the right to make changes to this document without prior notice.

This document is intended as a guide only; the manual of the equipment under 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 Sequence for testing the REL650 relay in the PSB\_OoS software

#### 1. Relay connection to CE-6710

Appendix A-1 shows the relay terminal designations.

#### **1.1** Auxiliary Source

Connect the positive (red terminal) of the Auxiliary Source to pin 3 on the relay terminal X410 and the negative (black terminal) of the Aux Vdc Source to pin 1 of the relay terminal X410.



#### **1.2** Current and Voltage Coils

To establish the connection of the voltage coils, connect channels V1, V2 and V3 with pins 1, 3 and 5 of the relay terminal X102 and the common ones to pins 2, 4 and 6. If these last three points are short-circuited, connect all common to that point. To establish the connection of the current coils, connect channels I4, I5 and I6 with pins 1, 3 and 5 of the relay terminal X101 and the common ones to pins 2, 4 and 6. If these last three points are short-circuited, connect all common to that point.





#### **1.3** Binary Inputs

Connect the binary inputs of the CE-6710 to the binary outputs of the X307 relay slot.

- BI1 to pin 07 and its common to pin 08.
- BI2 to pin 09 and its common to pin 10.



Figure 3

#### 2. REL650 relay configuration

Connect a notebook Ethernet cable to the relay. Then open PCM600 by double clicking on the software icon.



## Note: In this tutorial, it is considered that there is no configuration in the relay, so that all parameterization will be inserted in the relay.

#### 2.1 Creating a new file

First, a new project must be added. Click on "File" and then "New Project...".



File	Edit View Tools	Window Help
	New Project	Ctrl+N
1	Open/Manage Project	. Ctrl+O
	Close Project	
	Save	Ctrl+S
	Exit	
	1: Local Server\CONPRO	OVE
	2: Local Server\Rockeml	pach

Figure 5

Choose a name for the project, in which case "68" was used and then click on "Create".

Create New Project	
Server name:	
My computer (SUPURIET	EUUINPEMSERVERJ
Project name:	
68	
Description:	
Srão apresentandos detalh por oscilação de potência	es da parametrização da função bloqueio
1	Create Cancel
	Figure 6

Right click on the created plant and insert a substation.



🔤 Local Server\68 - PC	M600		
File Edit View Too	ols Window Help		
🗅 🚅 🖬   X 🖻 🛍			
Object Types 🔷 🔻 🛱 🗙	Project Explorer		<b>→</b> ‡ X
General 🖍	Plant Structure		
Generic IEC61850 IED 🛛 🗙	🖯 🔝		
Sub-Transmission IEDs 🛛 🗙	New 🕨	General	► Substation
Transmission IEDs	Properties	Create from Template	IED Group

Figure 7

Inside the created substation, enter the voltage level according to the following figure:



Within the voltage level, a bay must be inserted.



🔤 Local Server\68 - PC	M600		
File Edit View Tool	s Window Help		
0 🚅 🔒 👗 🖻 🛍			
Object Types 🛛 🔻 🕈 🗙	Project Explorer		<b>→</b> 中 X
General 🕱	Plant Structure		
Generic IEC61850 IED	·⊟ - 🖯 68		
Sub-Transmission IEDs 🛛 🗙	Substation		
Transmission IEDs	THE FOROIGE LEVER		
	IED Compare	1	
	EC 61850 Configuration		
	New	General	▶ 琵 Bay
	X Cut	Create from Template	
	🔒 Сору	-	
	Delete		
	Rename		
	Properties		
	Figure	<u>9</u>	

The REL650 relay is inserted inside the bay.

🔤 Local Server\68 - PCM	1600	
File Edit View Tools	: Window Help	
0 🛩 🖬 👗 🖻 🔞		
Object Types 🛛 🔻 🕂 🗙	Project Explorer	<b>→</b> ₽ X
General	Plant Structure	
Generic IEC61850 IED	· 🖃 – 📵 68	
Sub-Transmission IEDs 🔹	ि	
Transmission IEDs 🔹	E Bay	
	IED Compare 규규 IEC 61850 Configuration Import	
	New 🔸	Generic IEC61850 IED
	X Cut	Sub-Transmission IEDs 🔹 🕨 🔜
	Сору	Transmission IEDs
	Delete	Create from Template
	Rename	
	Properties	
	Figure 1	0



#### 2.2 Setting up communication

Choose the option "Online Configuration" and click on "Next >".

REL650 - Configuration Mode Selection Page	
REL650 Configuration Wizard Configuration Mode Selection Page	
This wizard helps you to create configuration for your relays. Configurat sets the basic hardware and communication properties. The configurat made either offline or online.	ion wizard ion can be
Configuration Mode           Image: Online Configuration           Image: Offline Configuration	
Cancel	Next >

Figure 11

Choose the *"Next > "* option again.



EL650 Configuration Wizard Communication protocol selection page		
ED protocol:	IEC 61850	~
Communication provider:	PCM600	~

#### Figure 12

On the next screen, the user chooses between two options "LAN1" or "Front Port", then the relay itself must be displayed which IP is configured. To do so, go to "Main Menu > Configuration > Communication > TCP-IP Configuration" and view the desired IP. Adjust this value in the PCM and in this tutorial the "Front Port" option was chosen.

IEC61850 commun	ration Wizard	2
PCM600 communica Port: IP address:	ion Front Port 10 , 1 , 150 , 3	¥
	Course Course	Mouts

Then click on *"Next >"* and on the next screen on *"Scan"*.



REL 650 - Version Select	tion Page
Version Selection Page	
Online Mode     IED Type     Product Version	Scan
	Cancel < Back Next >



If the settings are correct, the software identifies the relay model and its version, as shown in the following screen.

Online N	Aode		~
	IED Type Product Version	REL650	an
		Cancel < Back	Next >

On the next screen the relay identifies the rack and display type.



🖻 RE	L650 - Housing\Displa	y Selection Page	
REL: Ho	650 Configuration W using\Display Selection Page	lizard 9	
Onlin	e Mode		
	Housing Type : Display Type :	6U ½ 19" rack casing IEC, 1/2 19", 6U, Basic	]
		Cancel < Back	Next >

Figure 16

Finally the complete relay information.

🖃 REL650 - Setup Comp	lete Page	×
REL650 Configuration Setup Complete Page	Wizard	
Setup is complete. The cor	ifiguration that is made for the selected IED is below :	
IED Type	REL650	
Product Version	1.0.0	
IP Address	10.1.150.3	
Order Option	Online Option Selected	
NOTE: Once configuration w	vizard is finished it can't be reopened.	
	Cancel < Back Finish	]
	Figure 17	

#### 2.3 TRM\_2



Click on the "+" signs next to "*IED Configuration*" and "*HW Configuration*". Within the last option the relay shows all the slots that are inserted in the relay. Right-click on the "*TRM\_2*" option and select "*Parameter Setting*".

Elocal Server\68 PCM	600			
File Edit View Tools	Window Help			
Object Types X	Project Explorer	2	* # X	
General \$	Plant Structure			
Genetic ECS1850ED & Xo Francessico FDL & Tenomission/EDL &	88 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	tors also Level 2 By 2 By	n 27. Parameter Setting 28. Parameter Setting 29. Parameter Setting 20. Cellific Configuration Properties In In In In In In In In In In	
Output				
Date and Time	Calennau	Liner Obient	Marrana	
0 25/0/2013 03/59/24 197	Massaa	Incal/CONERGVE Suitem	Protect opened SUPORTETECOT\PCMSERVER\SR	
Logging				
				quarta feira 26 de junho de 2013 09 01-52

Figure 18

In this window, the current and voltage transformation ratio must be configured. For current use the first four channels and for voltage use channels 6 to 8.

📟 Local Server\68 - PCM	4600									
<u>File Edit View T</u> ools	IED <u>W</u> indow (	Help								
i 🗅 🚅 🖬 🚳 🕉 🖻				🗈 🔂 All param	neters 👘 🔹 🔛	1 🛄 - 🔼				
Object Types 🛛 🔻 🛱 🗙	Project Explorer			<b>→</b> ‡ X	REL650 - Parameter Setti	ing				<b>*</b> 4 Þ <b>*</b>
General 🗙	Plant Structure	]			Group / Parameter Name	IED Value [SG1/Common]	PC Value [SG1/Common]	Unit	Min	Max 🔥
Generic IEC61850 IED	- 🖃 – 🟮 68				InputType1		Current			-
Sub-Transmission IEDs 🕱	ि <sub>र</sub> र्रेर Subs	tation Voltage Level			CTStarPoint1		ToObject			
Transmission IEDs	9	Bay			CTsec1		5,0	A	0,1	10,0
		REL650	figuration		CTprim1		500	A	1	99999
		🛱 🍓 HV	√ Configuration		NAMECH2		CH2			13 charac
			COM_101		InputType2		Current			
			TRM_2		CTStarPoint2		ToObject			
BI0_3					CTsec2		5,0	A	0,1	10,0
B = Q Arives esting group B = Q Arives esting group B = Q Time					CTprim2		500	A	1	99999
					NAMECH3		СНЗ			13 charac
		⊞ - <sup>6</sup> 6 Co	mmunication		InputType3		Current			
		🗷 😯 An	alog modules		CTStarPoint3		ToObject			
		ta so no	onitoring		CTsec3		5,0	A	0,1	10,0
		😟 💏 Applicati	ion Configuration		CTprim3		500	A	1	99999
					NAMECH4		CH4	_		13 charac
					InputType4		Current			
					CTStarPoint4		ToObject			
					CTsec4		5,0	A	0,1	10,0
					CTorim4		500	A	1	99999 💌
					<					
					Selected parameter: TRM_2/NAME	ECH5				
Output										<b>▼</b> ₽ X
Date and Time	Category	User	Object	Message						
<b>V</b> 26/6/2013 08:59:34.187	Message	[local]\CONPROVE	. System	Project opened: SI	UPORTETEC01\PCMSERVER\68					
Carling Logging										
							guarta-feira. 26	de junho d	le 2013 09:04:	40
and the second se								the second s	and the second se	

Figure 19



bject Types 🛛 🔻 🛱 🗙	Project Explorer			- 4 X	REL650 - Parameter Setting					- 4 Þ
eneral 🗙	Plant Structure	ן			Group / Parameter Name	IED Value [SG1/Common]	PC Value [SG1/Common]	Unit	Min	Мах
eneric IEC61850 IED	- <b>()</b> 68				CT sec5		1,0	A	0,1	10,0
ub-Transmission IEDs 🛛 🗙		tation Voltage Level			CTprim5		1000	A	1	99999
ansmission IEDs 🛛 🗙	9	I Bay			NAMECH6		CH6			13 charac
		B REL650	opfiguration		InputType6		Voltage			
			HW Configuration		VTsec6		115,000	V	0,001	999,999
	VTprim6		138,000	kV	0,001	9999,999				
			TRM_102		NAMECH7		CH7			13 charac
			BIO_3		InputType7		Voltage			
⊞ - <sup>Q</sup> t Activate setting group		VTsec7		115,000	V	0,001	999,999			
B - Co Time				VTprim7		138,000	kV	0,001	9999,999	
		ta - 10 ta - 10	Fower system Communication		NAMECH8		СН8	_		13 chara
		B - 6	Analog modules		InputType8		Voltage			
		tite	Monitoring		VTsec8		115,000	V	0,001	999,999
		🗄 👸 Applic	ation Configuration		VTprim8		138,000	kV	0,001	9999,999
					NAMECH9		CH9	-		13 chara
					InputType9		Voltage			
					VTsec9		110,000	v	0,001	999,999
					VTprim9		132,000	kV	0,001	9999,999
					NAMECH10		CH10			13 charar
					<					>
					Selected parameter: TRM_2/VTprim1	0 [0,0019999,999] kV				
ıtput										• 1
Date and Time	Category	User	Object	Message						
26/6/2012 00:50:24 107	Message	[local]\CONPROVE	· System	Project opened	SUPORTETEC01\PCMSERVER\68					

Figure 20

In the icon highlighted in green in the previous figure, the changes are sent to the relay. There are three shipping options:

- 1. Submit only a specific value;
- 2. Submit all changes made within a setting group.
- 3. Send all parameterized settings within the group.

In this case, only the settings that have been changed are sent.

🗴 Write parameters to REL650	
Parameter range TRM_2 Selected group VTprim8	
Parameter options           Orall Data           Orall Data	Read back
	OK Cancel
Figure	21

Note: Whenever the user makes a change in any setting group, this procedure must be repeated.



#### 2.4 SETGRPS: 1

Click the "+" sign near to "Activate setting group" and then "SETGRPS: 1" and make sure that group one is active.

Local Server\68 - PCA	4600								
Ele Edit View Iools	; IED <u>Window</u> Help								
i 🗅 🚅 🖬 🎒 🐰 🖻			Al parame	ters 🔹 🗣 🛥 🔳 🚺 •					
Object Types 🔻 🕂 🗙	Project Explorer			REL650 - Parameter Setting					- 4 Þ ×
General 🛠	Plant Structure		Į.	Group / Parameter Name	JED Value [SG1/Common]	PC Value [SG1/Common]	Unit	Min	Max
Generic IEC61850 IED	-= - 🕤 68			SETGRPS: 1					
Sub-Transmission IEDs 🕱	B - 8 Substation		1	ActiveSetGrp		SettingGroup1		1	
Transmission IEDs 🗙	B T Bay			MaxNoSetGro		1		1	4
		ES0     ID Configuration     IB Configuration     ID Configuration     Configuration     Application Configuration		C					
Output									<b>-</b> ₽ ×
Date and Time	Category User	Object Me:	ssage						
126/6/2013 08:59:34.187	Message (local/\CON	PROVE System Proj	ject opened: SUF	PORTETEC01\PCMSERVER\68					
<ul> <li>26/6/2013 10:17:23.468</li> <li>26/6/2013 10:17:25.281</li> </ul>	Message [local]\CON Message [local]\CON	PROVE REL650 Para PROVE REL650 Para	ameters written s ameters read suc	uccessfully cessfully					
Logging									
						quarta-feira, 26	de junho de	2013 10:19:20	ABB

Figure 22

#### 2.5 PRIMVAL: 1

Click on the "+" signs near to "Power System" and "Primary values" and select the "PRIMVAL: 1" option. In this group, the frequency and phase sequence values are adjusted. Send the settings to the relay if there is any change.



Figure 23

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#### 2.6 GBASVAL: 1

Click the "+" sign near to "Global base values" and then "GBASVAL: 1" and adjust the base voltage, current and power values. The other groups of base values will not be used.

Local Server\68 - PC#	4600									
File Edit View Tools	s IED Window He	b								
				Al para	neters 🔹 🕀 🛥 🏳					
Object Types T 4 X	Project Explorer			<b>▼</b> ₽ X	REL 650 - Parameter Set	ting				- 4 Þ ×
General \$	Plant Staucture				Group / Parameter Name	IED Value (SG1/Comm	on] PC Value (SG1/0	ommon] Unit	Min	Max
Generic IEC61850 IED				~	GBASVAL: 1					
Sub-Transmission IEDs	⊟ − <sup>8</sup> / <sub>₹₹₹</sub> Substat	ion			∠ LIBase		138.00	iv.	0.05	2000.00
Transmission IEDs	B - ₩ A	oltage Level			10		500		1	00000
Hanshort Los A		BEL650			10 896		500			33333
			/ Configuration Configuration I COM_101 I PSM_102 I TRM_2 I RID_3 I RID_4 I RID_4 I RID_4 I RID_5 I RID_4 I RID		٤		1			
Output										<b>→</b> ‡ X
Date and Time	Category	User	Object	Message						
26/6/2013 08:59:34.187	Message	[local]\CONPROVE	System	Project opened: S	UPORTETEC01\PCMSERVER\68	1				1
26/6/2013 10:17:23.468	Message	[local]\CONPROVE ·	REL650	Parameters writter	n successfully					
26/6/2013 10:17:25.281	Message	[local]\CONPROVE ·	REL650	Parameters read s	uccessfully					
Logging										
							quarta-l	eira, 26 de junho o	le 2013 10:25	58 ABB

Figure 24

#### 2.7 AISVBAS: 1

Click on the "+" signs beside "Analog modules" and "Reference channel service values" and select the option "AISVBAS: 1" and set channel 6 as the reference channel, which is equivalent to the A-phase voltage.

Local Server\68 - PCN	4600								🗐 🗖 🔀
Ele Edit Yew Loois	IED Window	Halp							
D 📽 🖬 🚳 🖾 🕸	B . E			Al para	meters 🔹 🖓 🖙 🖽 🛔	L - 1			
Object Types 💌 🕸 🗙	Project Explorer			x	REL650 - Parameter Setting	N			- 4 - ×
General 🎗	Plant Structure				Group / Parameter Name	IED Value [SG1/Common]	PC Value [SG1/Common]	Unit Min	Max
Generic IEC61850 IED		Bay		0	AISVBAS: 1				
Sub-Transmission IEDs		REL650	formation		✓ PhaseAngleRef		TRM - Channel 6 🛛 💌		
			L COLJACION           L COLJACION           L COLJACION           PSNL 102           PSNL 102	values	C Solotoj preventer ASTAN: [Fita	ak-génet			3
Output									<b>₩</b> ₽>
Date and Time	Category	User	Object Mr	essage					
3 26/6/2013 08:59 34:187	Metsage	(local/ICONPROVE -	. System Pro	sject opened. S	SUPORTETECO1 VPCMSERVER V68				
<ul> <li>26/6/2013 10:17:23:468</li> <li>26/6/2013 10:17:25:281</li> </ul>	Message Message	(local)\CONPROVE	REL650 Pa . REL650 Pa	rameters writter rameters read s	n successfully successfully				
Logging									
							guarta-feira, 26 de	unho de 2013 10.2	9.56 ABB

Figure 25



#### 2.8 Application Configuration

Select the *"Application Configuration"* option, right click and choose *"Application Configuration"* again. In this field, the protection logic blocks must be entered.

Local Server\68 - PCk	1600					
File Edit View Tools	IED Window Help					
D 🖨 🖬 🚳   X 🖻		meters 🔹 🔹 🖶 🙀 •	· 🔝			
Object Types 🔻 🕈 🗙	Project Explorer	REL650 - Parameter Setting				
General 🛠	Plant Structure	Group / Parameter Name	IED Value [SG1/Common]	PC Value [SG1/Common]	Unit Min	Max
Generic IEC61850 IED	🖻 📅 Bay 🔼	<ul> <li>Application Configuration</li> </ul>				
Sub-Transmission IEDs 🕱	E REL650					
Transmission IEDs 🎗						2
Output	Application Confi	guration				<b>-</b> ₽ X
Date and Time	Category User Object 375 IEC 61850 Confu	uration				
126/6/2013 08:59 34.187	Message [local]/CONPROVE System	PCMSERVER\68				
26/6/2013 10:17:23.468	Message [local]\CONPROVE REL650 Properties					
26/6/2013 10:17:25.281	Message [local]\CONPROVE REL650 Parameters read	successfully				
🖺 Logging						
				quarta-feira, 26 de j	unho de 2013 10:49:0	ABB

Figure 26

On the screen that opens, right click and then choose the option "Insert FunctionBlock".

🔤 Local Server\68 - PCM	4600			- 6 🛛
File Edit View Tools	Format Insert IED Debug Window Help			
i 🗅 🥔 🔛 🕘 💽 🐰	🕨 🕲 🔍 🔹 🖬 📰 🖾 🖉 🗄 🖉 🖄 🖄 👘 🔛 🕼 👘		Fixed 🔹 🖬 🛄 🗐 🗐 🗡	
Object Types 🛛 🔻 🛱 🗙	Project Explorer + 4 X	REL650 - Parameter Setting R	EL650 - Application Configuration	<b>*</b> 4 Þ <b>*</b>
All 🗙	Plant Structure	1	2	3
Basic IED functions	亩 - 琵 Bay			
Control	🖻 🔤 🥵 REL650			
Current protection	B W Configuration			
Frequency protection	COM_101	A		
Hardware 🏠	TBM 2		Insert Page Ctrl+Shift+	P
Impedance protection	🖬 BIO_3		Insert Variable	•
Local HMI functions	BIO_4		Insert FunctionBlock Ctrl+Shift+	F
Logic 🎗	SETGRPS: 1		Insert Hardware Channel Ctrl+Shift+	н
Metering	⊞ <sup>Q</sup> C Time		Delete page Ctrl+Shift+	D
Monitoring	i⊟ — 40. Power system i⊟ — 4h. Primary values		Select All Chile	
Scheme communication	D PRIMVAL: 1			
Station communication	Global base values     GRASVAL 1	-	Find Otrl+	F
Supervision 🕱	BASYAL 1	8	Lock Ctrl+Shift+	·L
Voltage protection	GBASVAL: 3			
Hardware 1/0	GBASVAL 5 GBASVAL 5 GBASVAL 6 GBASVAL 6 GBASV			
	D AISVBAS: 1	<		>
		MainApp		• 4 Þ
re Application Configuration	😽 Application Configuration 🗸	🛞 🛞 1 of 1 🛞	) (H) 200,108	
Output				<b>+</b> ‡ X
MainApplication Name F	Page No Description			
Logging Application Confi	guration		quarta-feira, 26 di	e junho de 2013 10:50:28 ABB

Figure 27

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#### 2.9 SMAI\_20\_1 (Currents)

Click on the "+" sign near to "*Basic IED functions*" and insert the " $SMAI_20_1$ " block that will be responsible for the current channels. To understand the perfect functioning of the different blocks, consult the REL650 manual.



Figure 28

On the next screen set the "Cycle Time" to 5.

Function Block Inst	ance	l l
Name:	SMAI_20_1	
Cycle Time:	5	~
Execution Order, Instance Number:	1,1	~
	<u>Assign</u>	Cancel

Figure 29

Insert the same block again, repeating the operation of the three previous figures, however change the "*Cycle Time*" to 20.



Function Block Instance			
Name:	SMAI_20_1		
Cycle Time:	20 💌		
Exec Order, Instance Number:	1.2		
C	<u>Assign</u>		
Figure 30			

The next step is to route the channel input of the function block with its physical channel. To do this, right-click outside the block and choose the following option.

	Insert Page	Ctrl+Shift+P	
	Insert Variable		×
	Insert FunctionBlock	Ctrl+Shift+F	
	Insert Hardware Channel	Ctrl+Shift+H	
	Delete page	Ctrl+Shift+D	
	Select All	Ctrl+A	
89	Find	Ctrl+F	
	Lock	Ctrl+Shift+L	

Figure 31

Choose the "Analog Input" option and click on "Insert".

Insert Hardware Channel	
Select a Hardware Channel  Hardware Channels  Hardware Channels  Hardware Channels  Hardware Channels  Analog Input	
Insert	Cancel

Figure 32



Hardware Channel Al	location	
Hardware Module	TRM_2	¥
Hardware Channel	CH1	~
User Defined Name	CH1	
Create unassigned Ha	rdware Channel	<u>C</u> ancel
Fi	joure 33	

Repeat the procedure of the 3 previous figures changing the "*Hardware Channel*" option and "*User Defined Name*" to CH2, CH3 and CH4. Then make the connections with the blocks.



Figure 34

Assign an output to the "AI3P" option of each block. Right click and choose "Insert Variable > Output".



_		Figure 35	
	Lock	Ctrl+Shift+L	
24	Find	Ctrl+F	
	Select All	Ctrl+A	
	Delete page	Ctrl+Shift+D	
	Insert Hardware Channel	Ctrl+Shift+H	
	Insert FunctionBlock	Ctrl+Shift+F	Output
	Insert Variable	•	Input
	Insert Page	Ctrl+Shift+P	

Choose a name for these variables, in this case " $AI3P\_TC\_05ms$ " for the first block and " $AI3P\_TC\_20ms$ " for the second block and connect with the "AI3P" outputs of each block.



Figure 36

Clicking on the icon highlighted in green and on the "*MainApp*" tab, change the name of the tab to "*CANAIS\_CORRENTE*", for example.





Figure 37



Close the "Object Properties" window then click on "Insert > MainApplication".

Figure 38



#### 2.10 *SMAI\_20\_2 (Voltages)*

In the new tab, configure the block responsible for the voltage channels. Repeat the procedure in figures 27 to 36, changing the block used to " $SMAI_20_2$ ", the measurement channels CH6, CH7 and CH8 and the output variables to " $AI3P_TP_05ms$ " and " $AI3P_TP_20ms$ ".



Figure 39

Click on the icon highlighted in green, click on the "MainApp2" tab and change the name of the tab to "CANAIS TENSÃO".



Figure 40

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Close the "*Object Properties*" window and insert a new "*MainApplication*" tab to create the distance function block.

🔤 Local Server\68 - PCM	600								
File Edit View Tools	Format	Ins	ert IED Debug Window Help						
	1 C		MainApplication	🖸 100% 🔹 🗩 📴 🤮	•	A 🖻 🗖 🗆 🖸 🕻	Fixed 📑 🖬 🖬 🐺 🗙		
Object Types 🔻 🕈 🗙	Project E		Page	<b>→</b> # X	REL	650 - Parameter Setting	REL650 - Application Configuration		- 4 Þ ×
All 🏠	Plant 9		FunctionBlock	1		1	2	3	^
Basic IED functions 🕱		2	Picture						
Control	ė.	T::	Text						
Current protection			Variable >						
Frequency protection			Hardware Channel >		A		SMAI_20_:	2 8	
Hardware 🎗			MainApplication Template Manager			[mie]	BLOCK	AI3P AI3P_TP_05ms	
Impedance protection			E CANAIS_CORREN	TE		TRM_2.CH6	GR92L1 GR92L2	4/2 4/3	
Local HMI functions 🕱			CANAIS_TENSÃO     Mainôm?				GRP2N	AN T	
Logic 🏠			□ <sup>1</sup> C Impedance				C Subat		
Metering 🛠			D FDPSP	DIS: 1		36			
Monitoring			D ZMBPS	9H: 1 B: 1		TRM_2.CH7			
Scheme communication			I ZQDPD	IS: 1			SMAL 20		
Station communication					1	REL	BLOCK	A3P AI3P_TP_20ms	
Supervision 🎗					в	TRM_2.CHS	GRP2L1 GRP2L2	411 412 413	
Voltage protection							GRP2L3 GRP2N	404 - AIN -	
Hardware I/O							0:117:20//2		
									~
					<				
					CAN	AIS_CORRENTE CANA	IS_TENSAD		- 4 Þ
are Application Configuration					(H)	(d) 1 of 1	(н) -2,387		
Output									<b>→</b> ₽ X
MainApplication Name Pa	age No	Desc	ription						
190	energia de la composición de								
Logging Application Config	uration								
								quarta-feira, 26 de junho de 2013 12:23:4	1 ABB

Figure 41

#### 2.11 ZQDPDIS (Quadrilateral Distance)

Right-click on the new tab, choose the "*Insert Function Block*" option, click on the "+" sign next to "*Impedance protection*" and finally choose the "*ZQDPDIS*" block.







Click "Assign" in the next window (not shown). To use the full potential of the distance function, three more blocks must be used together with the ZQDPDIS block.

#### 2.12 ZDNRDIR (Directionality of the distance function)

Right-click on the tab and choose the "Insert Function Block" option, click on the "+" sign next to "Impedance protection" and finally choose the "ZDNRDIR" block. This block determines if the zone characteristics are forward, reverse or no directionality (offset).



Click "Assign" in the next window (not shown).

#### 2.13 FDPSPDIS (Phase selector with load compensation)

Right-click on the tab and choose the "Insert Function Block" option, click on the "+" sign next to "Impedance protection" and finally choose the "FDPSPDIS" block. This block determines in which phase the fault occurs and also allows load compensation.

Select a Function Block	Туре	
🗄 🚪 Basic IED func	tions	^
🗈 🚪 Control		
🕀 🚪 Current protect	ion	
🗷 🚪 Frequency prot	ection	
🗄 🚪 Hardware		
Plant P		
🗄 🚪 Local HMI fund	ations	
🕀 📕 Logic		100
🕀 📕 Metering		
🕀 📕 Monitoring		
E Scheme comm	unication	~

Click "Assign" in the next window (not shown).



#### 2.14 ZMRPSB (Power Swing)

Right-click on the tab and choose the "*Insert Function Block*" option, click on the "+" sign next to "*Impedance protection*" and finally choose the "*ZMRPSB*" block. This block is responsible for detecting the power swing.



Click "Assign" in the next window (not shown).



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Right-click and choose "*Insert Variable* > *Input*" to insert two current and voltage input variables with a 5ms cycle. Use the same name given in figures 36 and 39. Connect with the voltage and current inputs of each of the distance function. For the voltage and current inputs of the "*ZMRPSB*" block, the 20ms signals are used.



Figure 47

Connect the "STDIRCND" output of the "ZDNRDIR" block to the "DIRCND" inputs of the "FDPSPDIS" and "ZQDPDIS" blocks. Then connect the "STCNDZI" output of the "FDPSPIDS" block to the "STCND" input of the "ZQDPIS" block. Create an output variable and connect it to the trip of the "ZQDPIS" block. The name of this variable can be "TRIP\_21". Connect the "START" output of the "ZMRPSB" block to the "BLOCK" inputs of the "FDPSPDIS" and "ZQPDIS" blocks. Create an output variable and link it with the "START" signal from the "ZMRPSB" block and name it, for example, as "Start\_68".





Figure 48

Local Server\68 - PCM600 - B X <u>File Edit View Tools Format Insert IED Debug Window Help</u> Project Explorer Plant Structure © 6 5% Substation W Voltage Level © 5 Bay © 6 RELESO © 70 Application Configuration © 70 Application Configuration Object Types 🗢 🕈 🗙 Project Explorer ▼ ₽ X 50 - Parameter Setting REL650 - Application Configuration ₹ 4 ▷ X **Object Properties** \* All 2 21 🖂 Misc
 Locked
 Name Basic IED functions \$ 2 Control \$ False PSB ZOUT Current protection \$ AI3P TP 20ms >> Frequency protection Hardware \* Impedance protection \* Local HMI functions \$ 2 Logic \$ \$ Metering AI3P\_TP\_05ms Monitoring \$ Scheme communication Station communication \$ Supervision Voltage protection \$ Hardware I/O \$ Name Name of work sheet. < > CANAIS\_CORRENTE CANAIS\_TENSÃO MainApp2 - 4 Þ re Application Configuration (H) (H) 1 of 1 (H) (H) 346,461 Application Configuration Application Configuration Output **•** 4 × MainApplication Name Page No Description Logging Application Configuration quinta-feira, 27 de junho de 2013 08:26:27 🛛 🙏 👪

#### Change the name of the tab to "PSB".

Figure 49

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#### 2.15 Binary Outputs

The last block to be created is the one for the binary outputs. So create a new "*MainApplication*" tab as shown below.

🐵 Local Server\68 - PCM600					
File Edit View Tools Format Insert IED Debug Window Help					
🗅 🚔 🖬 🖽 🖎 🖄 📭 🏤 🚺 MainApplication	🕞 100% 🔹 🗩 🔁 🕀		Fixed - E F X		
Object Types  T A Project Ex Page	<b>→</b> # X	REL650 - Parameter Setting	REL650 - Application Configuration	]	<b>→</b> 4 Þ <b>×</b>
All All Plant 9	1	1	2	3	~
Basic IED functions		A130 TC 20-1 The	ZMRPSB	art_68	
Control			START	• I3P	ZOUPUIS II
Current protection		AI3P_TP_20ms >> BLOCK	ZN	U3F 5.0	CK TRZI
Frequency protection		A BLK02 DCHECK		BLK BLK	TRZI TR TRZI
Hardware A MainApplication Template Manager	71	Chorne	2.1055[T.20]L1		CND START PE STZ1
Impedance protection				• B.X	AP STZ2 STZ3
Local HMI functions			ZONROIR		STZ4 STZ5 STND1
Logic 🕿		AL3P_TC_05ms 20 + 13P	DIR_POL		STND2 STND3
Metering		AI3P_TP_05ms >>++	O 895IT-5I-1		STND4 STND5
Monitoring					O:1101(T:5II:1
Scheme communication					
Station communication			• (3P	FDPSPDIS II	
Supervision 🕿		в	U3P BLOCK	START STFWL1	
Voltage protection			DIRCN	D STPWL2* STFWL3* STFWDF	
Hardware I/O				STRVL1 STRVL2	
				STRVL3 STRVPE	
				STNDL2 STNDL3	
				STNOPE STFW1PH	
				STFW2PH STFW3PH STF	
		<		erre à	>
		CANAIS_CORRENTE CANAIS	TENSÃO PSB		- 4 Þ
Jre Application Configuration			) (H) 7,159		
Output					<b>→</b> ‡ X
MainApplication Name Page No Description					
Logging Application Configuration					
				quinta-feira, 27 de junho de 2	013 08:28:05 🗛 👪 🔬

Figure 50

Right-click inside the new tab and choose "Insert Hardware Channel", then "Binary Output" and "Insert".

	Figure 51		_
	Lock	CERLESDIFFE	
88	Find	Ctrl+F	
	Select All	Ctrl+A	
	Delete page	Ctrl+Shift+D	
11	Insert Hardware Channel	Ctrl+Shift+H	
	Insert FunctionBlock	Ctrl+Shift+F	
	Insert Variable		۲
	Insert Page	Ctrl+Shift+P	

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Insert Hardware Channel	X
Select a Hardware Channel	-
Hardware Channels	
Insert Cancel	

Figure 52

The next step is to choose the Hardware module " $PSM_102$ " and the binary output (BO4).

🕾 Local Server\68 - PCM600		
File Edit View Tools Format Insert IED Debug Window Help		
. Q • 2000 Q I II ( 10 M ) 🛛 🖬 🖬 🕼 🖉 X   🖉 🖶 🖬 🖞	₽! ⊕ (	
Object Types 🔻 🕂 Project Explorer 👻	<b>₽</b> ×	REL650 - Parameter Setting REL650 - Application Configuration + 4 P ×
Al  Plant Structure	- i	1 2 3
Basic IED functions       €       68         Control       €       €         Current protection       €       ₩ Voltage Level         Frequency protection       €       ₩ Voltage Level         Hardware       €       ₩ ELD50         Impedance protection       €       ₩ ELD50         Local HMI functions       €       ₩ Application Configuration	,	A
Metering       A         Monitoring       A         Scheme communication       A         Station communication       A         Supervision       A         Volkage protection       A         Hardware I/O       A	1	Har dware Channel Allocation Hardware Module P5M_102 Hardware Channel B04_P0 User Defined Name B04_P0 Create unassigned Hardware Channel OK Cancel
	3	<
		CANAIS_CORRENTE CANAIS_TENSÃO PSB MainApp2
ure Application Configuration		(H) (e) 1 of 1 (F) (F) 207,165
Output		<b>▲</b> ‡ X
MainApplication Name   Page No   Description		
Logging Application Configuration		ouinta-feira. 27 de junho de 2013 08 29:41

Figure 53



Create two input variables using the same names as the output variables of the "*PSB*" tab and associate the binary outputs. Change the name of the tab to " $SAIDAS\_BINARIAS$ ".

🔤 Local Server\68 - PCN	A600			
Eile Edit View Iools	s Eormat Insert IED Debug Window Help			
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Object Types 🔻 🕂 🗙	Project Explorer + 4 X	50 - Parameter Setting REL650 - Applicati	ion Configuration 🗦 📢 🕨 🗙	Object Properties V X
All 🗙	Plant Structure	1	2 ^	(m) 41 (m)
Basic IED functions	8			
Control	the second			Locked False
Current protection	B Bay			Name SAÍDAS_BINÁRIAS
Frequency protection	🖨 🔤 🔜 REL650			r apprinter (Pac
Hardware 🎗	ED Configuration     B    BW Configuration	A		
Impedance protection	COM_101			
Local HMI functions	PSM_102			
Logic 🎗	BI0_3			
Metering	BIO_4	Trip_21	-• \	
Monitoring 🗙	G Activate setting group     G Activate setting group		P5M_102.804_P0	
Scheme communication	Power system			
Station communication	Communication     Analas modulos	Start_68 🌫		
Supervision 🗙	a → R HMI		P3H_102.803_P0	
Voltage protection	Ro Monitoring			
Hardware I/0	H	B		
		1	~	Name Name of work sheet
		CANAIS CORRENTE CANAIS TENSÃO	P58 MainApp2 7 1 >	
re Application Configuration		(H) (e) 1 of 1 (H) (H	) 320,135	REL650 Application Configuration
Output				<del>~</del> # X
MainApplication Name F	Page No Description			
Logging Application Confi	guration			
			qu	uinta-feira, 27 de junho de 2013 08:38:53 ABB 🚲

Figure 54

Click on the icon highlighted in green to validate the configuration, then on "OK" and save the configuration.

	1 %	116% - P	R 🕈 🖬 🖸 🙀 🛛	🗄 🔲 🖸 🔽 Fixed		
Object Types 🔻	9 X :	Project Explorer	• • × REL650 - P	arameter Setting REL650	- Application Configuration	- 4 Þ X
All	*	Plant Structure		1	2	3
Basic IED functions	*	- B Substation				
Control	^	B				
Current protection	*	B Bay				
Frequency protection	*	ELCOU				
Hardware	~	🖃 — 🚵 HW Configuration	<b>^</b>			
Impedance protection	~	COM_101				
Local HMI functions	~	TRM_102				
Logic	×	BID_3		2004 00 00 00 00 000		
Metering	~	Ph Activate setting group		Trip_21 2>	PSM 102-804 PD	
Monitoring	~	⊕ - % Time			101-101-004-00	
scheme communication	*	Power system     Messa	je			
station communication	×				PSM_102.B05_P0	
Supervision	~	🗊 🖓 HMI 🚺	Configuration validate	d successfully		
Voltage protection	~	Monitoring     Monitoring     Monitoring		6a		
	_					
			<			>
			CANAIS_C	ORRENTE CANAIS_TENSÃ	0 PSB SAÍDAS_BINÁRIAS	• 4 Þ
Application Configura	ation		(H) (H)	1 of 1 🛞	н) 315,150	
Output						<b>↓</b> ‡ >
MainApplication Nam	ne Pa	age No Description				

Figure 55

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#### INSTRUMENTOS PARA TESTES ELÉTRICOS 3. Parameterization of the ABB REL650 relay

#### 3.1 REL 650 Parameter Setting

Choose the top tab "*REL 650 Parameter Setting*" and click on the "+" signs beside "*Application Configuration* > *DISTANCE* > *Impedance*" and finally "*ZQDPDIS*: *1*".

	Project Explorer 🔻 🕂 🗙	REL650 - Parameter Setting	REL650 - Application Configuration			- 4 1
neral 🛠	Plant Structure	Group / Parameter Name	ED Value [SG1/Common] PC Value [SG1/Common]	I) Unit	Min	Max
neric IEC61850 IED 🛛 🕿	-= - 🔁 21	ZQDPDIS: 1				
o-Transmission IEDs 🛛 🗙	■ <sup>1</sup> 代 Substation ■ 松 Votage Level	General				
nsmission IEDs 🔹	B - Bay	GlobaBaseSel	1		1	6
	REL650     Helless	<ul> <li>Setting Group1</li> </ul>				
	Application Configuration	V Operation	On			
	E CANAIS_CORRENTE     CANAIS_TENSÃO	IMinOpPP	20	%IB	10	30
	DISTANCIA	V IMinOpPE	20	%IB	10	30
	C EDPSPDIS 1	IMinOpIN	5	%1B	5	30
	D ZDNRDIR: 1	LineAng	80	Deg	0	180
	B) SAIDAS RINARIAS	✓ Zone 1				
		<ul> <li>Setting Group1</li> </ul>				
		RFPE1	100.00	ohm/1	1,00	9000,00
		REPP1	30,00	ohm/1	1,00	3000,00
		v Z1	30,000		0.005	3000.000
		KNMag1	0,80		0,00	3,00
		v KNAng1	0	Deg	-180	180
		V OpModetPE1	On			
		<ul> <li>OpModetPP1</li> </ul>	On			
		P DirMode1	Forward			
						3

Figure 56

The relay allows up to 5 protection zones to be parameterized, but for simplicity in this tutorial only 3 zones will be active. The first two will have forward directionality and the third reverse directionality. For the first zone make the following adjustments:

Interial Plant Structure nenic IEC61850 IED & 68 b-Transmission IEDs & Fremission IE	tation Votage Level T3 Bay	Group / Parameter Name Operation IMinOpPP	IED Value [SG1/Common]	PC Value [SG1/Common] On	Unit	Min	Max
meric IEC61950 IED 🗙 🖃 🛑 स्वेर b-Transmission IEDs 🛠 msmission IEDs 🛠	votage Level ⊶∐i Bay	Operation IMinOpPP		On 10			
ib-Transmission IEDs 🗙 🖶 🥳 Sub ansmission IEDs 🇙	tation Voltage Level - 중 Bay	IMinOpPP		10			
ensmission IEDs	Bay			10	%1B	10	30
	Provent in the second se	IMinOpPE		10	%1B	10	30
⊞ — ∰ IED Configuration ⊟ — ∰ Application Configuration ⊞ — ∰ CANNAS_CORRENTE	REL650     F	IMinOpIN		5	%IB	5	30
	E Application Configuration	LineAng		75	Deg	0	180
	CANAIS_CORRENTE     CANAIS_TENSÃO	Zone 1					
	B PSB	Setting Group1					
	G Impedance     G Engeptic 1	RFPE1		10,00	ohm/l	1,00	9000,00
	D ZDNRDIR: 1	BFPP1		10,00	ohm/l	1,00	3000,0
3 ZMRPSB: 1 3 ZQDPDIS: 1	D ZMRPSB: 1	Z1		15,000		0,005	3000,0
	SAÍDAS_BINÁRIAS	KNMag1		0.80		0.00	3,00
		KNAng1		0	Deg	-180	180
		OpModetPE1		On			
		OpModetPP1		On			
		DirMode1		Forward			
		tPE1		0,000	s	0,000	60,000
		IPP1		0,000	s	0.000	60,000
		OpMode1		Enable Ph-E PhPh			
		Zone 2	1				
		<u> &lt;</u>					

Figure 57

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adjustments to the second zone.

Object Types     * 9 ×     Project Explorer       Jamed     Amat Structure       Jameric IEC61850 IED     Image: Substation       Jub Transmission IEDs     Image: Substation       Image: First Substation     Image: Substation </th <th>▼ ₽ X Grou</th> <th>REL650 - Parameter Setting oup / Parameter Name tPP1</th> <th>REL650 - Application Config IED Value [SG1/Common]</th> <th>uration</th> <th></th> <th></th> <th>- 4 Þ ×</th>	▼ ₽ X Grou	REL650 - Parameter Setting oup / Parameter Name tPP1	REL650 - Application Config IED Value [SG1/Common]	uration			- 4 Þ ×
immerial     A       Plant Structure       immeric IEC61850 IED       iub-Transmission IEDs       immerial       Irransmission IEDs       immerial       immeria <th>Grou</th> <th>up / Parameter Name tPP1</th> <th>IED Value [SG1/Common]</th> <th></th> <th></th> <th></th> <th></th>	Grou	up / Parameter Name tPP1	IED Value [SG1/Common]				
Generic IEC51850 IED    Generic IEC51850 IED		tPP1	<ul> <li>Decision of the second sec second second sec</li></ul>	PL Value [SG1/Common]	Unit	Min	Max 🔥
Sub-Transmission IEDs A Transmission IEDs A Transmission IEDs A Construction Const				0,000	s	0,000	60,000
Transmission IEDs		OpMode1		Enable Ph-E PhPh			
e — 👿 REL650 ⊕ — 🏥 IED Configuration		Zone 2					
		Setting Group1					
So Application Configuration		RFPE2		20,00	ohm/l	1,00	9000,00
CANAIS_CORRENTE		RFPP2		20,00	ohm/l	1,00	3000,00
		Z2		25,000		0,005	3000,000
B → % Impedance		KNMag2		0,80		0,00	3,00
ZDNRDIR: 1		KNAng2		0	Deg	-180	180
D ZMRPSB: 1		OpModetPE2		On			
SAÍDAS_BINÁRIAS		OpModetPP2		On			
		DirMode2		Forward			
		tPE2		0,300	s	0,000	60,000
		tPP2		0,300	s	0,000	60,000
		OpMode2		Enable Ph-E PhPh			
		Zone 3					
		Setting Group1					
		RFPE3		100,00	ohm/l	1,00	9000,00
		RFPP3		30.00	ohm/l	1.00	3000.00
	<		III				>
					_		
Output							<b>→</b> 中 >
MainApplication Name Page No Description							
a Longing Application Configuration							

Figure 58

Finally, parameterize the third zone.

🐵 Local Server\68 - PCM600						- B X
<u>E</u> ile <u>E</u> dit <u>Vi</u> ew <u>T</u> ools IED <u>Wi</u> ndow <u>H</u> elp						
: D 🖆 🖬 🚳 🖄 🗞 🎕 🕼 🕫 📰 🖬 🕄 🗄 计 🔡 🕒 🖂 🔛 Aliper	ameters 🔹 🚽 🖶 🚺	- 🔝				
Object Types 🔻 🕈 X Project Explorer 🔷 🗸 X	REL650 - Parameter Setting	REL650 - Application Config	uration			<b>→</b> 4 Þ <b>×</b>
General  Plant Structure	Group / Parameter Name	IED Value [SG1/Common]	PC Value [SG1/Common]	Unit	Min	Max 🔥
Generic IEC61850 IED 🛠 🕞 🔞	tPE2		0,300	s	0,000	60,000
Sub-Transmission IEDs	tPP2		0,300	s	0,000	60,000
Transmission IEDs 🛠 😑 🏧 Bay	OpMode2		Enable Ph-E PhPh			
🖻 🔛 REL650	Zone 3					
	Setting Group1					
CANAIS_CORRENTE	RFPE3	1	30,00	ohm/l	1,00	9000,00
	RFPP3		30,00	ohm/l	1,00	3000,00
E Receive t	Z3		35,000		0,005	3000,000
D ZDNRDIR: 1	OpModetPE3		On			
	OpModetPP3		On			
B SA(DAS BINÁRIAS	✓ DirMode3	ſ	Beverse 🗸			
	tPE3	1	0,600	s	0,000	60,000
	(PP3		0.600	s	0.000	60.000
	OpMode3		Enable Ph-E PhPh			
	Zone 4					
	Setting Group1					
	RFPE4		100,00	ohm/l	1,00	9000,00
	RFPP4		30,00	ohm/l	1,00	3000,00
	Z4		30.000		0.005	3000.000 😒
	<				200204.0	>
	Selected parameter: ZQDPDIS: 1/Zone 3	3/Setting Group1/DirMode3				
Output						<b>→</b> ‡ X
MainApplication Name Page No Description						
Logging Application Configuration						
			quinta-feira, 27 d	e junho de	2013 08:56:0	ABB

Figure 59

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



To disable zones 4 and 5 make the following adjustment.

🔤 Local Server\68 - PCM	1600						
Eile Edit View Looks	IED Window Help						
i 🗅 🥔 🖬 🚳   X 🖻	🛍 🗠 📴 🖬 🖬 🔍 🗄 🛓 🗿 🔂 🖂 🛃 🖬 All paran	neters 💦 💽 🖓 😑 🖽 🚺	•				
Object Types 🛛 🔻 🖡 🗙	Project Explorer 🗸 🗸 🗙	REL650 - Parameter Setting	REL650 - Application Config	uration			<b>*</b> 4 Þ <b>*</b>
General 🗙	Plant Structure	Group / Parameter Name	IED Value [SG1/Common]	PC Value [SG1/Common]	Unit	Min	Max 🔥
Generic IEC61850 IED	- <b>6</b> 68	RFPE4		100,00	ohm/l	1,00	9000,00
Sub-Transmission IEDs	तरेर Substation	BFPP4		30,00	ohm/l	1,00	3000,00
Transmission IEDs 🗙	自 吞 Bay	Z4		30,000		0,005	3000,000
	😑 — 🔜 REL650	OpModetPE4		Off	1		
	Application Configuration	OpModetPP4		Off			
		DirMode4		Off			
	E PSB	tPE4		0,000	s	0,000	60,000
	□ - % Impedance	tPP4		0,000	s	0,000	60,000
	D ZDNRDIR: 1	OpMode4		Enable Ph-E PhPh			
		Zone 5					
	SAÍDAS_BINÁRIAS	Setting Group1					
		RFPE5		100,00	ohm/l	1,00	9000,00
		RFPP5		30,00	ohm/l	1,00	3000,00
		Z5		30,000		0,005	3000,000
		OpModetPE5		Off	1		
		OpModetPP5		Off			
		DirMode5		Off			
		tPE5		0,000	s	0,000	60,000
		IPP5		0.000	s	0.000	60.000 👱
		<u> </u> <					<u> </u>
Output							<b>▲</b> 廿 X
MainApplication Name F	Page No Description						
C Logging Application Confi	guration						
~				quinta-feira, 27 d	e junho de	2013 09:00:0	3 ABB

#### Figure 60

The next step is to parameterize the directionality limits. For this click on the *"ZNRDIR:1"* option and make the following adjustments:

🔤 Local Server\68 - PC	<i>\</i> 600				
Eile Edit View Ioo	; IED Window Help				
0 🚅 🖬 🎒 🕷	a 🎕 🗠 🚼 🚰 📰 💽 🔍 🤅 🏚 🗿 🗿 🔂 🗛 All parat	neters 🔹 🗣 🛥 🖽 🚻	- 🔼		
Object Types 🔍 🕈 🛪	Project Explorer 🔷 🕈 🗙	REL650 - Parameter Setting	REL650 - Application Configuration		<b>*</b> 4 Þ <b>*</b>
General	Plant Structure	Group / Parameter Name	IED Value [SG1/Common] PC Value [SG1/Common]	Unit Min	Max
Generic IEC61850 IED	-= - 🛢 68	ZDNRDIR: 1			
Sub-Transmission IEDs	Kit Substation     Kit Voltage Level	✓ GlobalBaseSel		1	6
Transmission IEDs	亩 臣 Bay	<ul> <li>Setting Group1</li> </ul>			
	🖨 😓 🙀 IED Configuration	ArgNegRes	115	Deg 90	175
	Application Configuration	🖌 ArgDir	15	Deg 5	45
		IMinOpPE	5	%IB 5	30
	B PSB	IMinOpPP	10	%IB 5	30
	SADAS_BINARIAS				
; Output MainApplication Name	Pres Me Description				* * ^
maneppinauunidane	age no presempadit				
Logging Application Con	guration				
			quinta-feira, 27 c	de junho de 2013 09:02	47 <b>ABB</b>

Figure 61

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The next parameterization is for the phase selector and load compensator. Select the *"FDPSPDIS:1"* option and perform the following adjustments.

🐵 Local Server\68 - PCM600						
Ele Edit View Icols IEE	D Window Help					
0 📽 🖬 🚳 🕮 🖻 🔞	🗠 🧱 🖀 📰 😒 🤅 🏚 🗓 🕲 🔂 💷 🖬 🛃 All parama	eters 💽 🚽 🖶 🔟	•			
Object Types 🛛 🔻 🕈 🛛 Proj	ject Explorer 🔷 🕈 🗙	REL650 - Parameter Setting	REL650 - Application Configuration			• 4 Þ ×
General 🎗 🏼 P	Plant Structure	Group / Parameter Name	IED Value [SG1/Common] PC Value [SG1/Common]	Unit	Min	Max 🔥
Generic IEC61850 IED 🕱 🗐	68	OperationZ<	On			
Sub-Transmission IEDs	Substation	Operation!>	Off			
Transmission IEDs	B - B Bay	INBlockPP	10	%IPh	10	100
	REL650     Rel 650     Rel 650	INReleasePE	10	%iPh	10	100
	Application Configuration	BLdFw	5,00	ohm/p	1,00	3000,00
	CANAIS_CORRENTE	RLdRv	5,00	ohm/p	1,00	3000,00
	B PSB	ArgLd	45	Deg	5	70
	Grand Impedance     Grand Engeneration	IPho	120	%IB	10	2500
	D ZDNRDIR: 1	IN>	20	%IB	10	2500
	D ZMRPSB: 1	X1	40,00		0,50	3000,00
	SAIDAS_BINÁRIAS	×0	120.00		0,50	3000,00
		REFWPP	30,00	ohm/l	0,50	3000,00
		REBVPP	30,00	ohm/l	0,50	3000,00
		RFFwPE	30,00	ohm/l	1,00	9000,00
		RFRvPE	30,00	ohm/l	1,00	9000,00
		TimetPP	Off			
		1/PP	0,000	s	0,000	60,000
		TimerPE	Off			
		IPE	0.000	\$	0.000	60.000 👱
		<u>s</u>				2
		Selecced parameter: PDPSPD15: 1/Settin	å exanbritissinobse forranni 2018			
Output						+ 4 ×
MainApplication Name Page N	lo Description					
Copping Application Configuration	n					
			quinta-feira, 27 d	le junho d	e 2013 09:05:	17 ABB



The last two parameters not shown in the previous figure must be set to their minimum values. The last parameterization is for the power swing. Select the *"ZMRPSB:1"* option and perform the following adjustments.

🐵 Local Server\68 - P	PCM600						
Elle Edit View Io	ools IED Window H	jelp					
0 📽 🖬 🚳 🐰	h 🛍 🗠 🔃 🗗	all 🛛 🗄 📋 🖥 🔁 🖃 🔂 🗐 All param	eters 🔹 🚽 🤤 🖽 🚹	• 🚯			
Object Types 🔷 🔻 🕂	× Project Explorer	+ + ×	REL650 - Parameter Setting	REL650 - Application Configurati	on		- 4 Þ ×
General :	Plant Structure		Group / Parameter Name	IED Value [SG1/Common] PC	Value [SG1/Common] U	nit Min	Max 🛃
Generic IEC61850 IED	☆ 😑 🛑 68		ZMRPSB: 1				
Sub-Transmission IEDs	★ E R Subst	ation	✓ GlobalBaseSel	1		1	6
Transmission IEDs	*	帮 Bay	Setting Group1				
		EL650	✓ Operation	On			
		Application Configuration	∠ X1InFw	50,	<b>00</b> oh	nm 0,10	3000,00
		CANAIS_CORRENTE     CANAIS_TENSXO	⊬ R1LIn	0,1	0 oh	nm 0,10	1000,00
		B PSB	✓ B1FInFw	50,	<b>00</b> oh	nm 0,10	1000,00
		B mpedance	⊬ X1InBv	50,	<b>00</b> oh	nm 0,10	3000,00
		ZDNRDIR: 1	⊮ B1EInBv	50,	<b>00</b> oh	nm 0,10	1000,00
		ZMRPSB: 1	✓ OperationLdCh	On			
		SAÍDAS_BINÁRIAS	✓ RLdOutFw	60,0	00 oh	nm 0,10	3000,00
			✓ ArgLd	5	De	eg 5	70
			✓ RLdDutRv	60,0	<b>00</b> oh	nm 0,10	3000,00
			⊮ kLdRFw	0,8	7 M	ult 0,50	0,90
			⊮ kLdRRv	0,8	7 M	ult 0,50	0,90
			v tP1	0,1	00 s	0,000	60,000
			v tP2	0,0	50 s	0,000	60,000
			v W	0,25	50 s	0,000	60,000
			v tH	0.50	00 s	0.000	60.000
			<	10			
Output							<b>→</b> ậ )
Date and Time	User	Message					
1 27/6/2013 09:29:42		- Parameter [ZMRPSB: 1/Setting Group1/Operation] value modificati	on has effected to parameter [ZMRPSB:	1/Setting Group1/tR1] properties.			_
127/6/2013 09:29:42		Parameter [ZMRPSB: 1/Setting Group1/Operation] value modification	on has effected to parameter [ZMRPSB:	1/Setting Group1/tR2] properties.			
127/6/2013 09:29:42		Parameter [ZMRPSB: 1/Setting Group1/Operation] value modificati	on has effected to parameter [ZMRPSB:	1/Setting Group1/IMinOpPE] prope	erties.		
Logging   Application Co	onfiguration Ell REL650 - F	Parameter Setting					
					quinta-feira, 27 de ju	nho de 2013 09:30:4	5 ABB

Figure 63

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The last three settings not shown "tR1", "tR2" and "IMinOpPE" are at their factory default settings. Click on the icon highlighted in green in the previous figure to view the distance and power swing characteristics.





These settings are the two responsible for power swing detection. In this case, two quadrilaterals were used, the smaller one (INNER) with a range of 50 $\Omega$  and the larger one (OUTER) with a range of 60 $\Omega$ . Save all settings by clicking on the icons highlighted in green and then right-click on the relay icon and send the changes. In the following message click on "*Yes*".

Local Server\68 - I	СМ600							
File Edit View T	ools IED Window Help							
0 📽 🖬 🚳 🐰	h 🛍 🗠 💽 🖬 🗖	- IV	i 8 D _ 2 8 B	All parameters 💽 😔 🖃 📗	L • 🔼			
Object Types 🛛 🔻 👎	× Project Explorer		Collapse	× REL650 - Parameter Setting	REL650 - Application Configuration	n]		<b>→</b> 4 Þ
General	Plant Structure		Signal Monitoving	Group / Parameter Name	IED Value [SG1/Common] PC V	alue [SG1/Common] Unit	Min	Max
ieneric IEC61850 IED	☆ 🗐 🙃 68		Disk shases Magelline	✓ REL650				
ub-Transmission IEDs	Substation		Event Viewer		(announce and a second s			
ransmission IEDs		Bay		_				
		🔜 REL650 🗏	Parameter Setting					
			Application Configuration					
			Signal Matrix					
		· · · · · · · · · · · · · · · · · · ·	<sup>5</sup> Graphical Display Editor					
			Hardware Configuration					
		- 2	IED Users					
		1	IED Compare					
		5	IEC 61850 Configuration					
		e	Communication Management					
		F	License Lindate Tool					
			Set Technical Key					
		*	Create Template					
			Import					
			Export					
			Read from IED					
			Write to IED					
			Report Parameters					
			Configuration Language		iii			
			Communication Port					_
Jutput			Documentation	•				<b>▼</b> 9
Date and Time	User	Message 🐰	Cut					
27/6/2013 09:29:42	F	Parameter	Copy	ication has effected to parameter [ZMRPS]	B: 1/Setting Group1/tR1] properties.			
27/6/2013 09:29:42	F	Parameter [ZMF			8: 1/Setting Group1/tR2] properties.			
27/6/2013 09:29:42	F	Parameter [ZMF	Delete	ication has effected to parameter [ZMRPS]	B: 1/Setting Group1/IMinOpPE] proper	ies.		
Logging Application C	onfiguration Ell REL650 - Param	neter Setting	Kename					
			Properties			quinta-feira, 27 de junho de	2013 09:44:06	ABB

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#### 4. PSB\_OoS software adjustments

#### 4.1 Opening the PSB\_OoS

Click on the CTC application manager icon.



Click the "*PSB\_OoS*" software icon.



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🚈   🗅 💕 🛃 🖛   P	SB OoS 2.02.171 (64 Bits)	- CE-6710 (0301018)	- 0 ×
Arquivo Home	Display Software Opt	itions	^ <b>U</b>
🕞 🚍 Hrd Set	🎲 GOOSE Set	Settings	
Channels Direc Connection	sv Set Sta	art General Inform. System Notes & Obs. Explanatory Figures Check List Others Connections	
Hardwa	are	lest:	
System Simulation	Trajectories Simulation	Distance Descr: Date:	
Insert/Edit Points	General Options	- Tested device:	•
Edit Oscillation	Oscillation Type:	Identif:          Model            Type:          Manufacturer:	
New Oscillation	- Synchronous Oscillation	n Location:	
Sequence	Slip Angle:	Substation:	lod. KS 1.00
	Time:	E Bay:	hg KS 0°
Remove		Address:	
		City: State: V	
Test Points		Responsible:	
Points Tested		Name:	
Nº Type of Oscillation O	Time of Interface O	Sector: Registry: V	
		Tool Test:	
		CE-6710 Series Num.: 03010187CCM33222211U5HVRGLGLGL220RXO	
		· · · · · · · · · · · · · · · · · · ·	
		Defend Event Event	
🗹 General Info. 🗹 O	peration 🗌 Time	Leious Teleterices OK Cancel	
Errors List Prote	ection Status		
🚯 ON Line	New	Aux Source: 0,00 V Heating: 0%	
		Figure 69	

#### 4.2 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.



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.



	,
DADA TECTE	
PARA IENIE	

	Teste:			
Distância	Descr: Power Swing Block	Data: 17/03/	/2022 14:30:23	_
	Dispositivo testado:			
	Identif: 23031982 ~	Modelo: REL65	i0	$\sim$
	Tipo: Line Protection ~	Fabricante: ABB		$\sim$
	Local de Instalação:			
	Subestação: Conprove			$\overline{}$
	Bay: 1 ~			
	Enderego: Visconde de Ouro Preto 75, Custódio Per	reira		$\sim$
	Cidade: Uberlândia	~	Estado: MG	~
	Responsável:			
	Nome: Michel Rockembach de Carvalho			$\sim$
	Setor: Engineering ~	Matrícula: 0001		$\sim$
	Ferramenta de Teste:			
	CE-6710 Núm. Série: 0	03010187CCM33222211U	5HVRGLGLGL2Z0RXO	

Figure 71

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

General	General Inform, System Notes & Obs.	Explanatory Figures Check List Others Connections
General	K < N001 > >	
Distance	Nominal Impedance Source	
	Frequency: 60 Hz V	
	Phase Seq.: ABC ~	
	3φ power: 119,5 MVA	
	1φ: 39,84 MVA	
	Primary Voltage (FF): 138,0 KV	
	(FN): 79,67 KV	<u> </u>
	Primary Current: 0,500 kA	
	Secondary Voltage (FF): 115,0 V	<u> </u>
	(FN): 66,40 V	÷ ÷ ÷
	Secondary Current: 5,00 A	
	VTR F: 1.20 k	Phase E Naster N Ground E Dired D
	CTR F: 100.0	
	VTR D / VTR F: 1,00	Voltage Currents
	CTR E / CTR F: 1,00	1 Va 5 la k to V0: 1,00
	Invert Polarity:	FN 2 Vb F 6 lb k to V2: 1.00
	🗌 VT's F 🔄 CT's F	3 VC 7 IC kto I0: 1.00
	UTD CTE	
-		

Figure 72



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.

#### 5. Channel Targeting and Hardware Configurations

Click on the icon illustrated below.





Channels Direct.  $\times$ Local Hard.: Nodes -O Basic Adapt I/Os Confirm Model Reset for Hard Set Connected Advanced CE-6710 GOOSE. Autoassociate 🚽 Cance Autoassociate otes Serial Number: 03010187CCM33222211U5HVRGLGLGL2Z0RX0 ~ ON Line 50 S. Value. Clean ÷ Clean ŝ Impor 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 + m Voltage Channels 7 -+ -1/1 m Descr. Hardware Node Point Nominal Line Source സ്പ 60 Hz AO\_V02 ▼ NO01 V2 Vb ABC V3 NO01 ▼ Vc Phase Seq. R AO V03 **0** OBJ AO\_V04 NO01 - UD • V4 3φ power: 119,5 MVA 1φ: 39,84 MVA Primary Voltage (FF): 138.0 KV (FN): 79.67 KV Primary Current: 0.500 kA condary Voltage (FF): 115.0 V 🍸 + 🕂 + 💻 Current Channels (FN): 66 40 V Voltage Currents Channel Channel Descr. Hardware Node Point ndary Current: 5,00 A AO\_V01 AO\_I01 1 Va 5 la 40 VTR F: 1,20 k FN Vb AO\_V02 F lb AO\_102 AO\_102 12 NO01 2 6 lb CTR F: 100,0 ▼ lc 3 7 AO 103 ▼ NO01 Vc AO V03 lc AO\_103 13 VTR D / VTR F: 1,00 Vab ~ Е 8 IE AO\_104 14 NO01 ▼ UD • • 15 NO01 - UD FF Vbc AO 105 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.l2 k.V2 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.



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

ings	
aster Slave 1 Slave 2	Main Sampled Value Others
Model CE-6710 V Serial Number 03010187CCM33222211U5HVRGLGLC	Binary Outputs: CL2Z0RXO V BO1: NO V BO3: NC V CL2Z0RXO V BO3: NC V CL2Z0RXO V BO3: NC V CL2Z0RXO V BO3: NC V CL2Z0RXO V CL2Z0
Standard - Voltages: • 4 x 300 V; 100 VA	B02: NO V B04: NC V B05 and B06 type: - 60 V
2 x 600 V; 180 VA     V2       2 x 300 V; 150 VA     V2       1 x 600 V; 350 VA     V3       1 x 300 V; 250 VA     V4	Conventional B05: NO B06: NO IRIG (B05) ∕Clock (B06)     Other
	Correr     Off     Transistor OTTL 110.00 V
Customized Assoc.	Binary / Analog Inputs:
Standard - Currents:     6 x 32 A; 220 VA	Bl1: Bl - Contact  Bl2: Bl - Contact Bl2:
O 3 x 64 A; 400 VA	BI3: BI - Contact
O 2 x 96 A; 550 VA	BI4: BI - Contact 👻
○ 2 x 10 00 A: 300 VA	BI5: BI - Contact
	BI6: BI - Contact
	BI/: BI - Contact
	BIS: BI - Contact
	BI10: BI - Contact
	BI11: BI - Contact
Electromechanical	BI12: BI - Contact 👻
○ 1 x 50 A; 700 VA	Considers absolute values to Voltage-BI AI 1-6 : 2V; 20V; 600V AI 7-12 : 200mV; 2V; 60
Customized Assoc.	Range 1,25 A

Figure 75

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

Cha	annels Direct.	- 0	×
Local	Model Reset for Hard.	Confirm	ב
otes	Serial Number:	Cancel	
Rem	03010187CCM33222211U5HVRGLGLGL2Z0RXO V 2 ON Line <sup>5</sup> v S. Value	Import Export	



#### 6. Distance Adjustments

Note: The ABB REL650 relay has peculiar characteristics for each type of fault. For a test in the distance function, 9 types of zones must be entered (for more details, check the respective tutorial). As the test to be performed is of power oscillation, it is enough to register the zones for three-phase faults.



#### 6.1 Distance screen > Distance Prot. Settings

Return to the "*Distance Prot. Settings*" screen, with the first screen showing the parameters of length, line angle and ground compensation factor. For this specific test there is no need to configure them.



Figure 77

#### 6.2 Inserting the Zones (Three Phase)

The following three figures show the parameters of each zone for three-phase faults to be set in the PSB\_OoS software.





Figure 78

Click on "*OK*" on the previous figure and on "*Insert*" on the next figure to add one more zone.



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Figure 80

Repeat the previous procedure to enter the third zone.



Figure 81

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#### 6.3 Inserting the Blinders

The following two figures show the parameters of each blinder used to detect power swing.



Figure 82



Figure 83

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#### **NOTE:** The REL650 has its impedance settings referenced to the primary. Therefore, the following option must be selected.



If the user does not select this option when clicking "OK" in the previous figure, the following message is displayed.

Confirm	×
There is at least one zone whose input data in the mask are usually defined with respect to the PRIMARY. However the option 'Impedances defined based on PRIMARY' is NOT checked. Are you sure that ALL ZONES were really defined with respect to the SECONDARY?	
Sim Não	ו
Figure 85	

In this case click "No" and check the highlighted option.



#### 7. Test structure for the PSB\_OoS function

#### 7.1 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 = Trip OoS.

Enable a pre-simulation situation with nominal conditions and duration of 100ms.



#### 7.2 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".

#### 7.3 Trajectories Simulation

The "*Trajectories 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 adjustment of the parameter "tP1" in the relay, which in this case is set at 100ms.



Depending on the time the trajectory takes to pass from the external to the internal blinder, two situations arise:

- 1. Time greater than 0.1 seconds to cross the two blinders regardless of the side (right or left). Power swing block signal actuation.
- 2. Time less than 0.1 seconds to cross the two blinders regardless of the side. Distance trip actuation (provided it enters a zone and remains longer than the time set for zone operation).

### Note: The difference between the external and internal blinder is $0.83\Omega$ (Primary), provided that a trajectory parallel to the abscissa axis is adopted.

#### 7.4 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 4.15Ω/s this ensures that the time to cross the two blinders is 0.2s (0.83/4.15), sufficiently greater than the one set (0.1s).



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



Gen	aeneral Options						
Tr	ajectory	System Fa	ult Evalua	tion			
	Source						
	E: 1	15,0 V 0 °					
	Set Z by:	ZS; KS			$\sim$		
	Mod. ZS	4,00 Ω	Mod. KS	1.00			
	Ang ZS	80.00 °	Ang KS	0 °			
		Figur	re 88				

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".

rajectory System Fault Evaluation	on
Operation: 🔵 No 🔹 Yes	Interface: PSB Alarm 🗸
Evaluation Time	
Reference for Start Time Count:	Pre-Simulation 1 $$ $$ $$
Nominal Time: 50,00 ms	
Positive Time Tolerance: 30,00 r	ns
Negative Time Tolerance: 30,00 r	ns

Figure 89

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





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



7.5 Simulation of Three-Phase Fault Trajectories

In this test, the performance of the distance trip is verified. A trajectory is simulated so that it crosses the blinders with a time less than 0.1sec. In this case, a dZ/dt of 16.60 $\Omega$ /s is used so that the time is 0.05 seconds (8.3/16.6). To do this make the following adjustments:



🍄   🗋 💕 🔙 🚽   PSB O	oS 2.02.171 (64 Bit	is) - CE-6710 (030	1018)								×
Arquivo Home Displ	ay Software G	Options									~ 🕐
Channels Direc ♥ Connection	९ GOOSE Set , SV Set	Start Stop	Next Point 🧹 Clear Next group 👹 Clear	all Settings	Present Report	● ~ P3 5 abs rel	ecreate Restore Charts Layout				
Hardware		G	eneration	Options	Report	Units	Layout				
System Simulation Trajec	tories Simulatior	n Test Settings									
Insert/Edit Points					•	Chart	Waveform Phasors	Trajectory			<b>~</b>
Insert/Edit Ger Edit Trajectory Trajectory Trajectory Groups Bemove Remove <u>A</u>	ajectory System ata Entry: ZI e Ø ✓ umber of Points: 2 ↓ ↓ dZ/dt Constant: 6,60 Ω/e	Fault         Evail           Ν*         IZI           1         10.04 Ω           2         0.591 Ω	uation	It         Duration           100.0 ms         100.0 ms           2/s         0.608 s           0.708 s         0.708 s		5,00 4,00 3,00 2,00 1,00 0					Legend: 
Test Points								1 147	$\mathbb{W}$		
Points Tested						-2,00				1/1/	/
No. Nº of Points Enab Trajectory Fau	led Time of It Trajectory	Interface Ope	erating minal Operated	Status		-3.00					4
01 4 No	3,64 s	PSB Alarm Ope	eration Yes	Passed		-4,00		-			
						-5,00	XX				R
Type: Individual V	General Info. 🛛	Operation 🗌 Tir	ne				-5,00 -4,00 -3,00 -	-2,00 -1,00 0	1,00 2,00 3,	00 4,00 5,00	
Errors List Protection	Status										
🚯 ON Line	New			Aux	Source: 110	,00 V Hea	ting: 0%				
					Fier	ma 02					

Figure 92

The parameters of the *"System"* tab are the same as in the previous test. The *"Fault"* field does not need to be adjusted and in the *"Evaluation"* option, make the following adjustments:

General Options				
Trajectory System Fault E	valuation			
Operation: 🔵 No 🛛 Yes		Interface:	Trip Dist	~
Evaluation Time				-
Reference for Start Time Count:		Pre-Simulat	ion 1	$\sim$
Nominal Time: 50,00 ms				
Positive Time Tolerance:	30,00 ms			
Negative Time Tolerance:	30,00 ms			
		<u>C</u> onfirm		Ca <u>n</u> cel
	Figure 93	;		

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.





#### 8. Report

After finishing the test, click on the icon highlighted in the previous figure or use 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.



Figure 95





Figure 96



#### APPENDIX A

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





Table 527: Auxiliary voltage supply of 110...250 V DC or 100...240 V AC

Case	Terminal	Description	
6U half 19"	X410-1	- Input	
	X410-3	+ Input	

Table 526:	Analog input i	modules			
Terminal	TRM 6I + 4U	TRM 8I + 2U	TRM 4I + 1I + 5U	AIM 6I + 4U	AIM 4I + 1I + 5U
X101-1, 2	1/5A	1/5A	1/5A	1/5A	1/5A
X101-3, 4	1/5A	1/5A	1/5A	1/5A	1/5A
X101-5, 6	1/5A	1/5A	1/5A	1/5A	1/5A
X101-7, 8	1/5A	1/5A	1/5A	1/5A	1/5A
X101-9, 10	1/5A	1/5A	0.1/0.5A	1/5A	0.1/0.5A
X102-1, 2	1/5A	1/5A	100/220V	1/5A	100/220V
X102-3, 4	100/220V	1/5A	100/220V	100/220V	100/220V
X102-5, 6	100/220V	1/5A	100/220V	100/220V	100/220V
X102-7, 8	100/220V	100/220V	100/220V	100/220V	100/220V
X102-9, 10	100/220V	100/220V	100/220V	100/220V	100/220V

Terminal	Description	PCM600 info	
		Hardware module instance	Hardware channel
X307-5	120	PSM_102	BO3_PO_TCS
X307-6	+		
X307-7	Power output 4, normally open	PSM_102	BO4_PO
X307-8			
X307-9	Power output 5, normally open	PSM_102	BO5_PO
X307-10			
X307-11	Power output 6, normally open	PSM_102	BO6_PO
X307-12			



Table 539: Output contacts X307, 6U half 19"

Terminal	Description	PCM600 info	
		Hardware module instance	Hardware channel
X307-13	Signal output 1, normally open	PSM_102	BO7_SO
X307-14			
X307-15	Signal output 2, normally open	PSM_102	BO8_SO
X307-16			
X307-17	Signal output 3, normally open	PSM_102	BO9_SO
X307-18			

#### A.2 Technical data

### Technical data

Table 19:

ZQDPDIS Technical data

Function	Range or value	Accuracy	
Number of zones	5 with selectable direction	100	
Minimum operate residual current	(5-30)% of IBase	± 1,0 % of I <sub>r</sub>	
Minimum operate current, phase- to-phase and phase-to-earth	(10-30)% of IBase	± 1,0 % of I <sub>r</sub>	
Positive sequence impedance reach for zones	0.005 - 3000.000	± 5.0% static accuracy ± 2.0 degrees static angular accuracy	
Fault resistance, phase-to-earth	(1.00-9000.00) Ω/loop	Conditions: Voltage range: (0.1-1.1) x Ur	
Fault resistance, phase-to-phase	(1.00-3000.00) Ω/loop	Current range: (0.5-30) x Ir	
Line angle for zones	(0 - 180) degrees	Angle: at 0 degrees and 85 degrees	
Magnitude of earth return compensation factor KN for zones	0.00 - 3.00		
Angle for earth return compensation factor KN for zones	(-180 - 180) degrees		
Dynamic overreach	<5% at 85 degrees measured with CVT's and 0.5 <sir<30< td=""><td></td></sir<30<>		
Impedance zone timers	(0.000-60.000) s	± 0.5% ± 10 ms	
Operate time	30 ms typically	м. 	
Reset ratio	105% typically	20 C	
Reset time	35 ms typically		

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#### **APPENDIX B**

Equivalence of software parameters and the relay under test.

Distance Software		ABB REL650 Relay	
Parameter	Figure	Parameter	Figure
Secondary Current	68	CT sec	19
Secondary Voltage	68	VT sec	20
Zn01_LE		Zone 1	
Trigger Time	74	tPE1	55
Z	74	Z1	55
LineAng	74	LineAng	55
KNMag	74	KNMag1	55
KNAng	74	KNAng1	55
RFPE	74	RFPE1	15
Operationz<	74	<b>OperationZ</b> <	60
X1 phs	74	X1	60
X0 phs	74	X0	60
RFFwPE phs	74	RFFwPE	60
RFRvPE phs	74	RFRvPE	60
RLdFw phs	74	RLdFw	60
RLdRv phs	74	RLdRv	60
AngLd phs	74	AngLd	60
FORWARD	74	DirMode1	55
AngDir zd	74	AngDir	59
AngNegDir	74	AngNegRes	59
Zn01_FF		Zone 1	
Trigger Time	77	tPP1	55
Z	77	Z1	55
RFPP	77	RFPP1	55
X1 phs	77	X1	60
RFFwPP phs	77	RFFwPP	60
RFRvPP phs	77	RFRvPP	60
RLdFw phs	77	RLdFw	60
RLdRv phs	77	RLdRv	60
AngLd phs	77	AngLd	60
FORWARD	77	DirMode1	55
AngDir zd	77	AngDir	59
AngNegDir	77	AngNegRes	59



INSTRUMENTOS PARA TESTES ELÉTRICOS			
Distance Software		ABB REL650 Relay	
Parameter	Figure	Parameter	Figure
Zn01_ABC		Zone 1	
Trigger Time	80	tPE1	55
Z	80	Z1	55
LineAng	80	LineAng	55
KNMag	80	KNMag1	55
KNAng	80	KNAng1	55
RFPP	80	RFPE1	55
<b>Operationz</b> <	80	<b>OperationZ</b> <	60
X1 phs	80	X1	60
X0 phs	80	X0	60
RFFwPP phs	80	RFFwPP	60
RFRvPP phs	80	RFRvPP	60
RLdFw phs	80	RLdFw	60
RLdRv phs	80	RLdRv	60
AngLd phs	80	AngLd	60
FORWARD	80	DirMode1	55
AngDir zd	80	AngDir	59
AngNegDir	80	AngNegRes	59

Note: To register zones: LE, LL and ABC remember to register the Loop in the Distance software. Zones 2 and 3 have equivalence in the way they are parameterized, being analogous to Zone 1.