

Implementing Zone Selectivity in low voltage devices using IEC 61850

Data Center



The purpose of this document is to explain how to implement Zone Selectivity in low voltage devices using IEC 61850.

The procedure can be applied to each type of user.

Equipment required

Software:

- Ekip Connect 3 (check in ABB Library for the latest version)
- PCM600 v2.9
- ABB IEC Connectivity Package Ekip Com IEC 61850 Ver. 1.44.0

Hardware:

- Ekip T&P communication tool.
- Ethernet cable

Procedure

Ekip Connect 3 settings

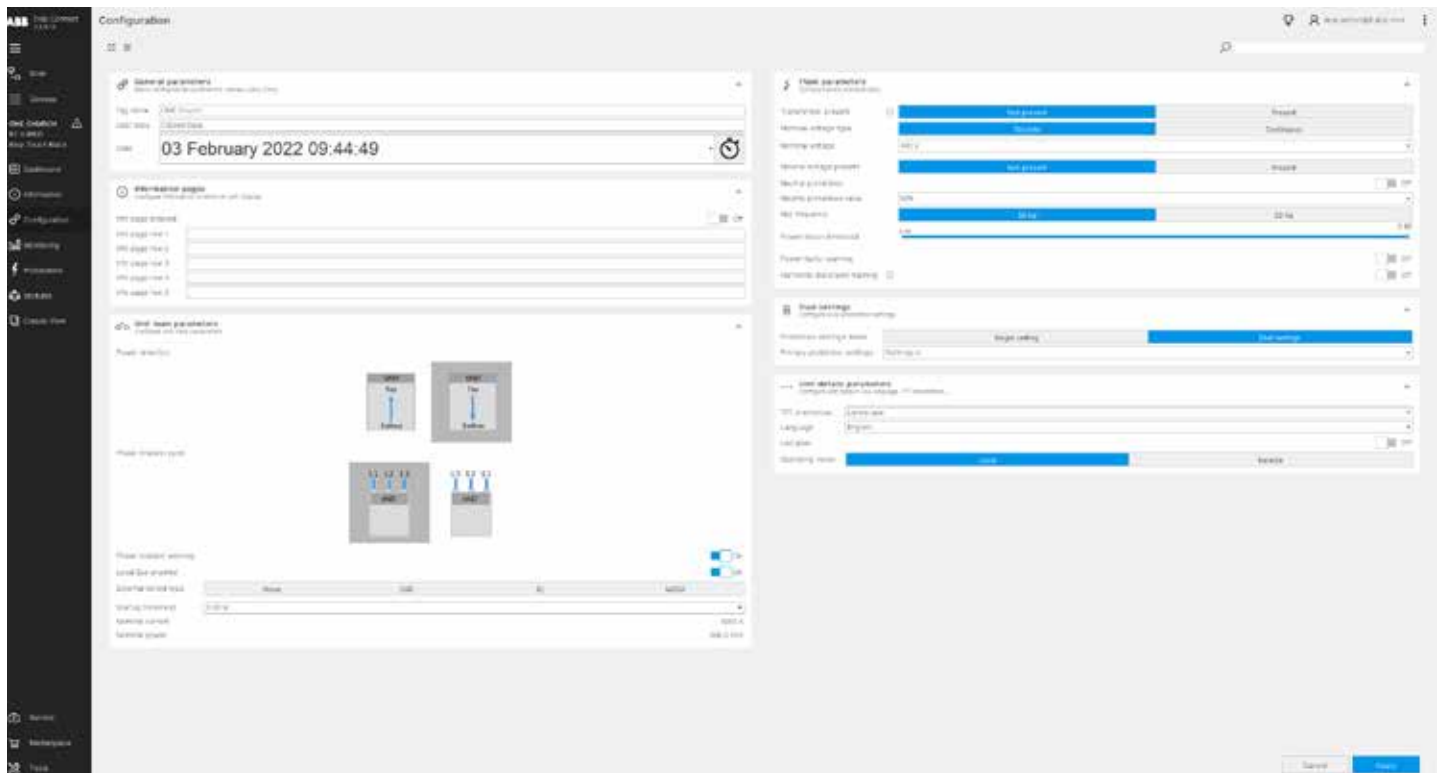
Step 1: identify the Circuit breaker

Open Ekip Connect 3 and scan your device using the T&P.



Step 2: Set Tag Name and Power Direction

1. Configuration
2. Tag Name
3. Power direction = Top → Bottom
4. Apply

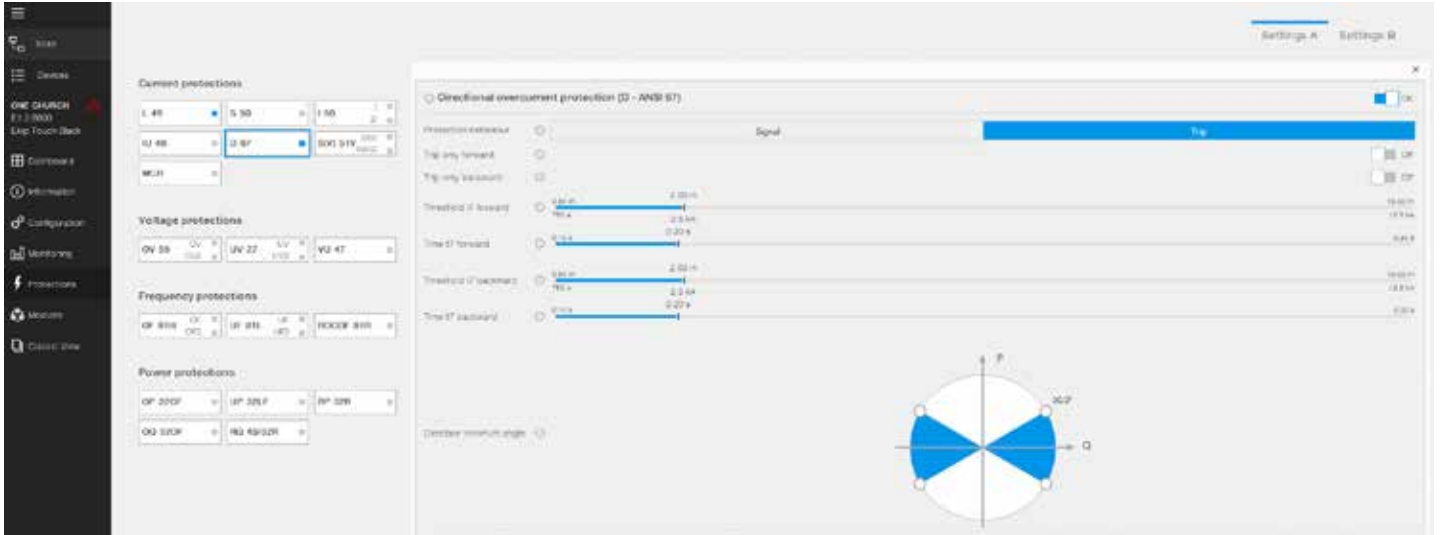


Note: choose the same Tag name as that of the device in the electrical system

Step 3: Set the protection settings

This step shows how to implement directional protection D. Set all the parameters according to your data.

1. Protection – D 67
2. Enable Directional overcurrent protection
3. Protection behavior - Trip
4. Threshold current I7 forward
5. Time I7 forward
6. Threshold current I7 backward
7. Time I7 backward
8. Min angle of direction: We advise a greater angle than Min angle of direction (t15 preset values are available, ranging from 3.6° to 69.6°)
9. Apply



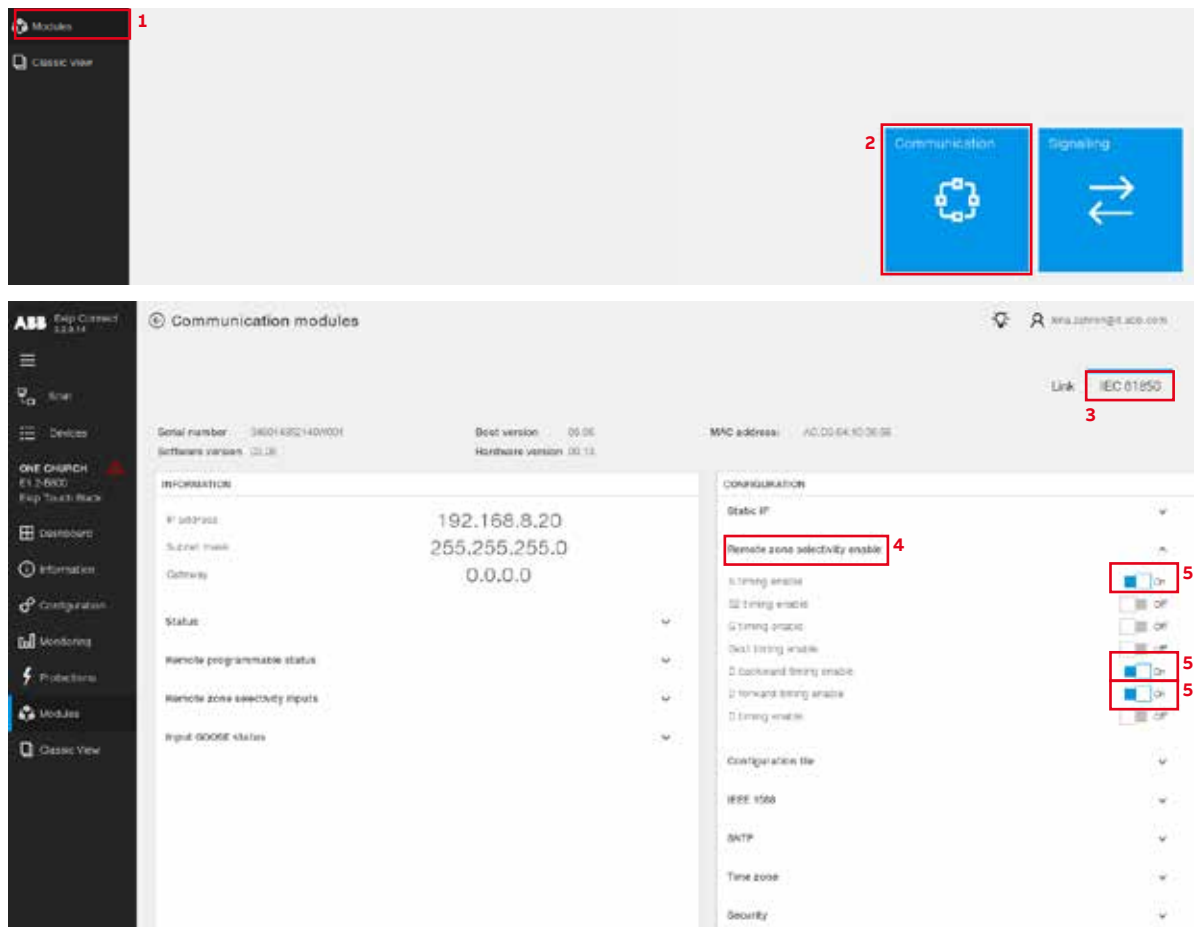
10. Follow the steps in the image below if directional zone selectivity is required



Note: S, S2, G or Gext Zone Selectivity cannot be set if Directional zone selectivity has been chosen.
The software will automatically recognize whether the chosen settings are incorrect and will generate an error message

Step 4: Enable remote zone selectivity for each protection

1. Modules
2. Communication
3. IEC 61850
4. Remote Zone Selectivity Enable
5. Enable for each protection required
6. Apply



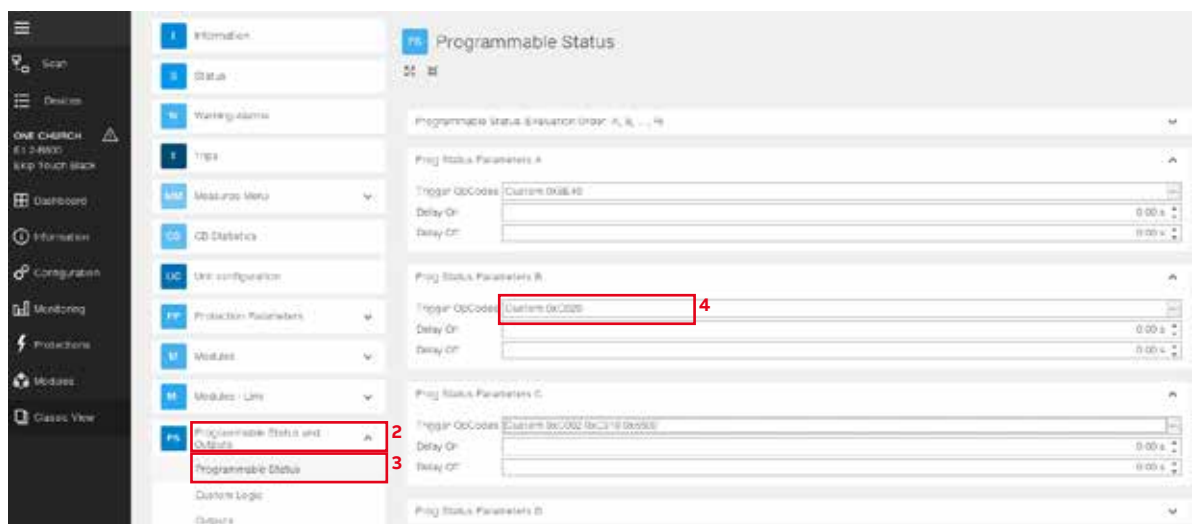
Step 5: Program the send signals

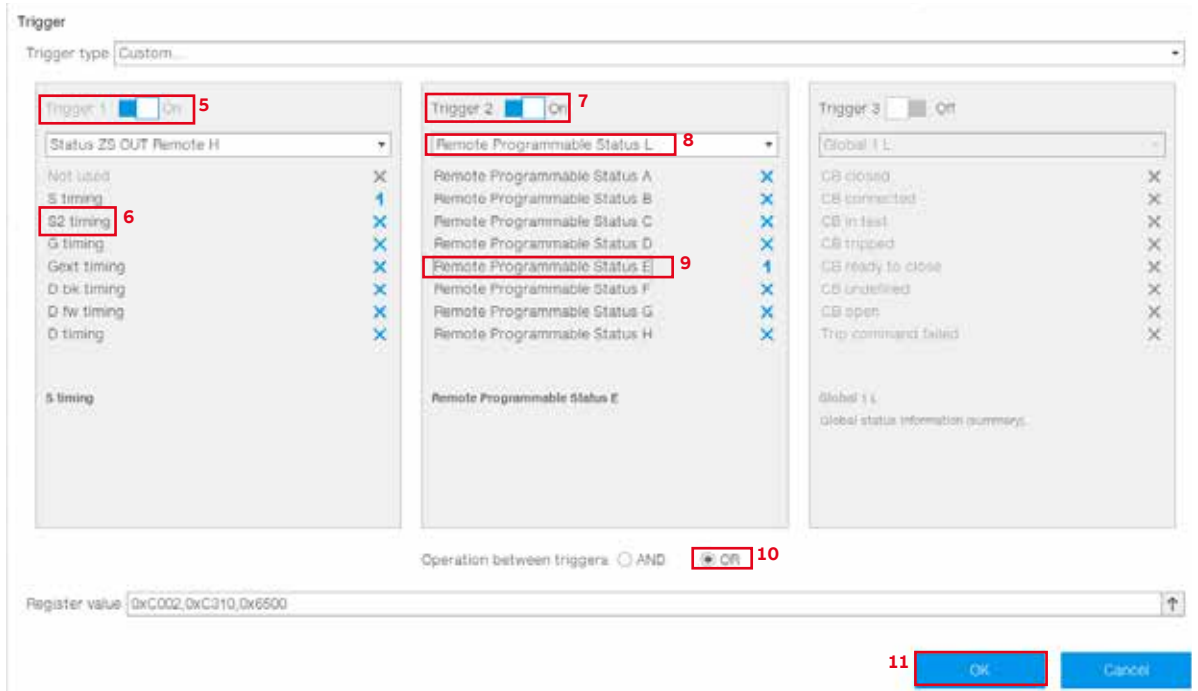
The following data can be programmed:

- Programmable Status A to Dfw timing (Directional Forward)
- Programmable Status B to DBw timing (Directional Backward)
- Programmable Status C to S timing and Remote Programmable Status E (with OR function)

1. Classic View
2. Programmable status and outputs
3. Programmable status

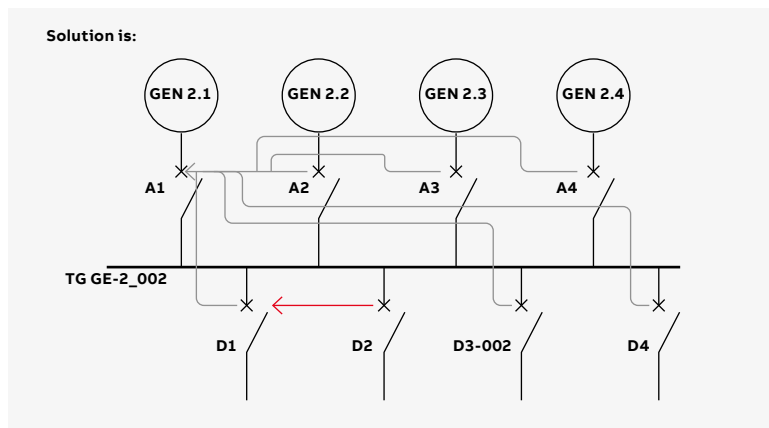
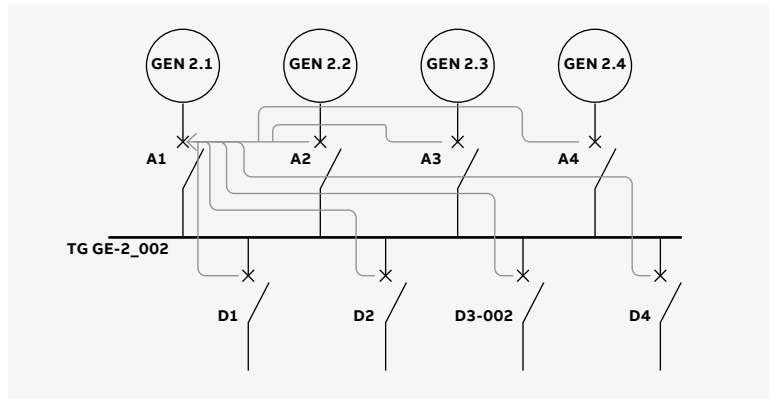
4. Prog Status Parameters C (for example), press on the 3 dots to access another window (Trigger) then custom
5. Status ZS out Remote H
6. S timing = 1
7. Trigger 2 - ON
8. Remote Programmable Status L
9. Remote Programmable Status E = 1
10. Operation between triggers - OR
11. OK
12. Apply





Note: steps 7 to 10 are not mandatory (Remote programmable L). They have only been used for shifting some of the commands to other circuit breakers. Each IEC61850 can receive up to 6 signals so if 7 signals have to be received by one IEC 61850, one signal could be shifted to another circuit breaker.

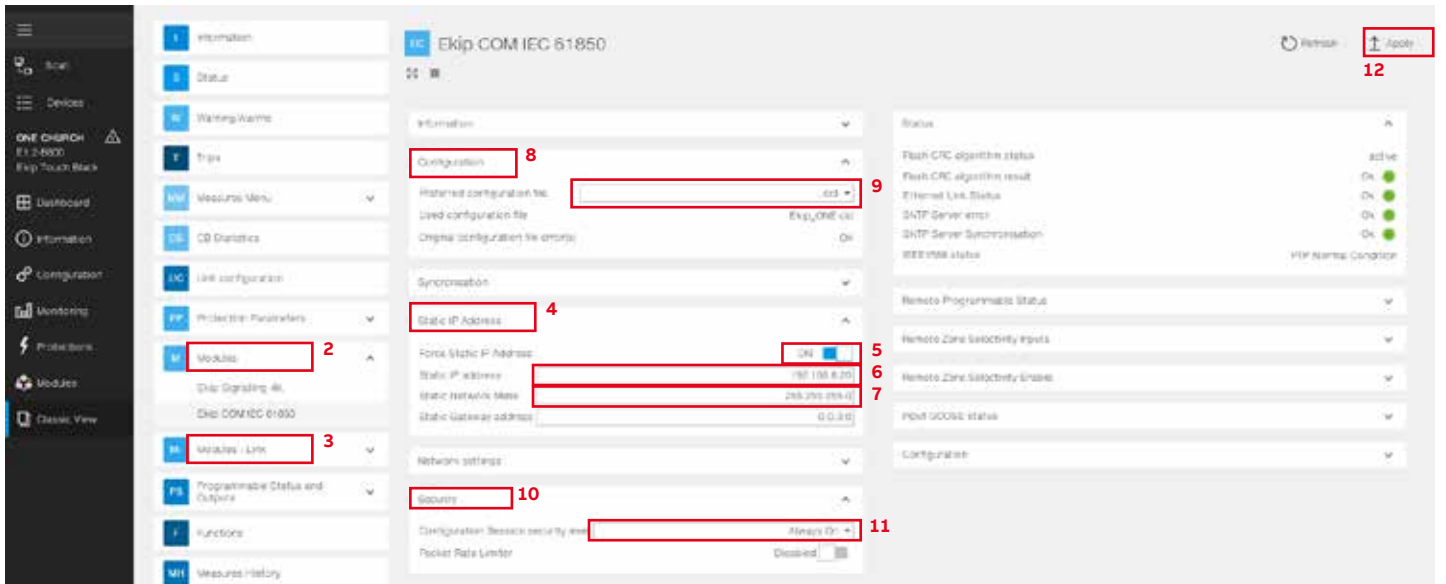
By way of example, all the signals that circuit breaker A1 can receive are illustrated in the single-line diagram below.
 Solution: in this case, a signal can be shifted from D2 to D1.



Step 6: Set static IP address and .cid file in Ekip Com IEC 61850 module

1. Classic View
2. Modules
3. Ekip Com IEC 61850
4. Static IP address
5. Force Static IP address ON
6. Static IP address
7. Subnet Mask
8. Configuration
9. Preferred configuration file = .cid
10. Security
11. Configuration Session security level should always = On
12. Apply

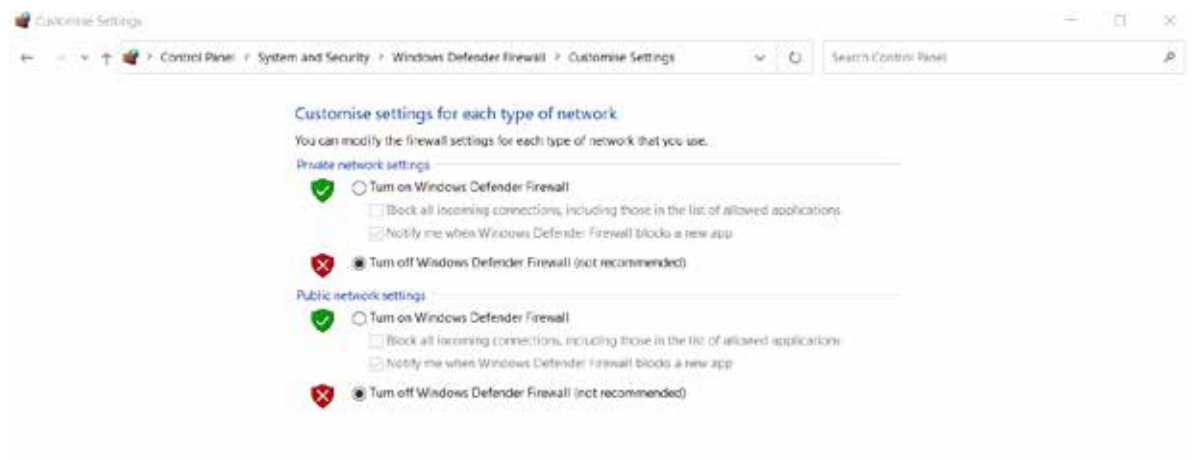
Note: all devices in the same system must be in the same network:
 • the first 3 numbers of the static IP address must be the same (for example 192.168.2.x)
 • The Static Network Mask must be the same (we suggest 255.255.255.0)



PCM Settings

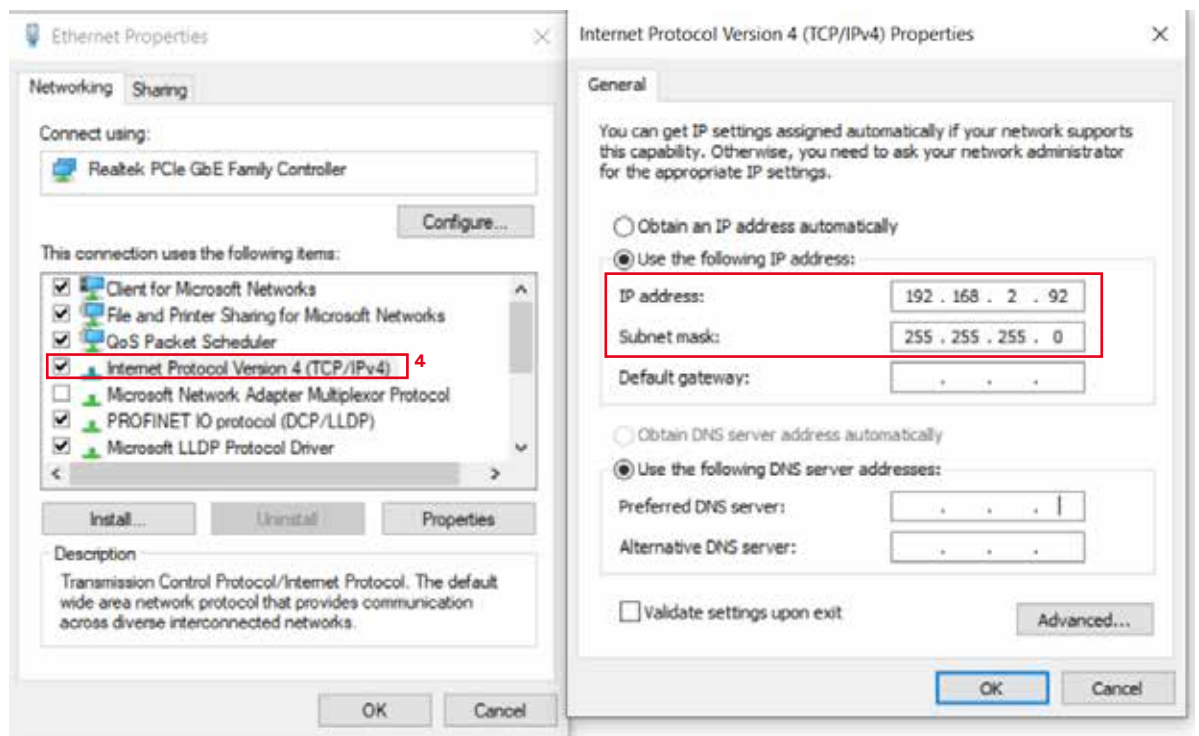
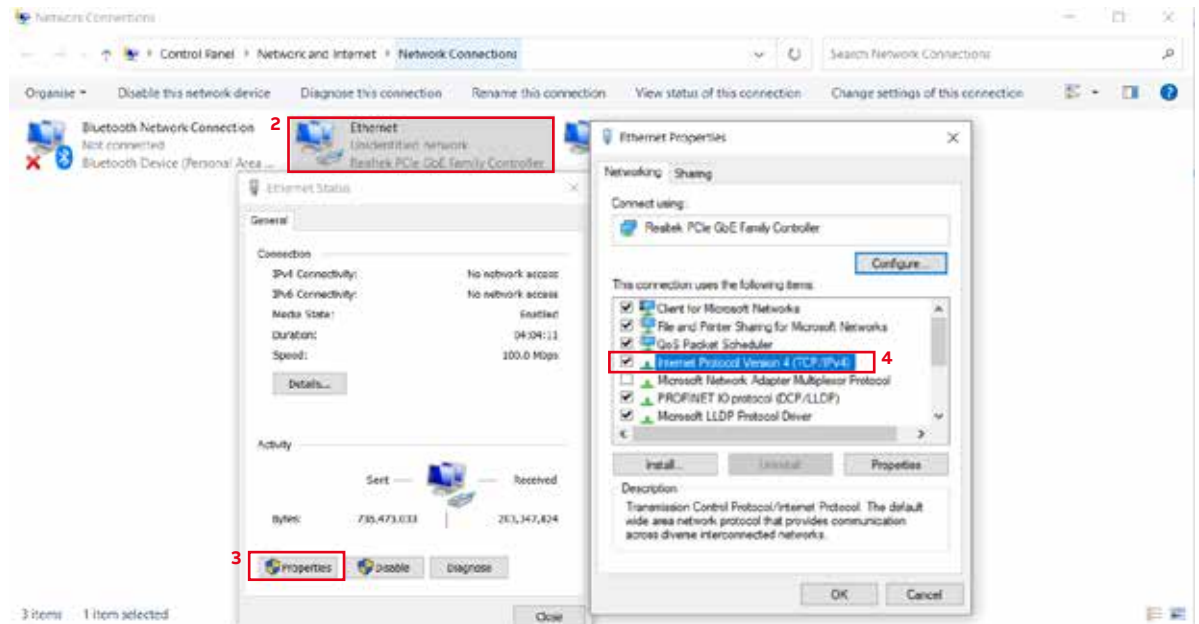
Step 1:

Firewall status of computer should = Off



Step 2:

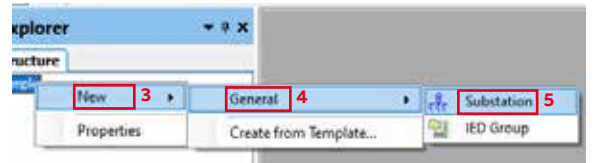
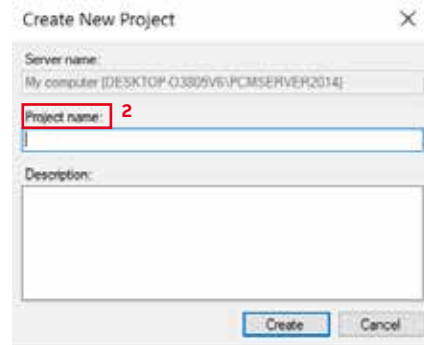
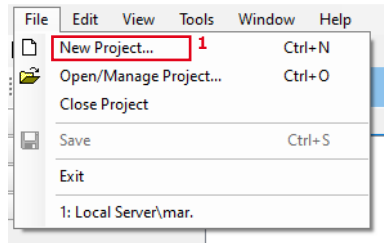
Computer IP address in same network as IEC 61850 module



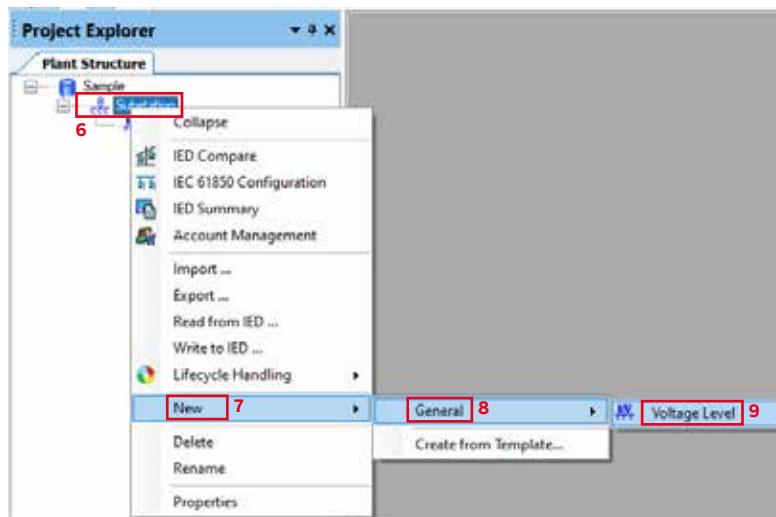
Step 3: Create the project

Open PCM600, create the project and build the plant.

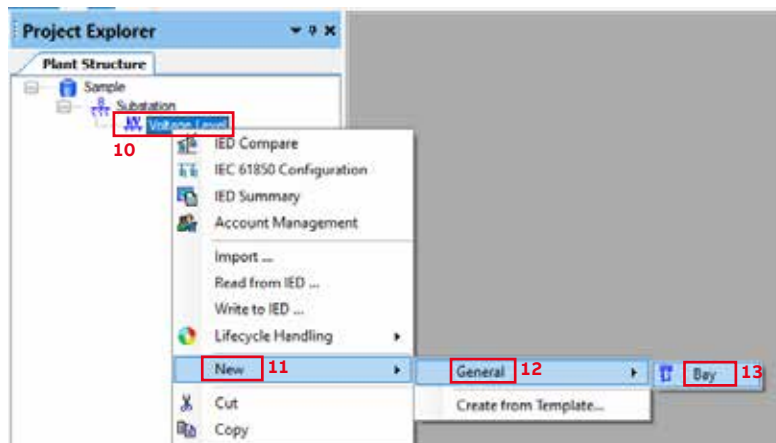
1. File - new project
2. Project name
3. Right click on project name - New
4. General
5. Substation



6. Right click on Substation
7. New
8. General
9. Voltage Level

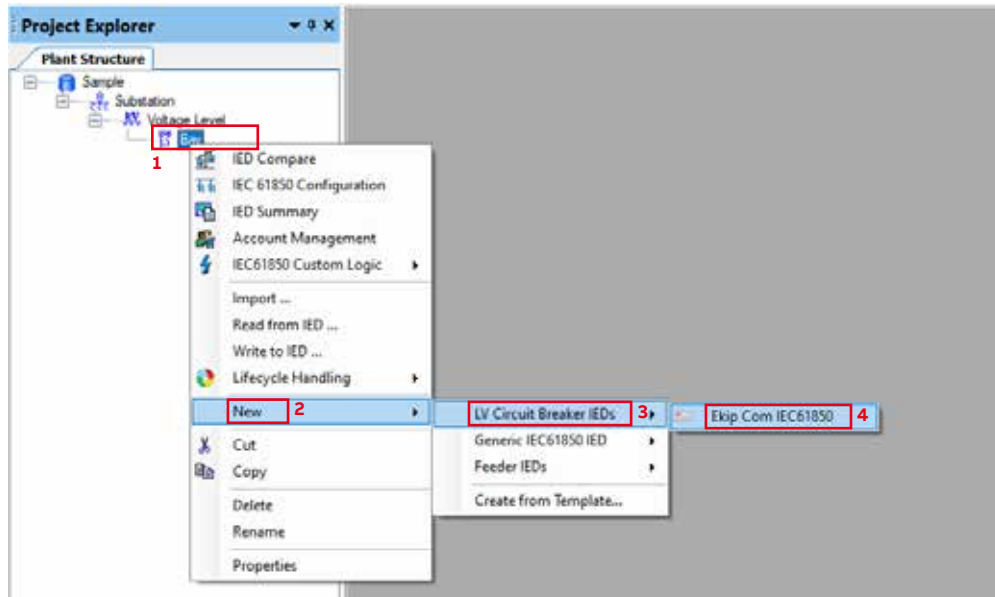


10. Right click on Voltage Level
11. New
12. General
13. Bay

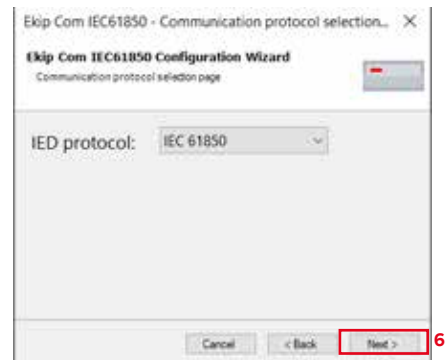
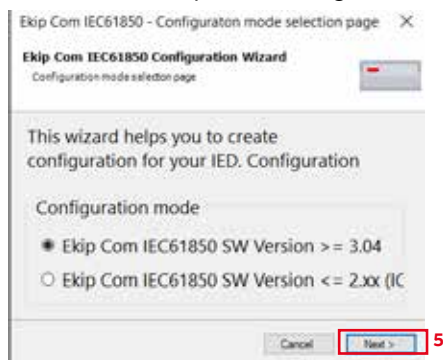


Step 4: Insert a new device

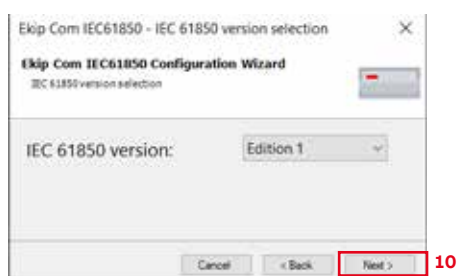
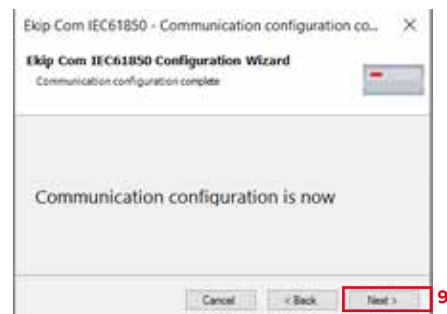
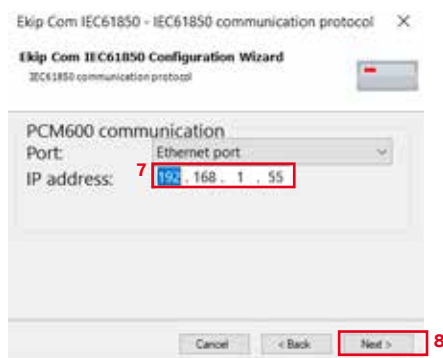
1. Right click on Bay
2. New
3. LV Circuit Breaker IEDs
4. Ekip Com IEC61850



5. Follow the steps in the image below

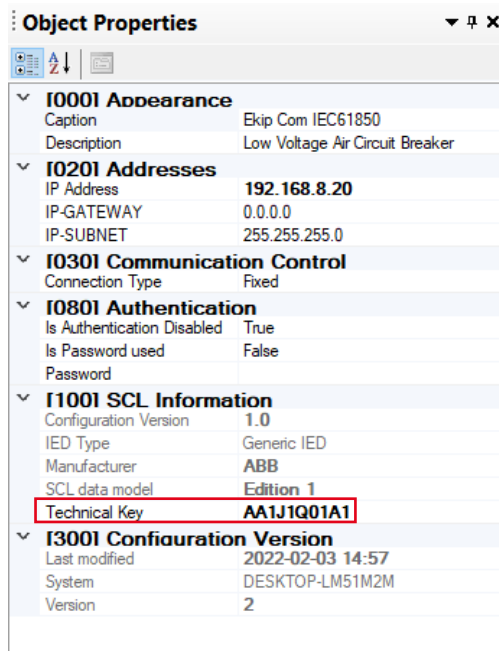


Enter chosen IP address in static IP of IEC61850 module in Ekip Connect.



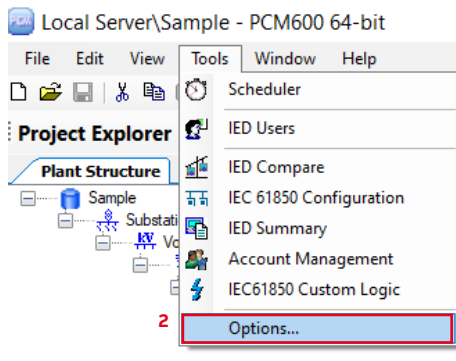
Step 5: Dealing with the Technical Key

Change Technical Key so that it is the same as tag name of device.

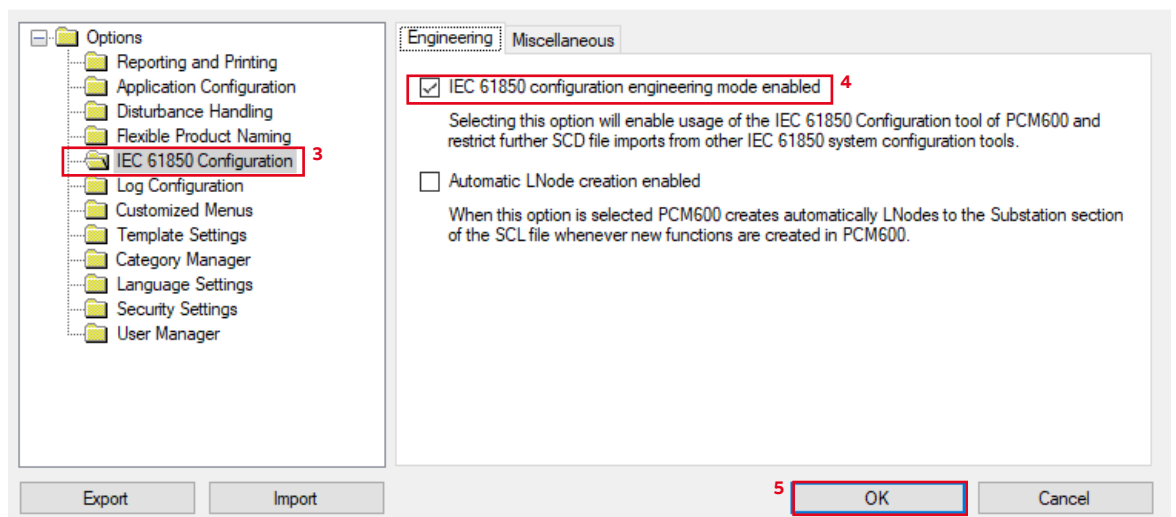


Step 6: Enability of IEC 61850 Configuration engineering

1. Tools
2. Options
3. IEC 61850 Configuration
4. IEC 61850 Configuration engineering mode enable
5. OK



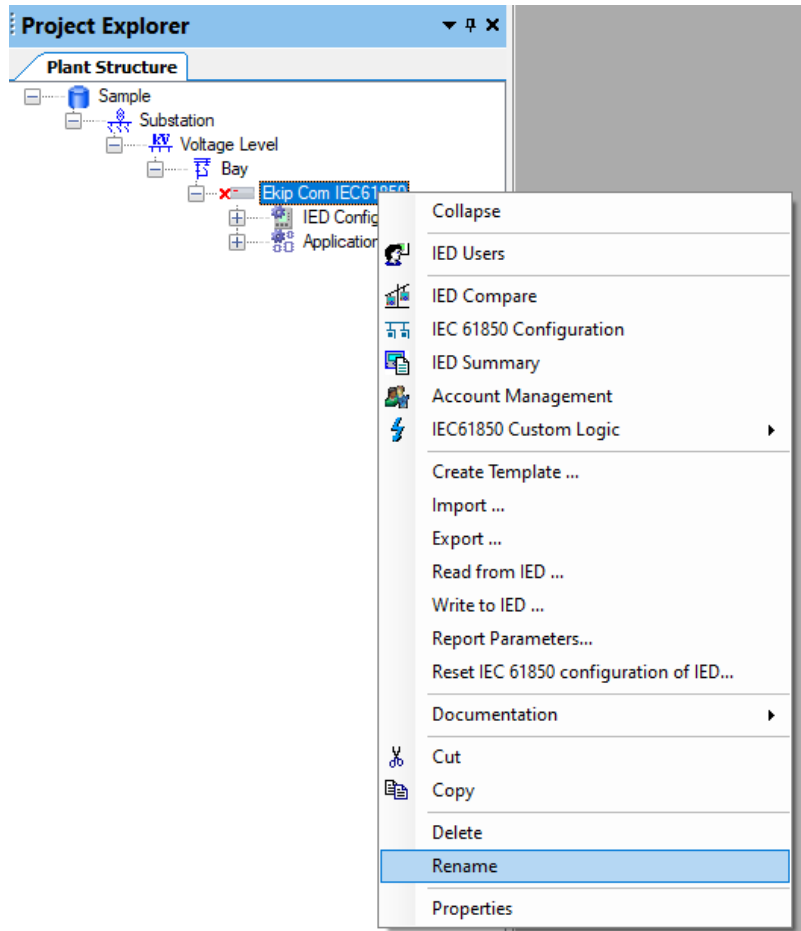
Options



Step 7: Rename Ekip Com IEC61850

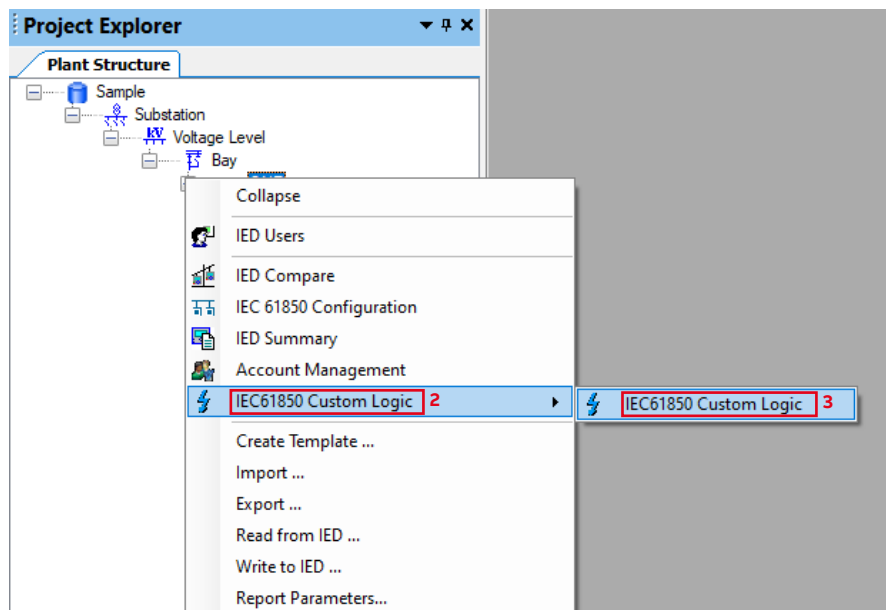
For ease of use and to distinguish Ekip Com IEC61850 devices, they can be renamed by a right

click on Ekip Com IEC61850, according to the tag name.



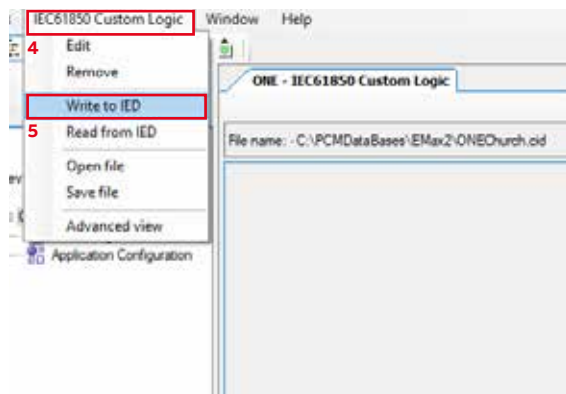
Step 8: Download the created IEC61850 settings from PCM600 to the device

1. Right click on Ekip Com IEC61850 (the name of which has been changed to distinguish between circuit breakers)
2. IEC 61850 Custom logic
3. IEC 61850 Custom logic

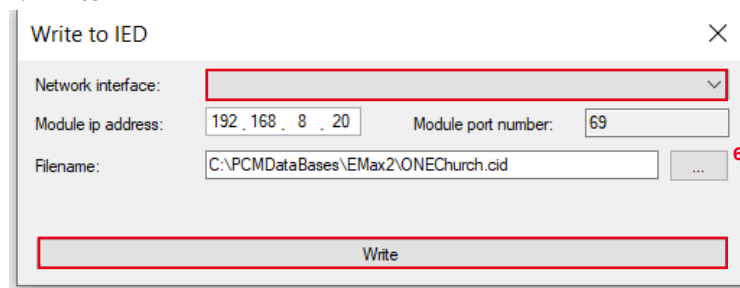


IEC61850 Custom Logic can be found at the top, in the File Menu bar.

4. Open IEC61850 Custom Logic
5. Write to IED



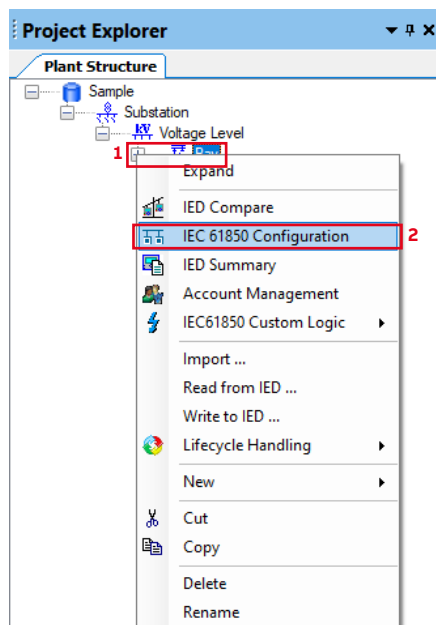
6. Choose the correct network interface:
7. Write



Repeat the procedure from Step 4 to Step 7 for each LV device in the ⁷electrical network.

Step 9: Set GOOSE messages

1. Right click on Bay
2. IEC 61850 Configuration



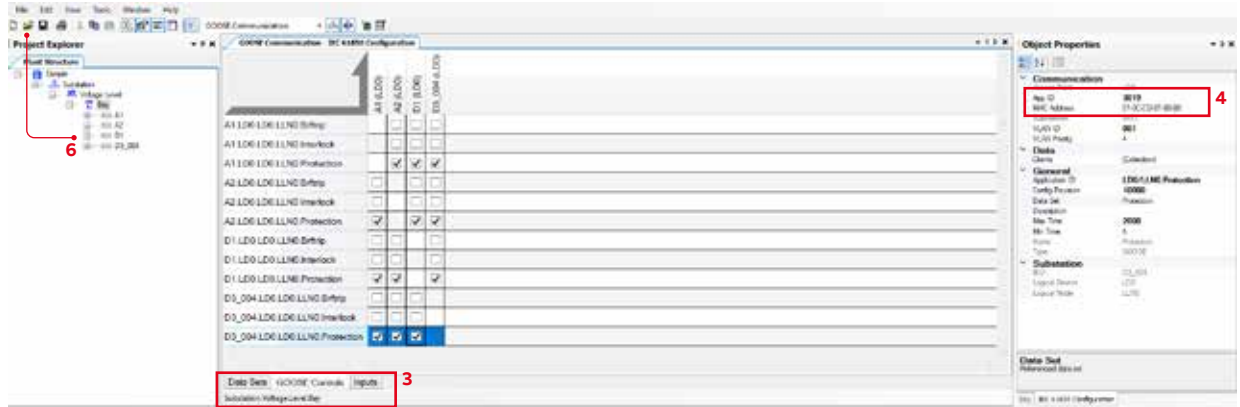
A new window will appear. There are 3 kinds of GOOSE messages:

- Bftrip : for Back up protection
- Interlock: for CB. Status (Open, Close)
- Protection: For protection signalling

3. GOOSE controls
4. Change APP ID and MAC Address

Note: The APP ID and Mac Address must be changed. Each one should be unique. The Mac Address cannot be 0. Press enter to acquire the change and press save each time after finishing.

- Cross-check the GOOSE messages according to the signalling matrix
- Save



GOOSE Communication - IEC 61850 Configuration

	A1 (LD0)	A2 (LD0)	D1 (LD0)	D3_004 (LD0)
A1.LD0.LD0.LLN0.Brtrip		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
A1.LD0.LD0.LLN0.Interlock		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
A1.LD0.LD0.LLN0.Protection		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
A2.LD0.LD0.LLN0.Brtrip	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
A2.LD0.LD0.LLN0.Interlock	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
A2.LD0.LD0.LLN0.Protection	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
D1.LD0.LD0.LLN0.Brtrip	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>
D1.LD0.LD0.LLN0.Interlock	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>
D1.LD0.LD0.LLN0.Protection	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>
D3_004.LD0.LD0.LLN0.Brtrip	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
D3_004.LD0.LD0.LLN0.Interlock	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
D3_004.LD0.LD0.LLN0.Protection	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	

Receiving side (top of table)

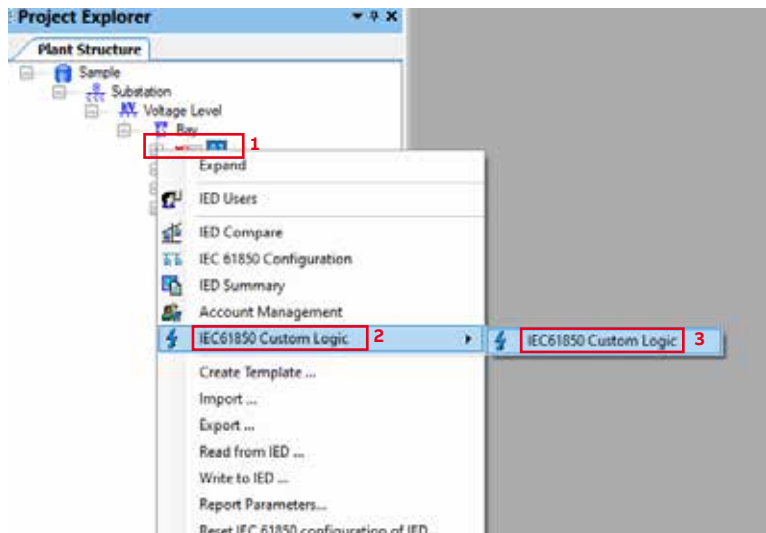
Sending side (bottom of table)

As shown, the left side of the Goose Communication is the Sender side and represents the Out side of the signalling Matrix while the Up side is the receiving side and represents the In side of the signalling Matrix. In this example, Circuit Breaker A1 is sending a Protection Signal to Circuit Breakers A2, D1 and D3_4.

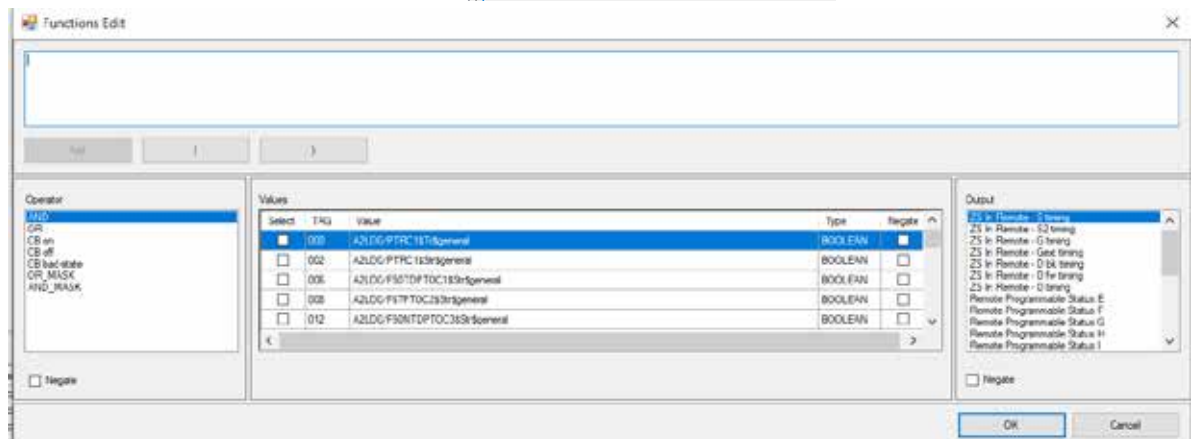
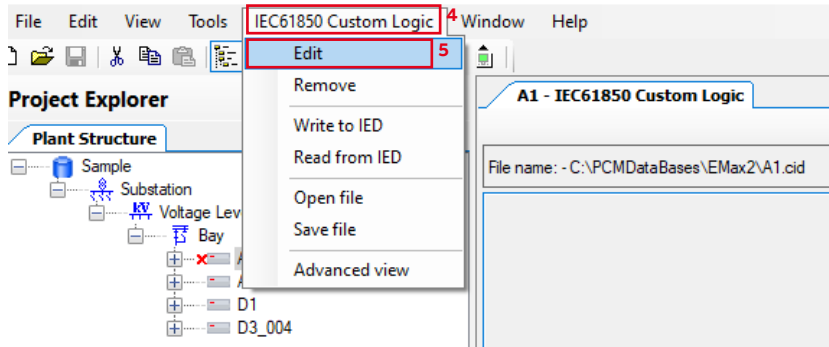
Step 10: Program the GOOSE messages

This step allows you to define which kind of GOOSE messages each device receives.

- Right click on device that should receive the message
- IEC 61850 Custom logic
- IEC 61850 Custom logic



- Click on IEC61850 Custom Logic at the top, in the File Menu bar
- Edit, now select Edit to access a new window



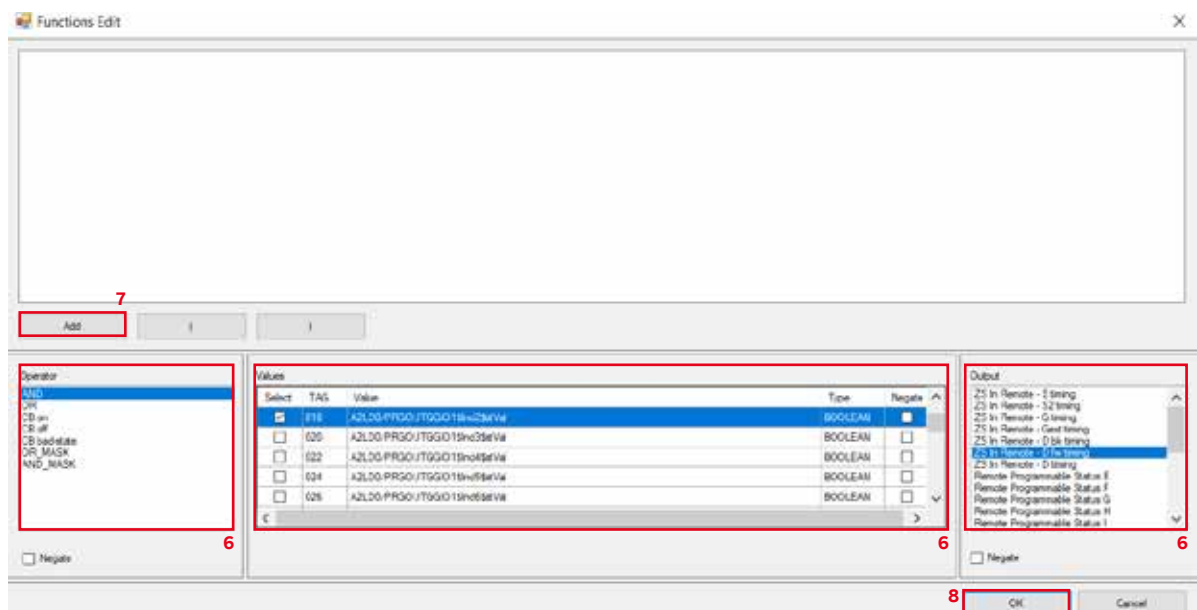
Interfacing between PCM and Ekip Connect 3

PCM	Ekip connect 3
PRGOUTGGIO1\$ST\$Ind1\$general	Programmable Status A
PRGOUTGGIO1\$ST\$Ind2\$general	Programmable Status B
PRGOUTGGIO1\$ST\$Ind3\$general	Programmable Status C

Important to understand

PCM	Definition
Values	OUT of Signalling Matrix (message sent)
Output	IN of Signalling Matrix (message received)
Operator	Operating function applied to transmitted message

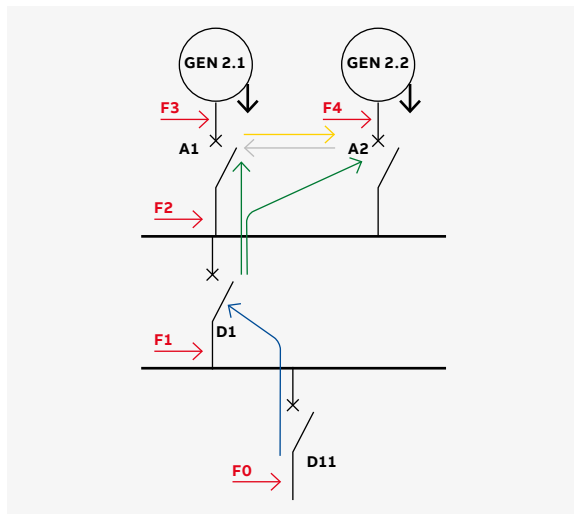
- Enter Operator, Values and Output
- Add
- OK



Example

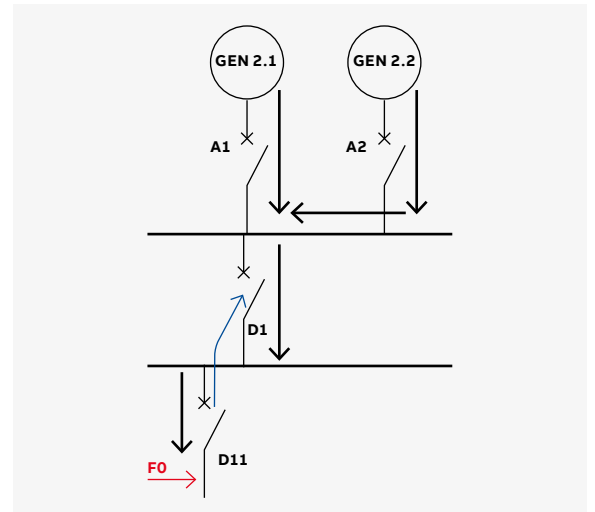
- Two supply sources (GEN2.1, GEN2.2) are feeding the plant
 - A1, A2 are circuit breakers with Directional protection
 - D1, D11 are circuit breakers with S protection.
- The Signalling Matrix and single-line diagram with Probable Fault Points and signalling directions are shown in the figure below.

		Out					
		A1		A2		D11	D2
		FW	BW	FW	BW	S	S
IN	A1	FW			●	●	
	A2	FW	●			●	
	D1	S					●
	D11	S					



- ← Fault (F0, F1, F2, F3, F4)
- ← Directions of Current Flows feeding the Fault
- ← D11 Signal due to F0
- ← D11 Signal due to F1
- ← A1 Signal due to F3
- ← A2 Signal due to F4

Considering Fault F0 as shown in the single-line diagram below, the current flows from G1 and G2 to feed the fault. D11 should trip and send a signal to D1.



To assign the Signal input to D1:

Test procedure

Scope: check whether the locking signals sent by the tested circuit breaker are correct in the case of a fault with zone logic discrimination feature active. The procedure will be implemented by using Ekip Connect 3.

Preliminary settings

The recorded Ekip Connect value is given below for each specific event:

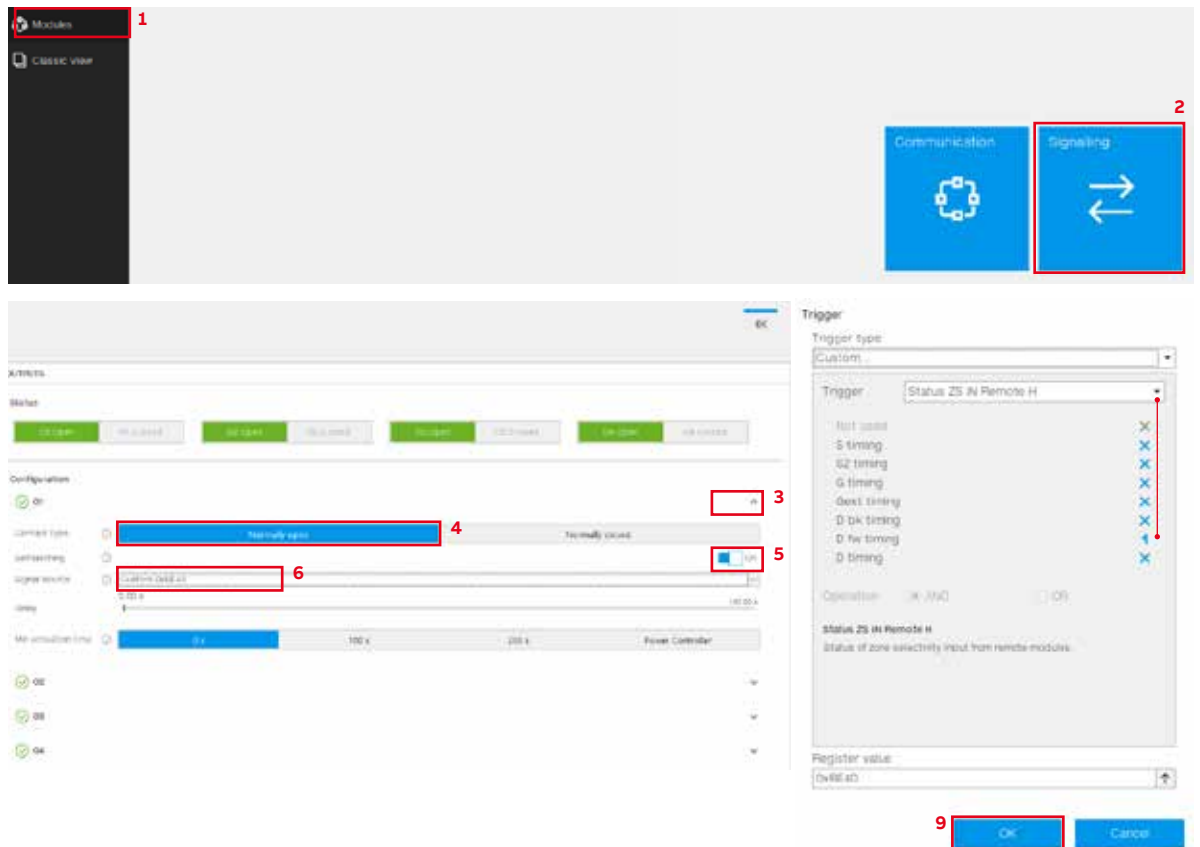
- Status ZS IN Remote H - S In = BE02
- Status ZS IN Remote H - D FW In = BE40
- Status ZS IN Remote H - D BW In = BE20

Ekip Signalling 4k

Comply with the instructions in this section if Ekip Signalling 4k is installed in the device.

A general example about how to program the Signalling 4k Outputs is given below:

1. Modules
2. Signalling
3. O1
4. Connection type – Normally Open
5. Self-latching – On
6. Signal source – click on the three dots
7. Custom
8. Status ZS IN Remote H - D FW In (BE40)
9. OK
10. Apply



A general setting for one circuit breaker is given below as a standard example.

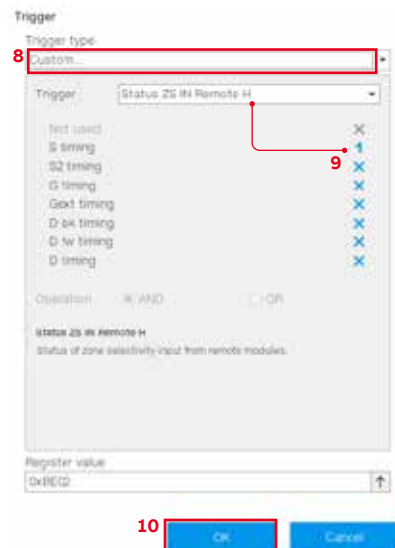
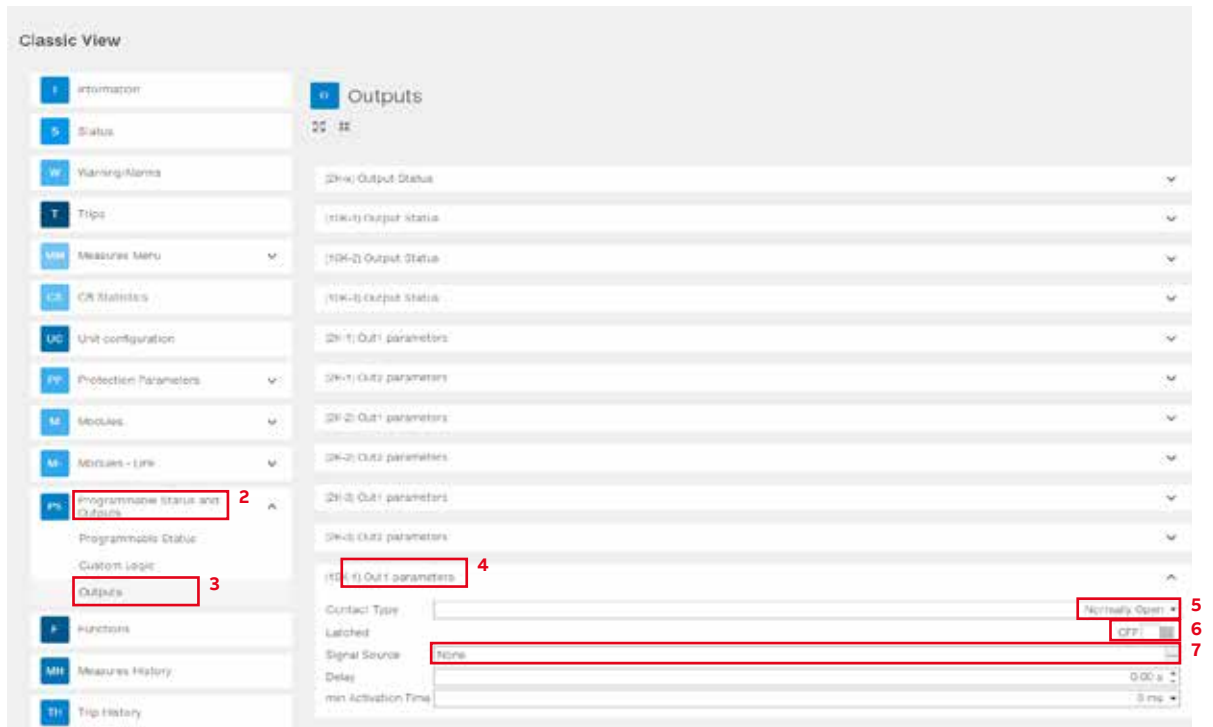
	O 01	O 02	O 03
Circuit breaker	BE40	BE20	BE02

Ekip Signalling 10k-1

There is no need to install an external Ekip Signalling 10k device. It can be set and checked from the Outputs page.

A brief example about how to program Signalling 10k-1 Outputs is given below:

1. Classic View
2. Programmable Status and Outputs
3. Outputs
4. (10k-1) Out1 parameters
5. Contact type – Normally open
6. Latched – ON
7. Signal Source – click on the 3 dots
8. Custom
9. Status ZS IN Remote H - S In (BE02)
- 10.OK
11. Apply



All the settings for one circuit breaker are given below, as a standard example.

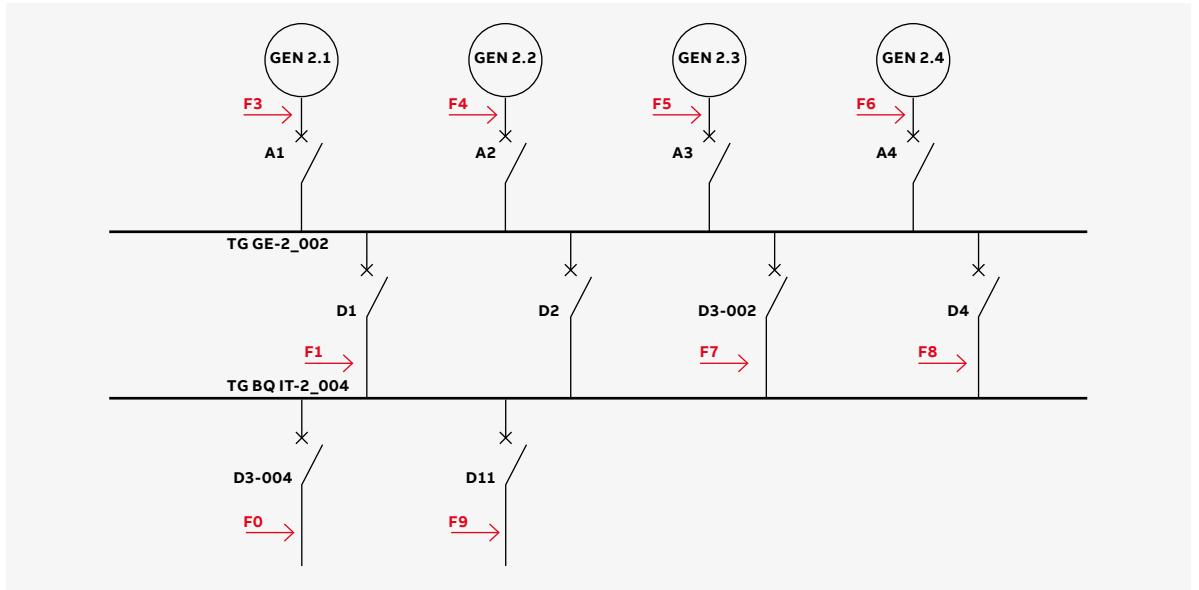
	OUT1	OUT2	OUT3
Circuit breaker	BE02	BE40	BE20

Example with 10 Circuit breakers:

A brief explanation is given about the network below, with a table showing the signalling setting using the 4K

- GEN 2.1, GEN 2.2, GEN 2.3, GEN 2.4 → power supply

- F0, F1, F2, F3, F4, F5, F6, F7, F8, F9 → fault probability
- A1, A2, A3, A4 → circuit breakers with Directional protection
- D1, D2, D3_002, D4, D3_004, D11 → circuit breakers with S protection



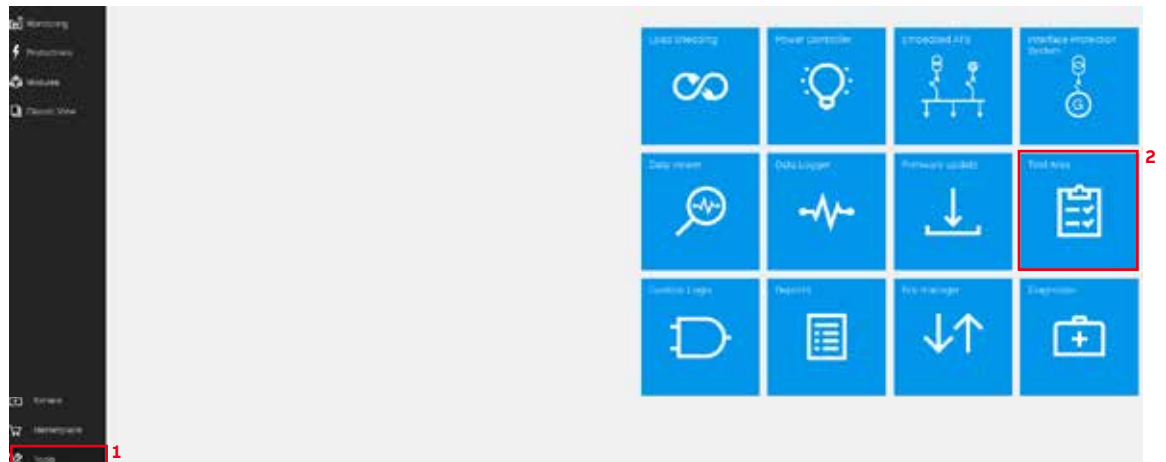
Circuit breaker	O 01	O 02	O 03
A1	BE40	BE20	BE02
A2	BE40	BE20	BE02
A3	BE40	BE20	BE02
D1	-	-	BE02
D2	-	-	BE02
D3_002	-	-	BE02
D4	-	-	BE02
D11	-	-	BE02
D3_004	-	-	BE02

Test with fault simulation sequence

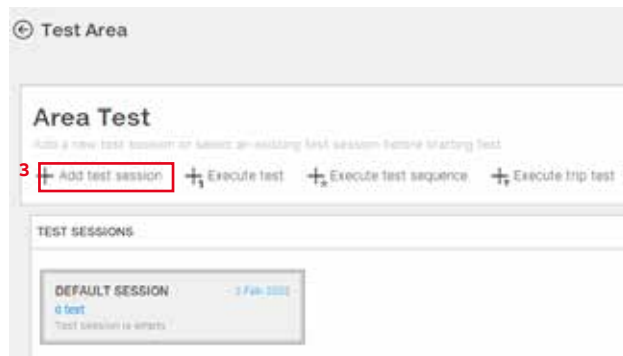
Inject the digital signal that simulates the fault into the release to find out whether tripping in the tested unit is correct.

Test area

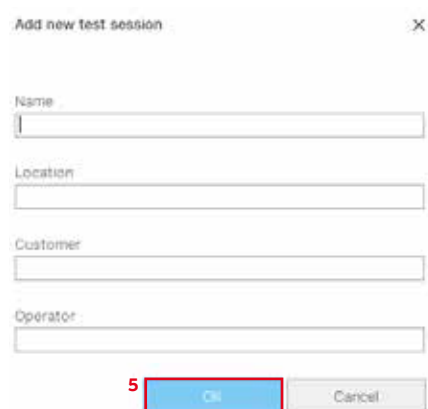
1. Tools
2. Test Area



3. Add Test Session



4. Fill in the data
5. OK



The screenshot shows the 'Add new test session' dialog box. It has a title bar with 'Add new test session' and a close button 'X'. The dialog contains four text input fields: 'Name', 'Location', 'Customer', and 'Operator'. At the bottom, there are two buttons: 'OK' and 'Cancel'. The 'OK' button is highlighted with a red box and labeled '5'.

6. Add Test

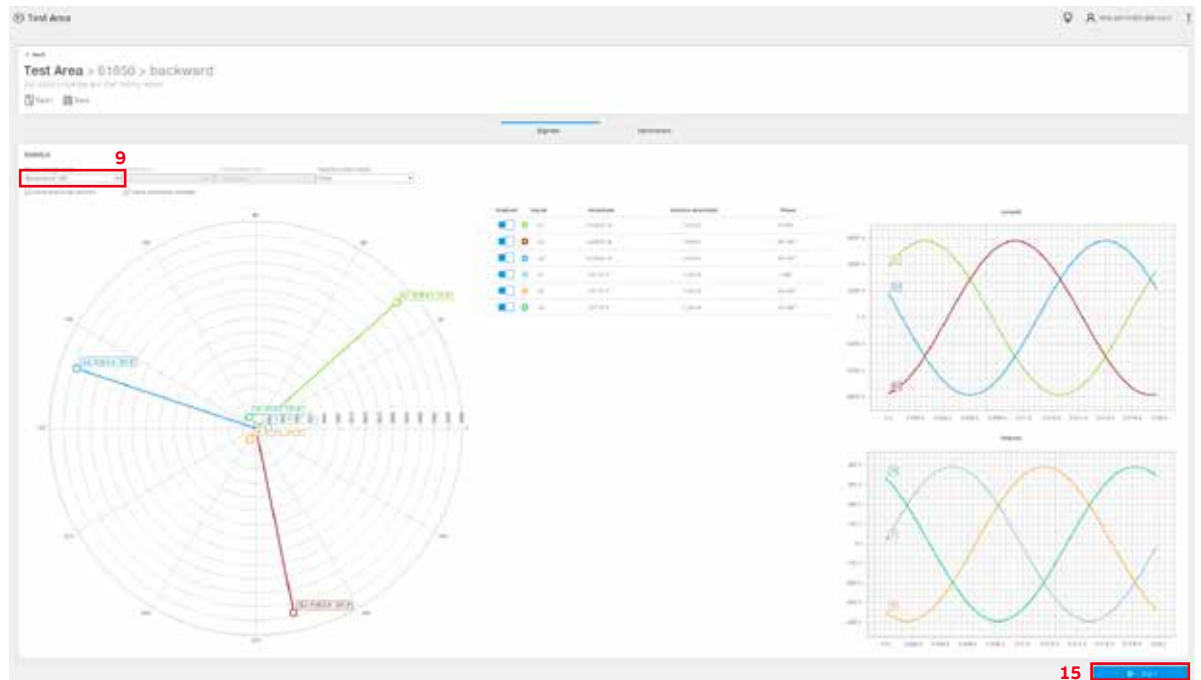
7. Fill the data
8. OK

Test name

7 BackWard

8 OK Cancel

9. Phase change mode – balanced at 120°
10. Shows relative amplitudes
11. Same amplitudes for currents
12. Same amplitudes for voltages
13. Select Relative amplitude for currents and voltages
14. Select phase for currents and voltages
15. Start



16. Test Session result

Completed

4 Feb 2022

- 10:04:08 Evaluating test preconditions...
- 10:04:09 Opening test session.
- 10:04:11 Injecting signal waveforms...
- 10:04:11 Start test.
- 10:04:12 Protection D Backward tripped in 130 ms
- 10:04:12 Stop test.
- 10:04:13 Close test session.

Test completed, D Backward tripped in 130 ms.

Repeat test View Test Report Close

17. Save file in a specific folder

Suggested Test Session conditions

Test	Signal	Relative amplitude	Phase	Power Direction
1	IL1	2.50In	30.00°	Backward
	V1	1.00Un	0.00°	
2	IL1	2.50In	-30.00°	Forward
	V1	1.00Un	0.00°	

Using the Test feature in the Ekip connect software define a test current that simulates the fault. The value of this current must be higher than the protection settings (at least +20%) and the angle between voltage and current must be defined according to the fault direction.

Note:

- To recognize the power direction, the phase difference between I and V must be higher than the minimum angle of direction set in D protection.
- It is backward if the phase is 30.00°, considering the voltage with reference to the current

Locking Signal check

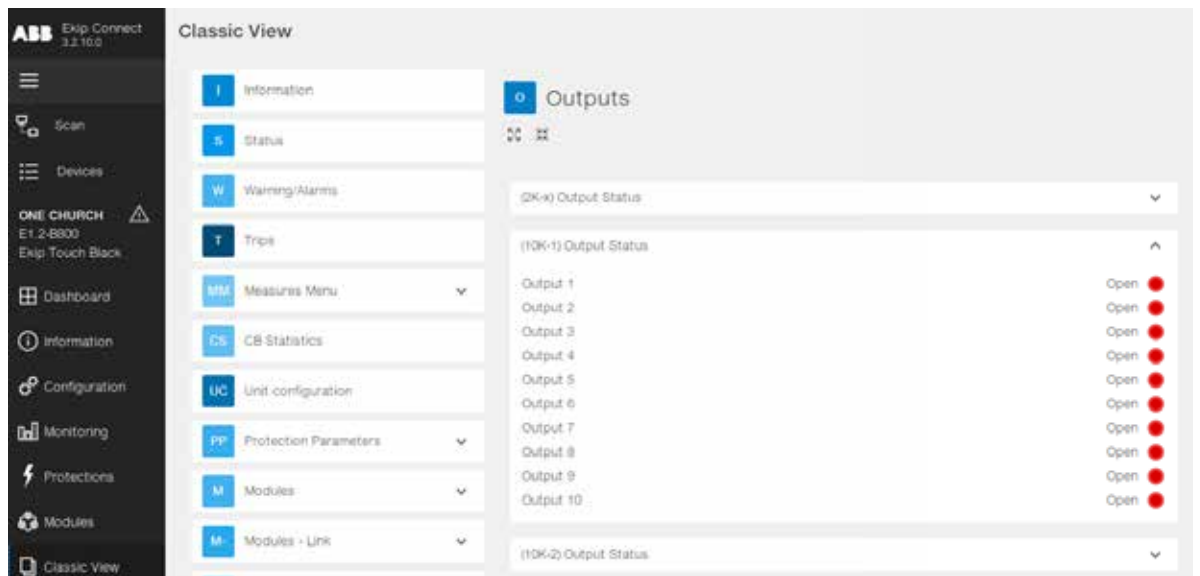
Check the Signalling 4K or Signalling 10k-1 Outputs status to make sure, in all the connected release units, that the state of the sent and received messages is correct.

In the case of Ekip Signalling 4k, you can see this directly on the device without using Ekip Connect, by checking the status of its leds.

Each output refers to the messages programmed in in the section on Ekip Signalling 4k.

In the case of Ekip Signalling 10k-1:

1. Classic View
2. Programmable Status and Outputs
3. Outputs
4. (10K-1) Output Status



Each output refers to the messages programmed in the section on Ekip Signalling 10k-1.

To reset the Ekip Signalling 4k and 10k-1 contacts click on Signal Reset from the classic view or press and hold the i button on the HMI for at least 5 sec.