

White paper - Preliminary

# Emax 2, all-in-one innovation

## Adaptive protections



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# Emax 2

## Adaptive protections

### General introduction

User's plants can work as a LV Microgrid thanks to the energy produced by renewable and local power sources, in particular as a consequence of lacking of the Utility power supply, e.g. due to a fault on the MV voltage side.

In order to still guarantee a high level of selectivity and continuity of service, it is important to take into account the variation of the short circuit power when moving from on-grid to off-grid operation. Indeed, in the former case the fault current on a Microgrid feeder is supplied by the Utility, while in the latter case, the fault current is "only" supplied by the local generation.

As a result, it is desirable that the several protection thresholds of the circuit-breakers can be automatically changed during the transition to the islanding condition.

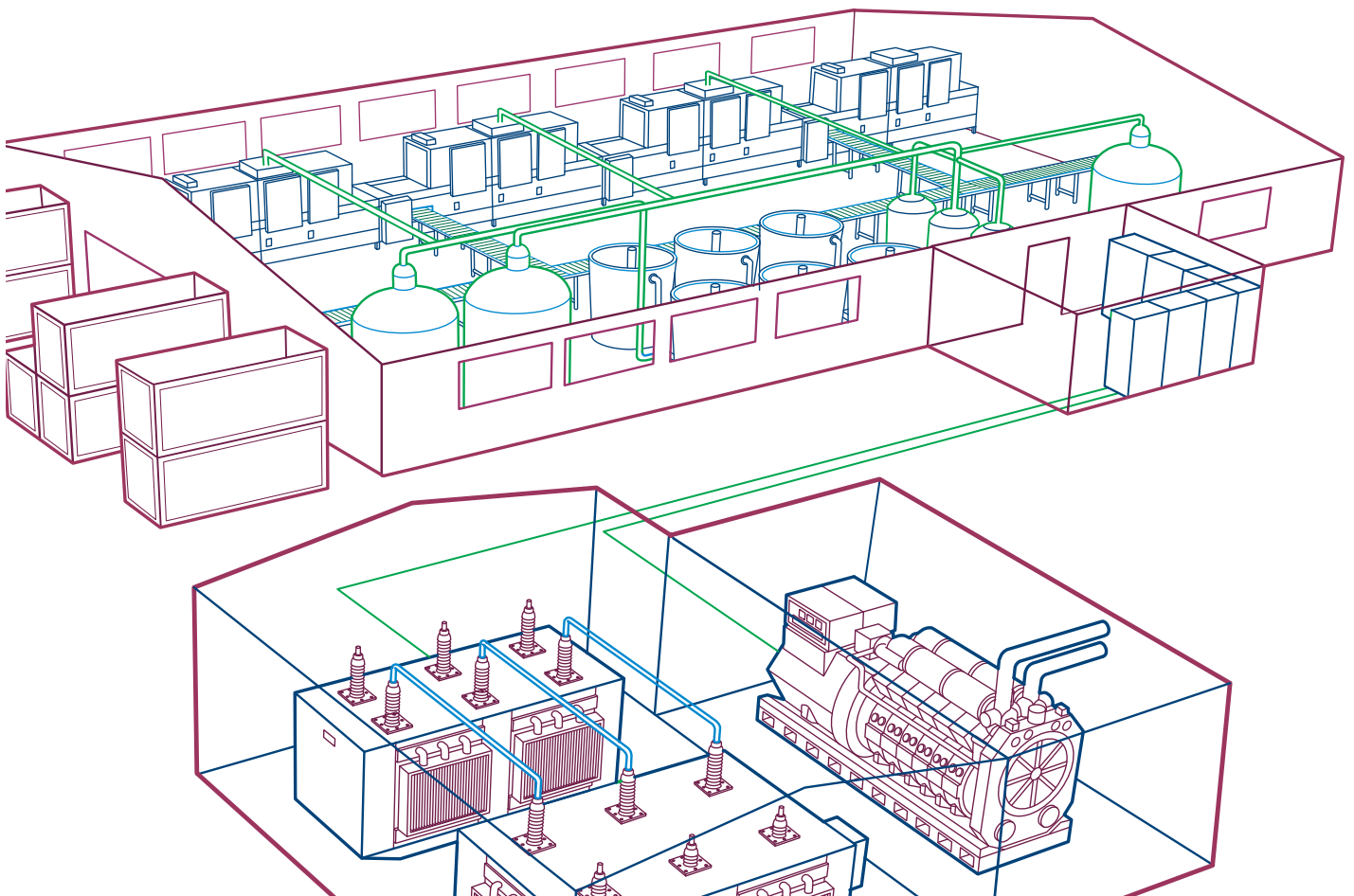
### Emax 2 solution

Emax 2 all-in-one innovation improves efficiency in any electrical plant thanks to its unique features. It offers the highest short circuit performance in the most compact size and thanks to its intelligent protection units Emax 2 adapts automatically the protection thresholds according to Microgrid scenarios.

### Benefits

Thanks to Emax 2 it is possible to have two sets of settings implemented in a single device. As a result, the following benefits are guaranteed:

- Overcurrent protection and selectivity 100% guaranteed both in grid-connected and islanded condition
- Reduction of redundant components inside the switchboard
- Ease of use, thanks to the Ekip Connect software which allows an immediate and intuitive commissioning phase.



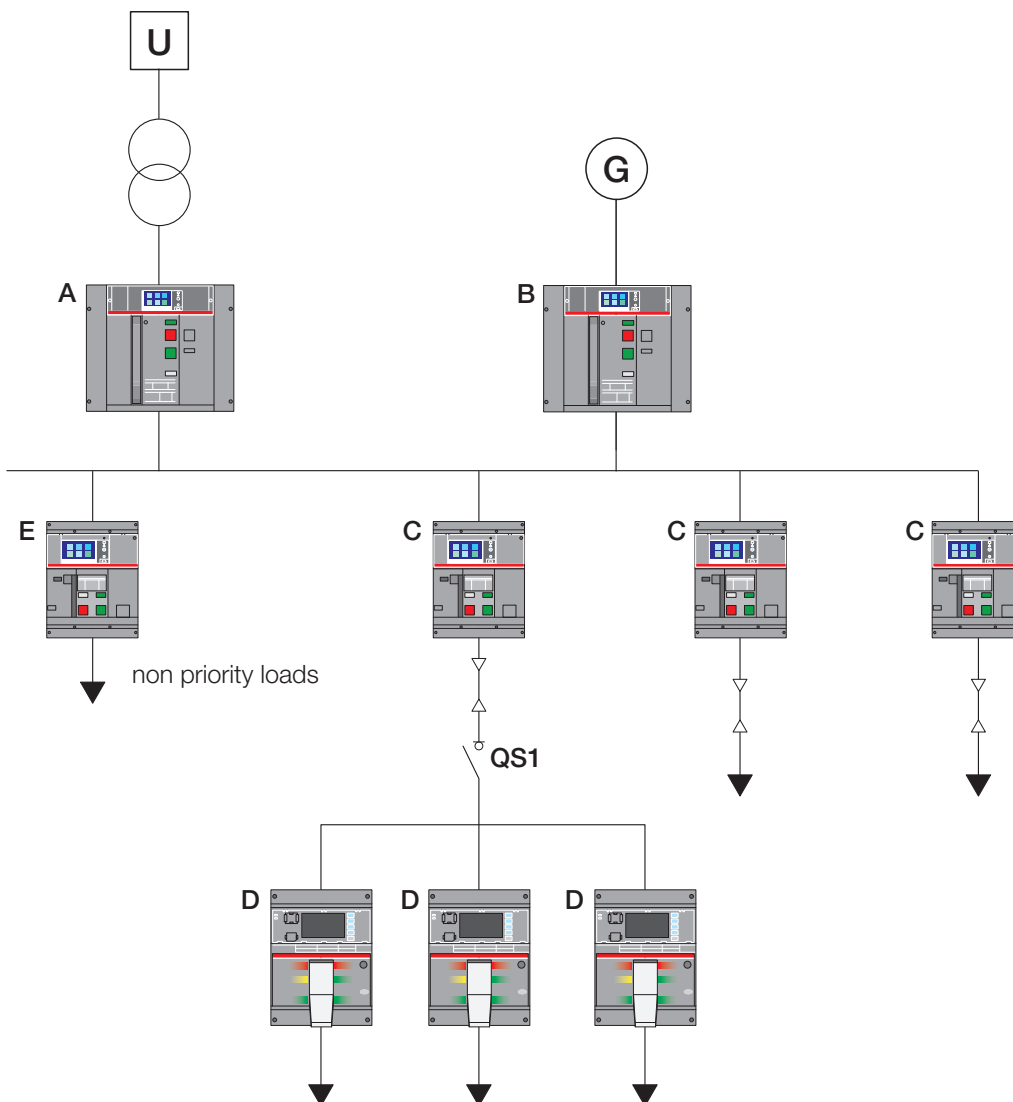
## Application scenario

We have a plant connected to the MV Utility by means of a MV/LV transformer. If the Utility shuts down, the plant will become a Microgrid supplied by the local generator G (Figure 1), which will feed the priority loads by using the loads shedding feature of Emax 2.

Now we analyze what happen in the plant in case of:

- Grid-connected condition
- Islanding condition without Adaptive protections
- Islanding condition with Adaptive protections
- Return to grid-connected condition

Figure 1



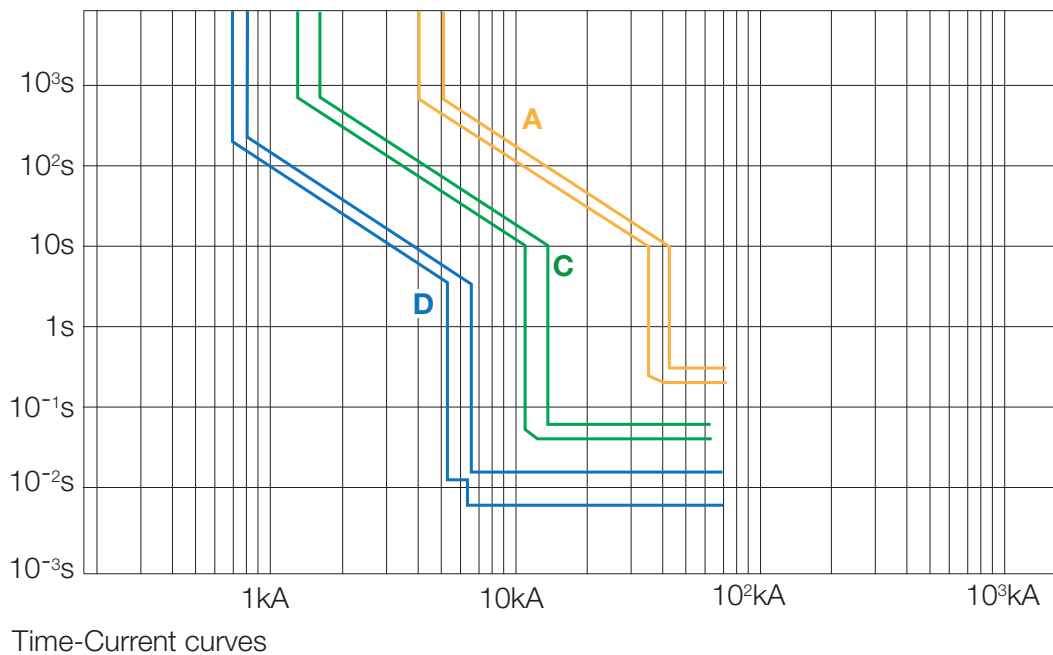
### Grid-connected condition

During this operating condition, the generator G is disconnected. With reference to Figure 2:

- Circuit breaker A is closed
- Circuit breaker B is open
- Circuit breakers C are closed
- Circuit breakers D are closed
- Circuit breaker E is closed
- Switch disconnector QS2 is closed
- All loads supplied

The circuit breakers C are programmed to be selectively coordinated with the upstream main circuit breaker A, supplied by the Utility, and the downstream load circuit breakers D. Figure 2 shows the time-current curves of the installation in grid-connected conditions. As it can be seen, the value set allows no intersection among the curves.

Figure 2



### Islanding condition without Adaptive protections

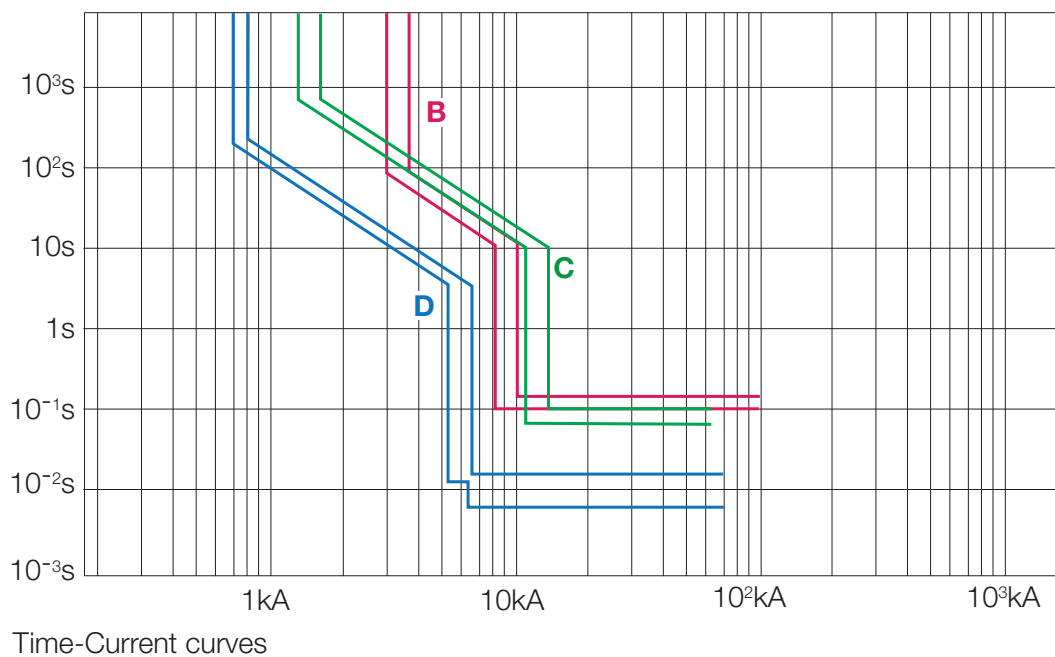
By switching from the Utility power source to the local power source by means of the ATS function, circuit breaker B now becomes the upstream main circuit breaker on the supply side of circuit breakers C.

With reference to Figure 3:

- Circuit breaker A is open
- Circuit breaker B is closed
- Circuit breakers C are closed
- Circuit breakers D are closed
- Circuit breaker E is open
- Switch disconnector QS2 is closed
- No priority loads disconnected thanks to the Load Shedding feature embedded in the trip unit of the circuit breaker B

Figure 3 shows the situation in which, after switching, the power is supplied by the backup generator through circuit breaker B. If the settings of circuit breakers C are not modified, there will be no selectivity with the generator circuit breaker B.

**Figure 3**



### Islanding condition with Adaptive protections

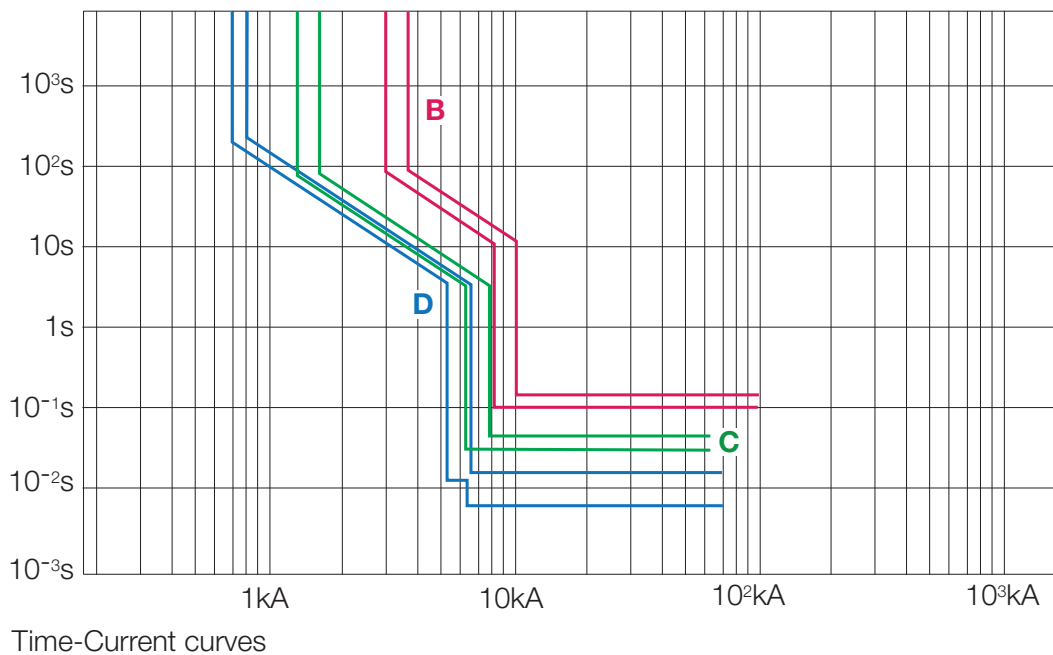
In order to still guarantee selectivity, an alternate set of protection settings can be enabled automatically due to this event. The alternate settings can be optimized for the characteristics of the local generator which ensures the incoming supply and load side circuit breakers will remain selectively coordinated.

With reference to Figure 4:

- Circuit breaker A is open
- Circuit breaker B is closed
- Circuit breakers C are closed and the protection thresholds move automatically to “Set B”
- Circuit breakers D are closed
- Circuit breaker E is open
- Switch disconnector QS2 is closed
- No priority loads disconnected thanks to the Load Shedding feature embedded in the trip unit of the circuit breaker B

Figure 4 shows how it is possible to switch to a set of parameters which guarantees selective coordination between circuit breakers C and B by means of the “Adaptive protections” function embedded in the trip unit of the circuit breaker C.

Figure 4





### Return to grid-connected condition

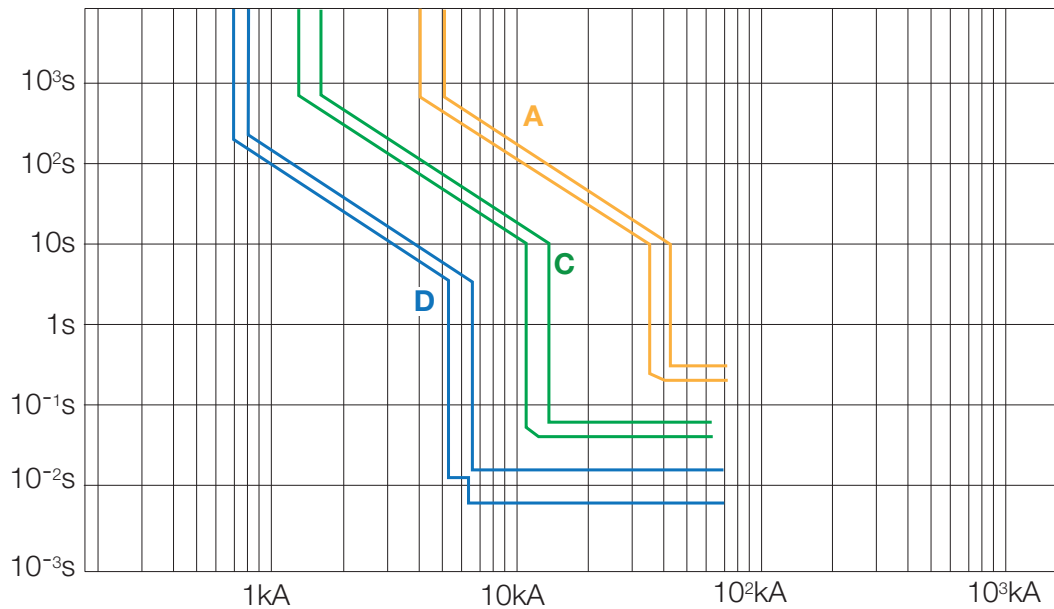
Thanks to ATS, there is an automatic reclosing of circuit breaker A and opening of circuit breaker B.

With reference to Figure 5:

- Circuit breaker A is closed
- Circuit breaker B is open
- Circuit breakers C are closed and the protection threshold get back automatically to "Set A"
- Circuit breakers D are closed
- Circuit breaker E is closed
- Switch disconnector QS2 is closed
- All loads supplied.

Figure 5 shows that when restoring to "Set A", circuit breaker C returns to be coordinated with the main circuit breaker A.

Figure 5



Time-Current curves

# Emax 2

## Adaptive protections

### How it works

The adaptive protections embedded in the Ekip Hi-Touch or G Hi-Touch trip unit of Emax 2 can be used effectively to fulfill the previous target, since it is possible to program two different sets of parameters and, by means of an external command, to switch automatically from one set to the other. The alternate settings can be optimized for the characteristics of the emergency generator so as to still maintain the coordination among the downstream circuit-breakers on priority load feeders themselves, and the circuit-breakers with the generator circuit-breaker.

### Activation of Adaptive protections

Activation of the alternate set of protection parameters on the Emax 2 Ekip Hi-Touch trip unit can be managed in four ways:

- Remotely, by using a digital input of the Ekip Signalling module;
- Remotely, by one of the seven Ekip Communication protocols and the relevant Ekip Com module:
  - Modbus RS-485
  - Profibus
  - DeviceNet
  - Modbus TCP
  - Profinet
  - EtherNet/IP
  - IEC61850
- Locally, directly from the Ekip Hi-Touch display;
- By a settable internal time, after circuit breaker closing

As a consequence, the Ekip display unit will show an A or a B according to which set is active.

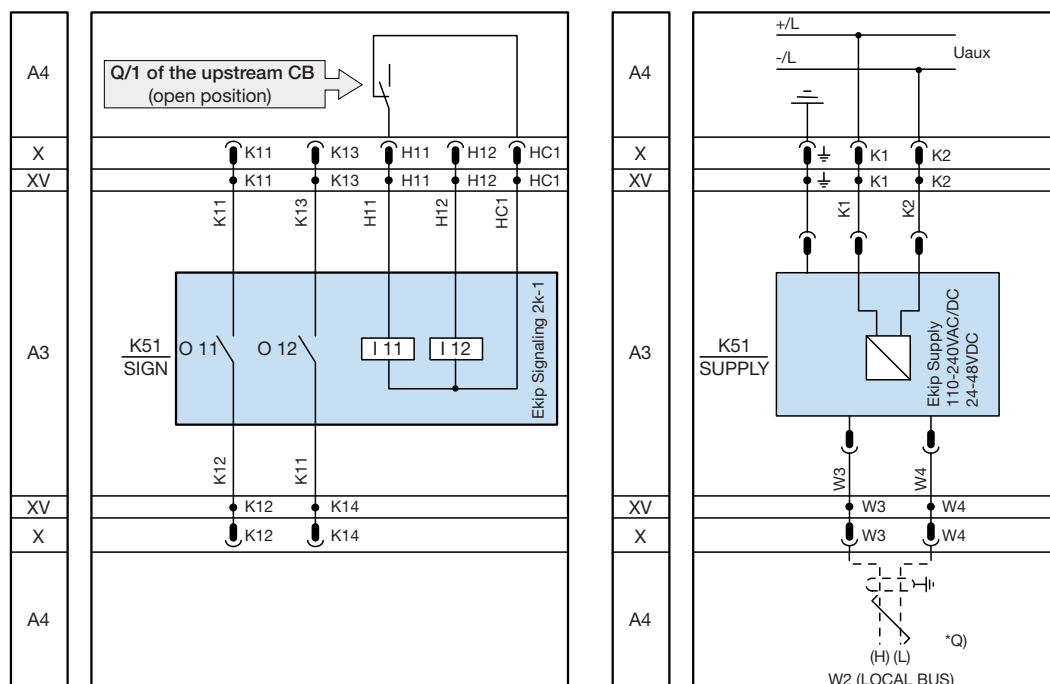
This paper specifically illustrates how to activate the adaptive protections by using a remotely activation via Ekip Signalling module and by programming on Ekip Connect software.

### Wiring

The digital input that will be used on the ABB Emax 2 Ekip Signalling 2k module is located on terminals H11 and HC1 of the circuit breaker and should be wired in series with a status contact Q/1 of the main circuit breaker installed immediately downstream of the MV/LV transformer. (Figure 6).

*Note: The Ekip Signalling 2k module requires the presence of an Ekip Supply module in the first available slot on the right of the circuit-breaker terminal box. The Ekip Supply module will power the digital input of the Signalling module which will trigger the protective parameters from Set A to Set B.*

Figure 6



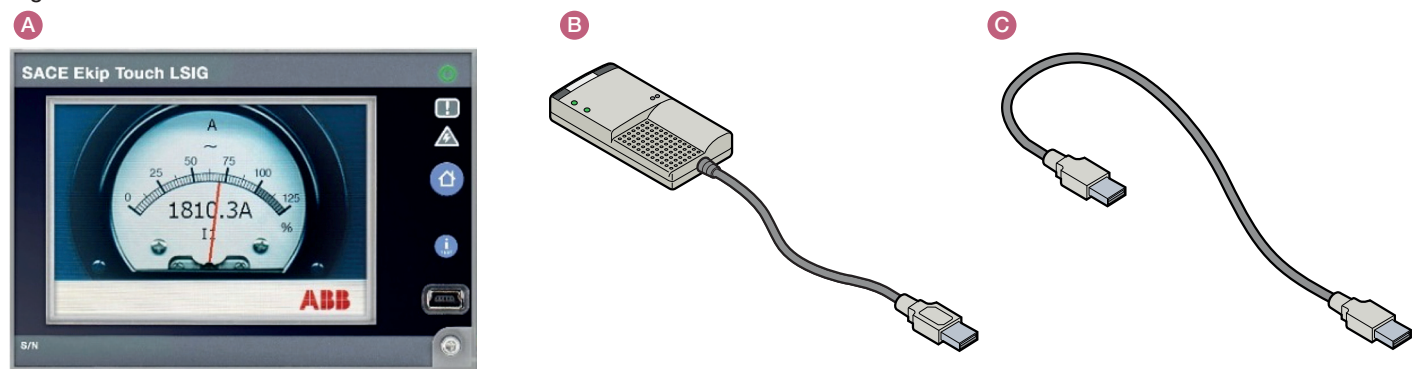
### Programming on Ekip Connect

Emax 2 Ekip Hi-Touch or G Hi-Touch trip units are very sophisticated and have many advanced features; in order to function properly it has to be programmed in a specific way to enable the desired functions. In this section we will outline the steps needed to complete the programming to enable adaptive protections.

1. Launch the free Ekip Connect software on the customer laptop.
2. Connect one side of the micro USB cable **C** to the Ekip T&P module **B** and the other side to the Ekip Touch trip unit **A**. Connect the USB connection on the Ekip T&P module **B** to the customer laptop.

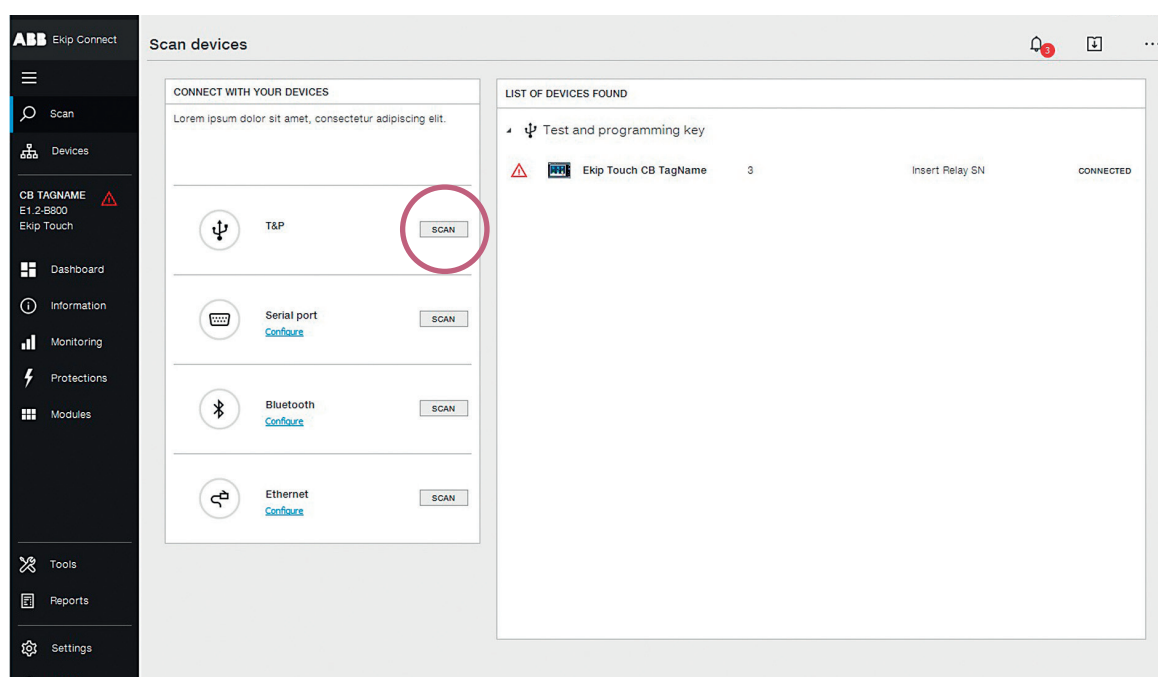
Proper connection is made when the green power led is on . Active communication is indicated via the orange transmission indicator  blinking on the Ekip T&P module **B**.

Figure 7



3. It may be necessary to scan for the trip unit via the T&P before the device appears in the Ekip Connect software (Figure 8).

Figure 8

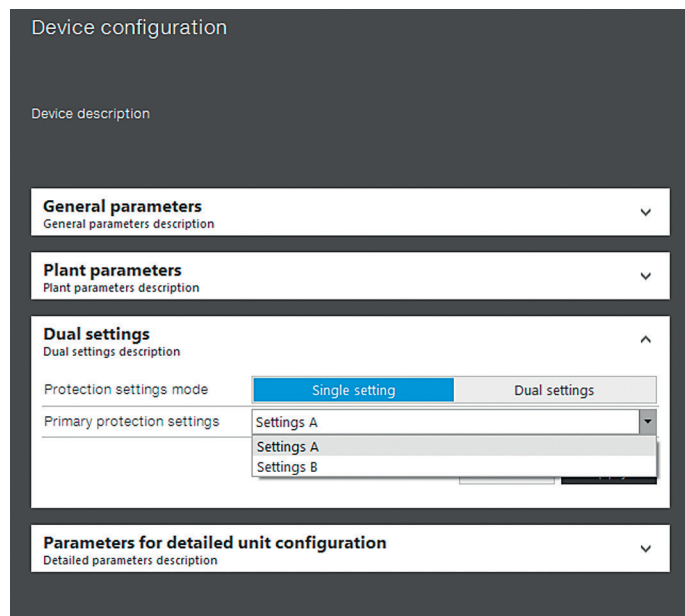


# Emax 2

## Adaptive protections

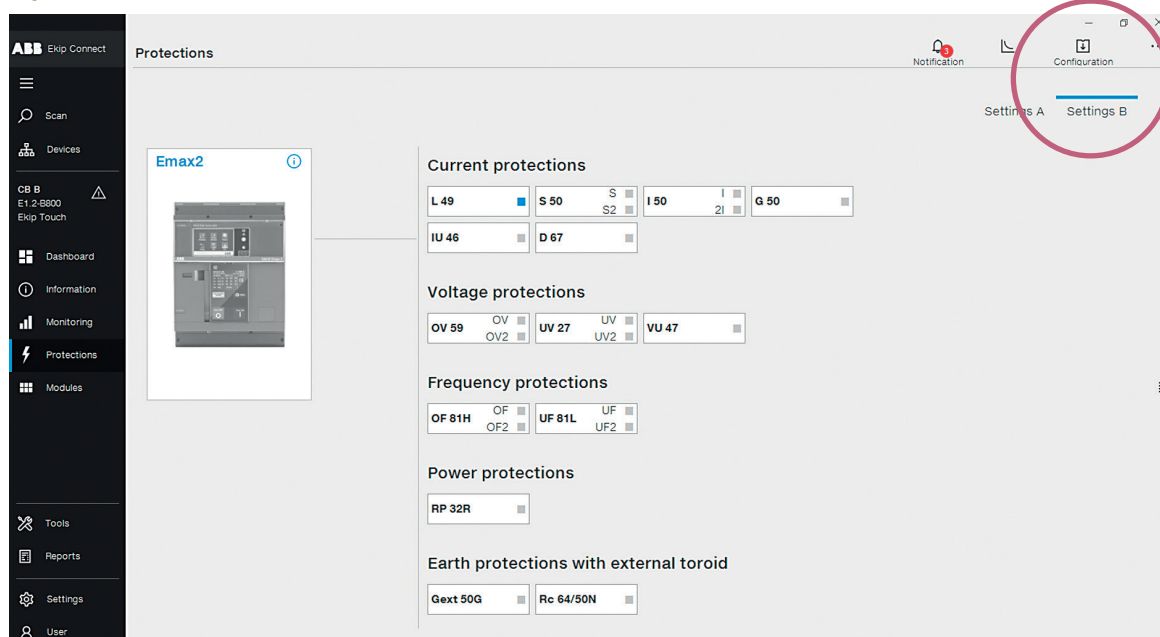
- Turn on the Adaptive protections by selecting “Device configuration”. Then under “Dual Settings” Tab, select “Dual Settings” in the “Protection settings mode” (Figure 9).
- Select “Settings A” from the drop down menu in “Primary protection settings”.
- Now click on “Apply” to save your changes.

Figure 9



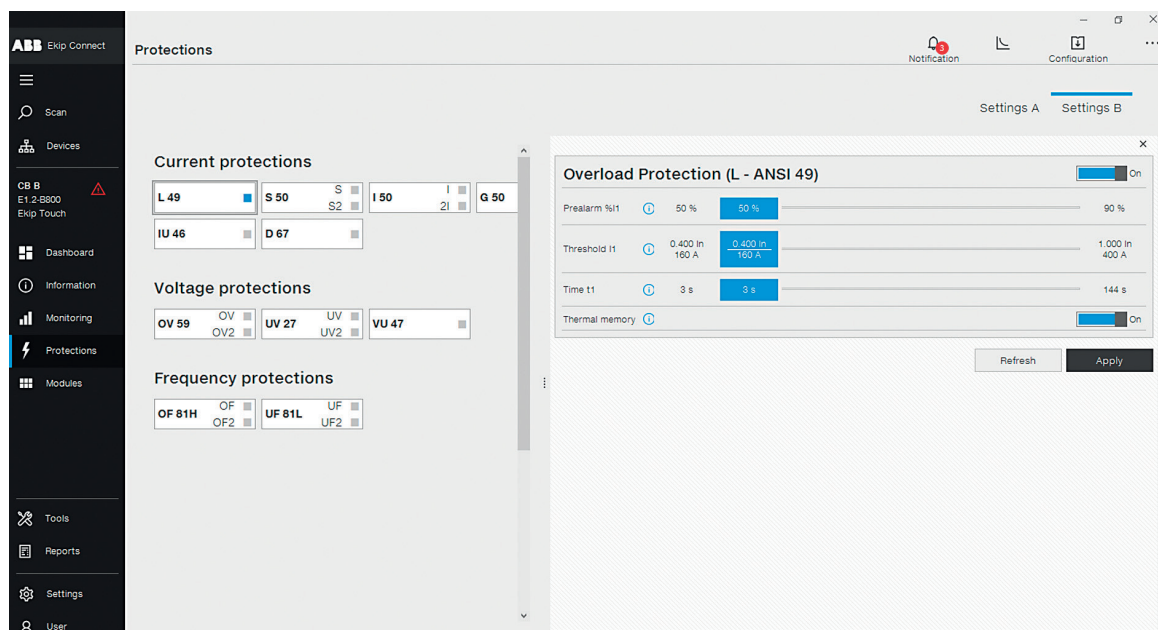
- Now click on “Protections” in the left hand column and then click on “Settings B” (Figure 10).

Figure 10



8. Enter the set B programming parameters in “Settings B” (Figure 11).
9. Click on “Apply” to save the changes in the protections.

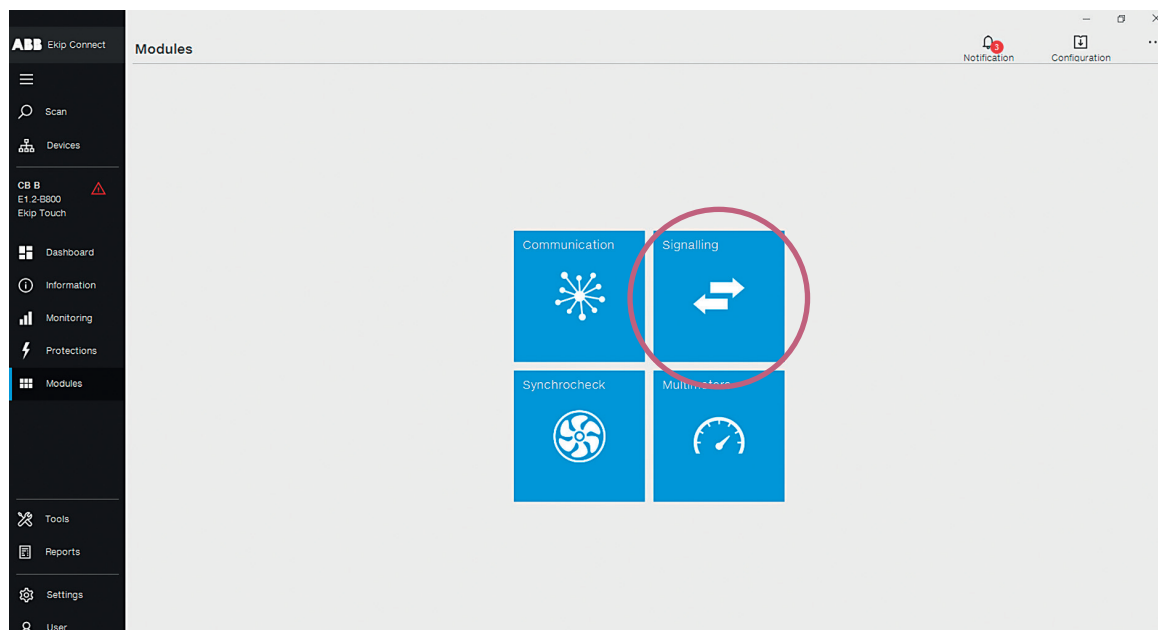
Figure 11



Note: The settings should be determined by the customer. The circuit-breaker is delivered with factory default settings.

10. The next step is to program the Signalling input of the Ekip Signalling 2K-1 module to activate the Adaptive protections and switch between the Set A and Set B programming parameters. Select “Modules” in the menu in the left hand column and click on the “Signalling” button (Figure 12).

Figure 12

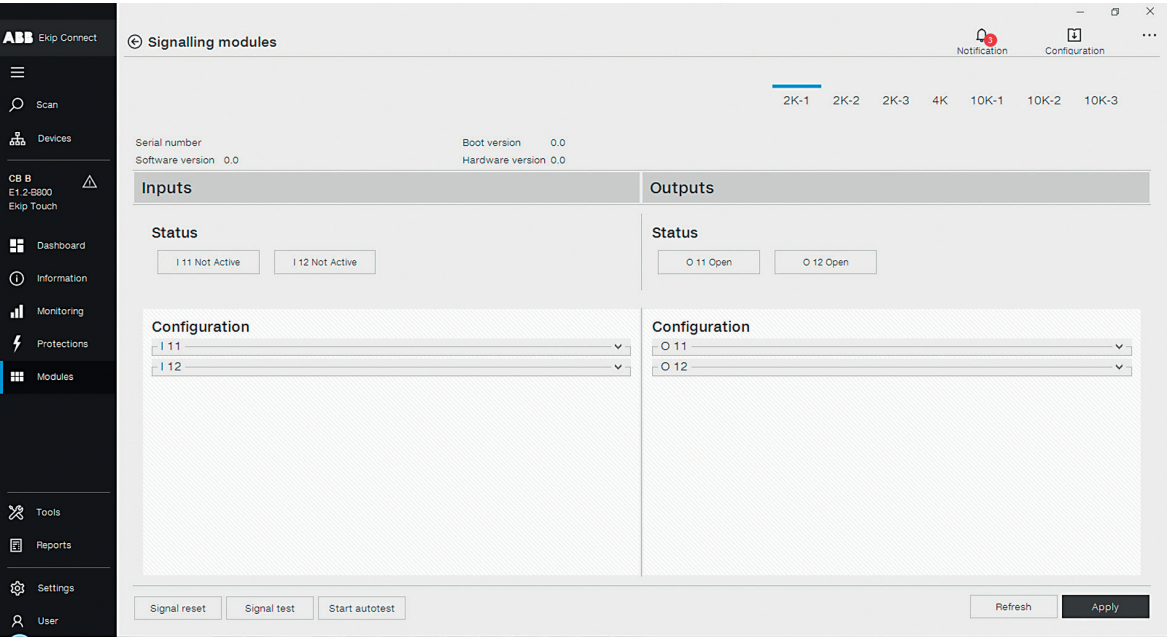


# Emax 2

## Adaptive protections

11. The next step is to program either the input I11 or I12 (where there is the wired connection). Select the input required from the drop down menu in “Configuration” (Figure 13).

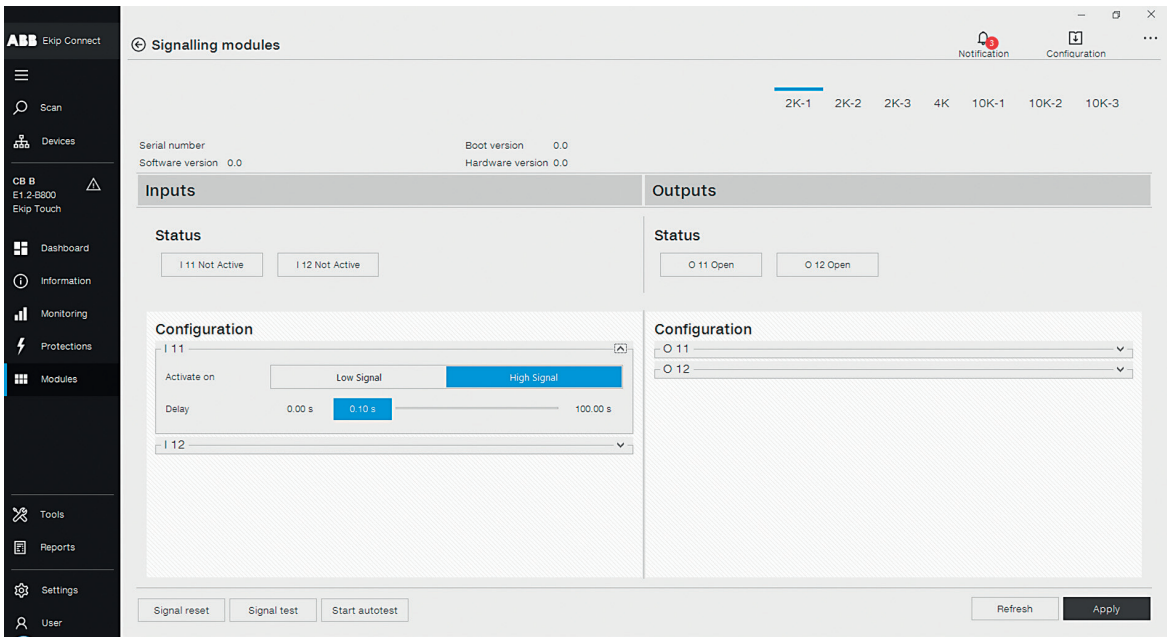
Figure 13



12. Select “High signal” and the delay wanted by means of the slider (Figure 14).

13. Now click on “Apply” to make the changes effective.

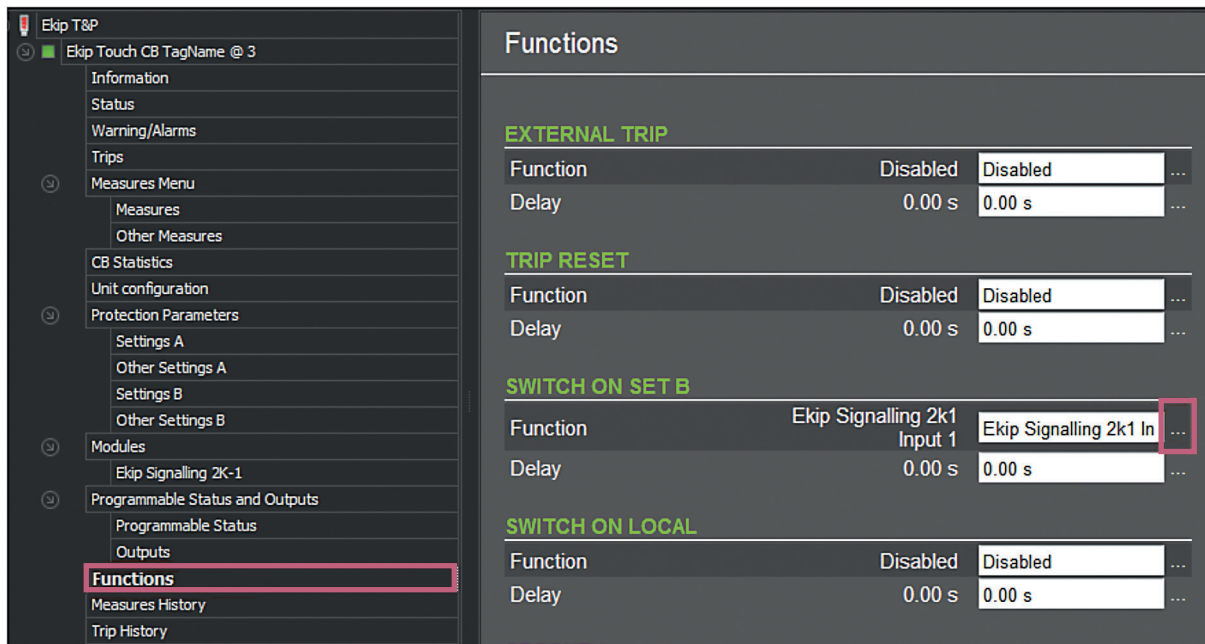
Figure 14





14. Then, choose “Functions” in the left hand column and, under “Switch to Set B”, change the “Function” to “trigger type” “Ekip Signalling 2K1 input 1”. Do this by clicking on the three dots next to the white box corresponding to the “Function” option and the “Simple trigger” window will pop up. (Figure 15).

Figure 15

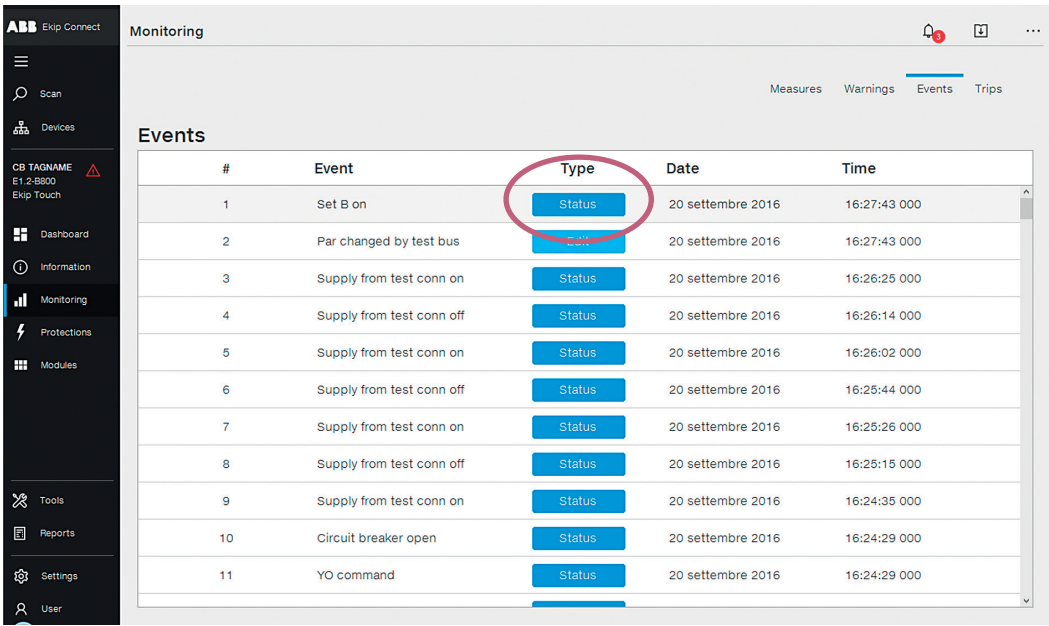


Adaptive protections verification

1. The default protective parameter set is “Set A”. When the Q/1 auxiliary contact of the upstream circuit-breaker changes status, the digital input variation of the Signalling module will cause the protective parameter set to change to “Set B”. The display of the trip unit will indicate if Set A or Set B is active by the presence of one of the following symbols.
- **A** o **B** if the **Dual Set** function is enabled (see the **Setting** menu), the letter identifies the active configuration.

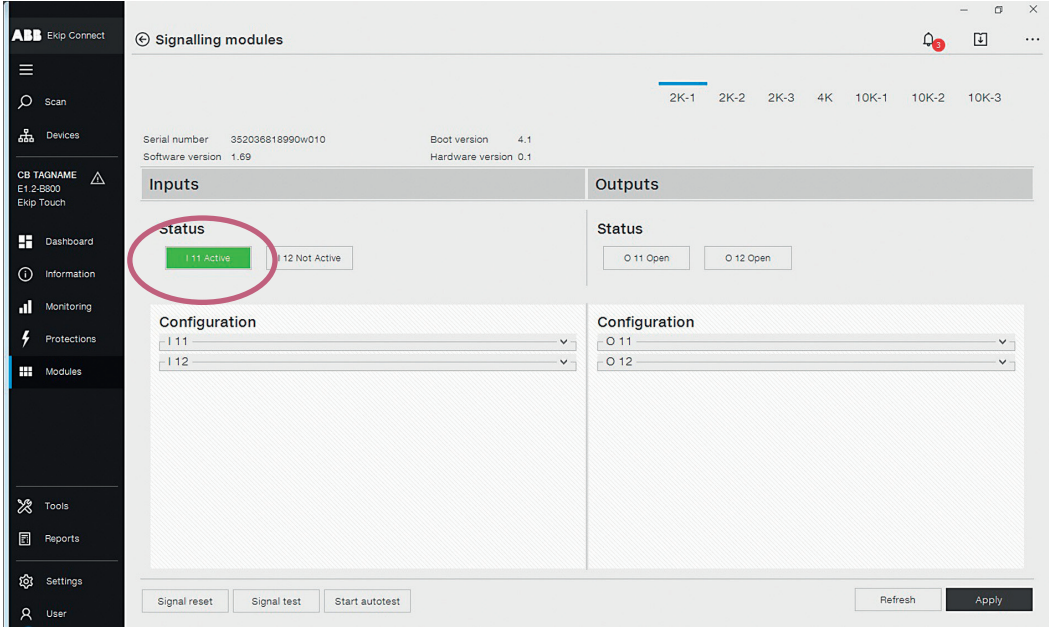
You can also verify this by looking for the “Set B ON” message, in the “Event Log” (Figure 16).

Figure 16



2. The Signalling module digital input can be checked to see if it is active by checking the Inputs status in “Signalling Modules”. “I11 Active” appears green when the “Q/1” changes status (Figure 17).

Figure 17





## Equipment Selection

To use the adaptive protections successfully in the scenario described above, the following devices have to be selected:

- ABB Emax 2 equipped with Ekip Hi-Touch or G Hi-Touch trip unit
- Free Ekip Connect Software (it can be downloaded from ABB website)
- Ekip Signalling 2k module
- Ekip Supply module
- Ekip Test & Programming unit.

### Example of selection:

|                                      |              |
|--------------------------------------|--------------|
| E1.2N 1600 Ekip Hi-Touch LSIG 4p     | 1SDA072869R1 |
| Ekip Connect Software                | -            |
| Ekip Signalling 2K-1                 | 1SDA074167R1 |
| Ekip Supply 24-48V DC                | 1SDA074173R1 |
| Ekip T&P – Programming and Test unit | 1SDA066989R1 |





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