

White paper - Preliminary

Emax 2, all-in-one innovation Adaptive protections



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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.

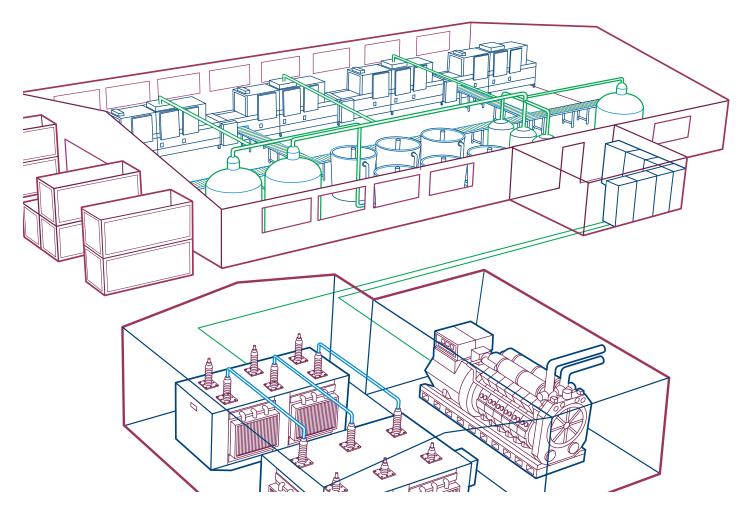
Emax 2 solution

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.

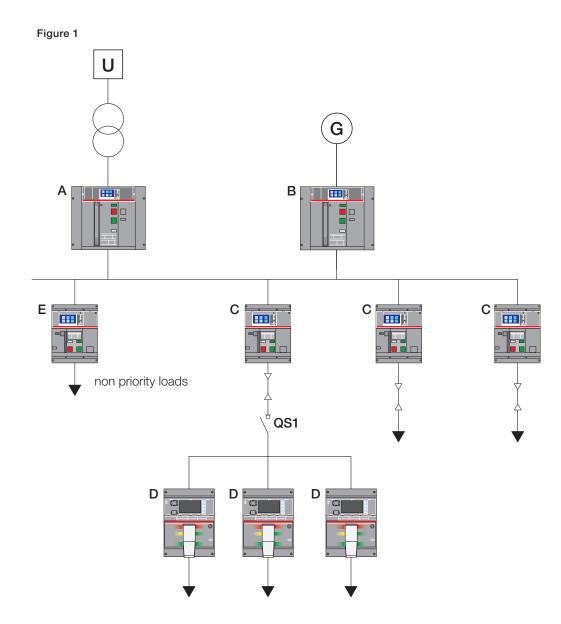


Application scenario

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



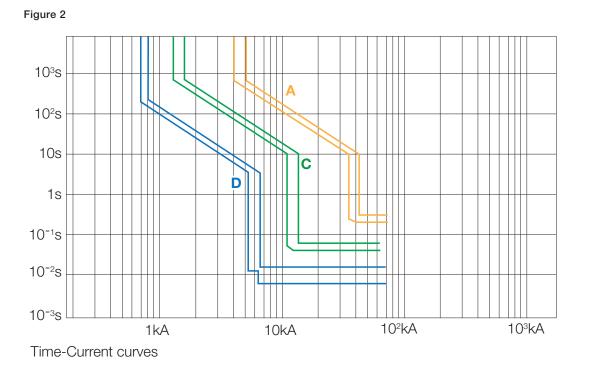
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Grid-connected condition

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.



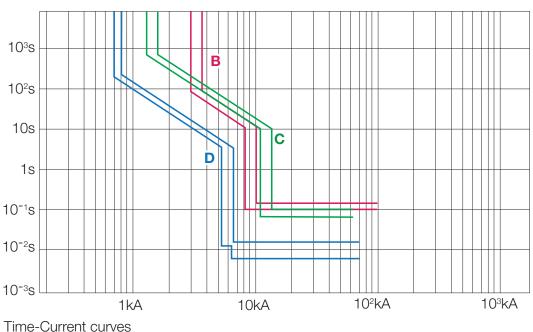
Islanding condition without Adaptive protections

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.



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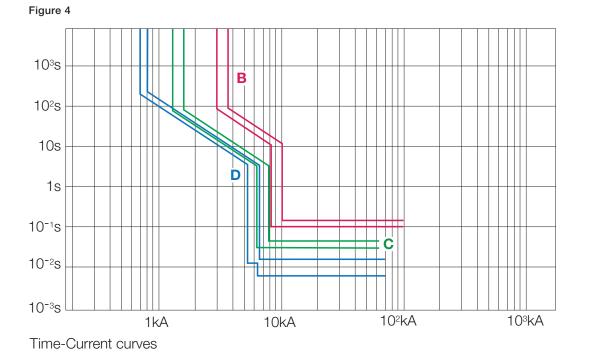
Islanding condition with Adaptive protections

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.



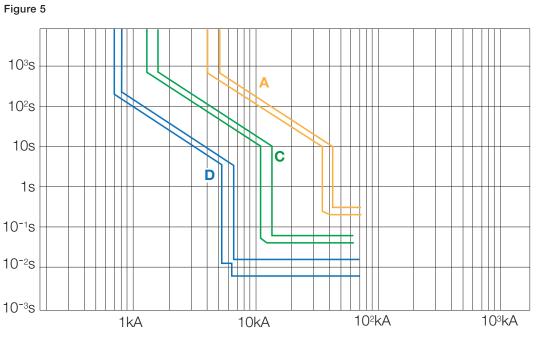
Return to grid-connected condition

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.



Time-Current curves

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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.

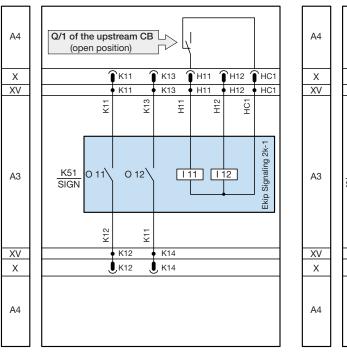
This paper specifically illustrates how to activate the adaptive protections by using a remotely activation via Ekip Signalling module and by programming on Ekip Connect software.

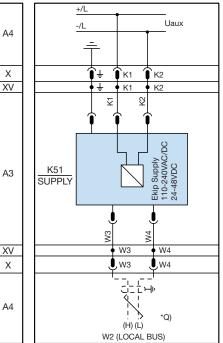
Wiring

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 down-stream 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.





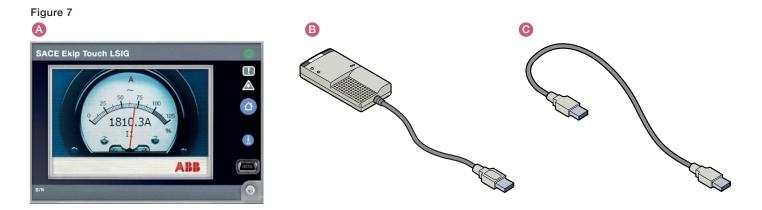


Programming on Ekip Connect

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 \bigcirc . Active communication is indicated via the orange transmission indicator blinking on the Ekip T&P module **B**.



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

ABB Ekip Connect	Scan devices		€
≡	CONNECT WITH YOUR DEVICES	LIST OF DEVICES FOUND	
오 Scan 샮 Devices	Lorem ipsum dolor sit amet, consectetur adipiscing elit.		
CB TAGNAME A	ф тар всам	Ekip Touch CB TagName 3 Insert Relay SN	CONNECTED
Dashboard Information Monitoring	Serial port SCAN		
ProtectionsModules	Bluetooth SCAN		
	Conformet SCAN		
X Tools			
Reports			
ស្រ៊ៃ Settings			

Emax 2 Adaptive protections

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

Figure 9

Device configuration			
Device description			
General parameters General parameters description			~
Plant parameters Plant parameters description			~
Dual settings			^
Dual settings description			
Dual settings description Protection settings mode	Single setting	Dual settings	
	Single setting Settings A	Dual settings	•
Protection settings mode		Dual settings	•
Protection settings mode	Settings A Settings A	Dual settings	
Protection settings mode	Settings A Settings A Settings B	Dual settings	~

7. Now click on "Protections" in the left hand column and then click on "Settings B" (Figure 10).

-			
ABB Ekip Connect	Protections		- © ×
O Scan			Settings A Settings B
品 Devices	Emax2 i	Current protections	
СВ В Д E1.2-8800 Ekip Touch		L 49 S 50 S 150 I C 50	
Dashboard		IU 46 D 67	
(i) Information		Voltage protections	
Monitoring		OV 59 OV UV 27 UV UV 27 UV UV 27 UV UV 27 UV	
Protections			
Modules		Frequency protections	1
		OF 81H OF UF 81L UF	
		Power protections	
X Tools		RP 32R	
Reports		Earth protections with external toroid	
ស្រ៊ំ Settings		Gext 50G 🔳 Rc 64/50N 🔳	
A User			

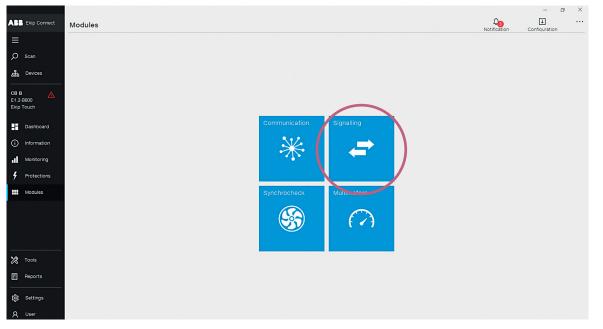
- 8. Enter the set B programming parameters in "Settings B" (Figure 11).
- 9. Click on "Apply" to save the changes in the protections.

Figure 11

				- a ×
ABB Ekip Connect	Protections		Q3 └∟ Notification	Configuration
≡				
O Scan			Settings A	Settings B
品 Devices	Current protections			×
СВ В		Overload Protection (L - ANSI 49)		On
E1.2-B800 Ekip Touch	L 49 S 50 S 150 G 50	Prealarm %I1 ① 50 % 50 %		90 %
Dashboard	IU 46 D 67 D	Threshold I1 0 0.400 ln 0.400 ln 160 A		1.000 In 400 A
(i) Information	Voltage protections	Time t1 () 3 s 3 s		144 s
Monitoring	OV 59 OV UV 27 UV UV 27 UV 2	Thermal memory ()		On
Frotections			Refresh	Apply
Modules	Frequency protections	1		
	OF 81H OF 2 UF 81L UF UF UF 2			
🔀 Tools				
Reports				
ស្ត្រិ Settings				
A User	×			

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).



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).



ABB Ekip Connect	ⓒ Signalling modules	− σ × Co Notification Configuration
Scan	Serial number Boot version 0.0 Software version 0.0 Hardware version 0.0	2K-1 2K-2 2K-3 4K 10K-1 10K-2 10K-3
CB B A E1.2-6800 Ekip Touch	Inputs	Outputs
Dashboard	Status 111 Not Active 112 Not Active	Status O 11 Open O 12 Open
Monitoring	Configuration	Configuration
 Protections Modules 	- l 11- - l 12-	v 011 v 012 v
X Tools		
Reports		
ති Settings ද User	Signal reset Signal test Start autotest	Refresh Apply

- 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.

	€ Signalling modules		Q	
=			Notificati	ion Configuration
O Scan		2K-1	2K-2 2K-3 4K 10K-	-1 10K-2 10K-3
品 Devices	Serial number Boot ve Software version 0.0 Hardwa	n 0.0 version 0.0		
CB B 🔬	Inputs	Outputs		
Dashboard	Status 111 Not Active 112 Not Active	Status 0 11 Open 0 12 O	Dpen	
Monitoring	Configuration	Configuration		
Protections	-111	O 11		~
Modules	Activate on Low Signal	igh Signal		~ ~
	Delay 0.00 s 0.10 s	100.00 s		
	- 12	~		
X Tools				
Reports				
ស្ត្រិ Settings		I		
0	Signal reset Signal test Start autotest			Refresh Apply

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).



Ekip		Functions		
	Ekip Touch CB TagName @ 3	I direttoris		
	Information			
	Status			
	Warning/Alarms	EXTERNAL TRIP		
	Trips	Function	Disabled	Disabled
	Measures Menu		0.00 s	
	Measures	Delay	0.00 S	0.00 s
	Other Measures			
	CB Statistics	TRIP RESET		
	Unit configuration	Function	Disabled	Disabled
	Protection Parameters	Delay	0.00 s	0.00 s
	Settings A	Delay	0.00 S	0.00 s
	Other Settings A			
	Settings B	SWITCH ON SET B		
	Other Settings B	Function	Ekip Signalling 2k1	Ekip Signalling 2k1 In
	Modules		Input 1	
	Ekip Signalling 2K-1	Delay	0.00 s	0.00 s
	Programmable Status and Outputs			
	Programmable Status	SWITCH ON LOCAL		
	Outputs	Function	Disabled	Disabled
	Functions			
	Measures History	Delay	0.00 s	0.00 s
	Trip History			

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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.



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

Ekip Connect Monito	oring				4 <mark>0</mark> 🗎
Scan				Measures	Warnings Events Trips
Devices	nts				
TAGNAME A	#	Event	Туре	Date	Time
Touch	1	Set B on	Status	20 settembre 2016	16:27:43 000
Dashboard	2	Par changed by test bus		20 settembre 2016	16:27:43 000
Information	3	Supply from test conn on	Status	20 settembre 2016	16:26:25 000
Monitoring	4	Supply from test conn off	Status	20 settembre 2016	16:26:14 000
Protections	5	Supply from test conn on	Status	20 settembre 2016	16:26:02 000
	6	Supply from test conn off	Status	20 settembre 2016	16:25:44 000
	7	Supply from test conn on	Status	20 settembre 2016	16:25:26 000
	8	Supply from test conn off	Status	20 settembre 2016	16:25:15 000
Tools	9	Supply from test conn on	Status	20 settembre 2016	16:24:35 000
Reports	10	Circuit breaker open	Status	20 settembre 2016	16:24:29 000
Settings	11	YO command	Status	20 settembre 2016	16:24:29 000

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).

ABB Ekip Connect	ⓒ Signalling modules	– σ × Д <mark>а</mark> ІІ ··
Scan	Serial number 352036818990w010 Boot version 4.1 Software version 1.69 Hardware version 0.1	2K-1 2K-2 2K-3 4K 10K-1 10K-2 10K-3
CB TAGNAME A E1.2-B800 Ekip Touch	Inputs	Outputs
Dashboard	11 Active 112 Not Active	Status O 11 Open O 12 Open
Monitoring	Configuration	Configuration
Protections		0 11
Modules	r112v_	© 12 ~~ ~
🎗 Tools		
Reports		
ැලි Settings Q User	Signal reset Signal test Start autotest	Refresh Apply

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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