

White paper - Preliminary

Emax 2, all-in-one innovation Embedded ATS system

Emax 2

Embedded ATS system

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Embedded ATS system

General introduction

ABB's embedded ATS system makes it easy to monitor, control and communicate in power networks

Over the past few years, service continuity in low voltage electrical installations has played an increasingly leading role. In actual fact, this requirement is a fundamental characteristic if economically and functionally efficient installations are to be created. A system able to switch the supply from the main line to an emergency line reduces problems caused by faulty conditions in the public network to the minimum. These operations, commonly known as “automatic switching”, comprise sequences that automatically control the installation components (the circuit-breakers play a fundamental role) without interventions from the operator. To guarantee that power is supplied to the loads, a fundamental requirement in an installation is to have a redundancy in supply sources type N+1, usually consisting of a transformer and emergency generator (or, as an alternative, a second transformer).

An installation with an automatic switching system:

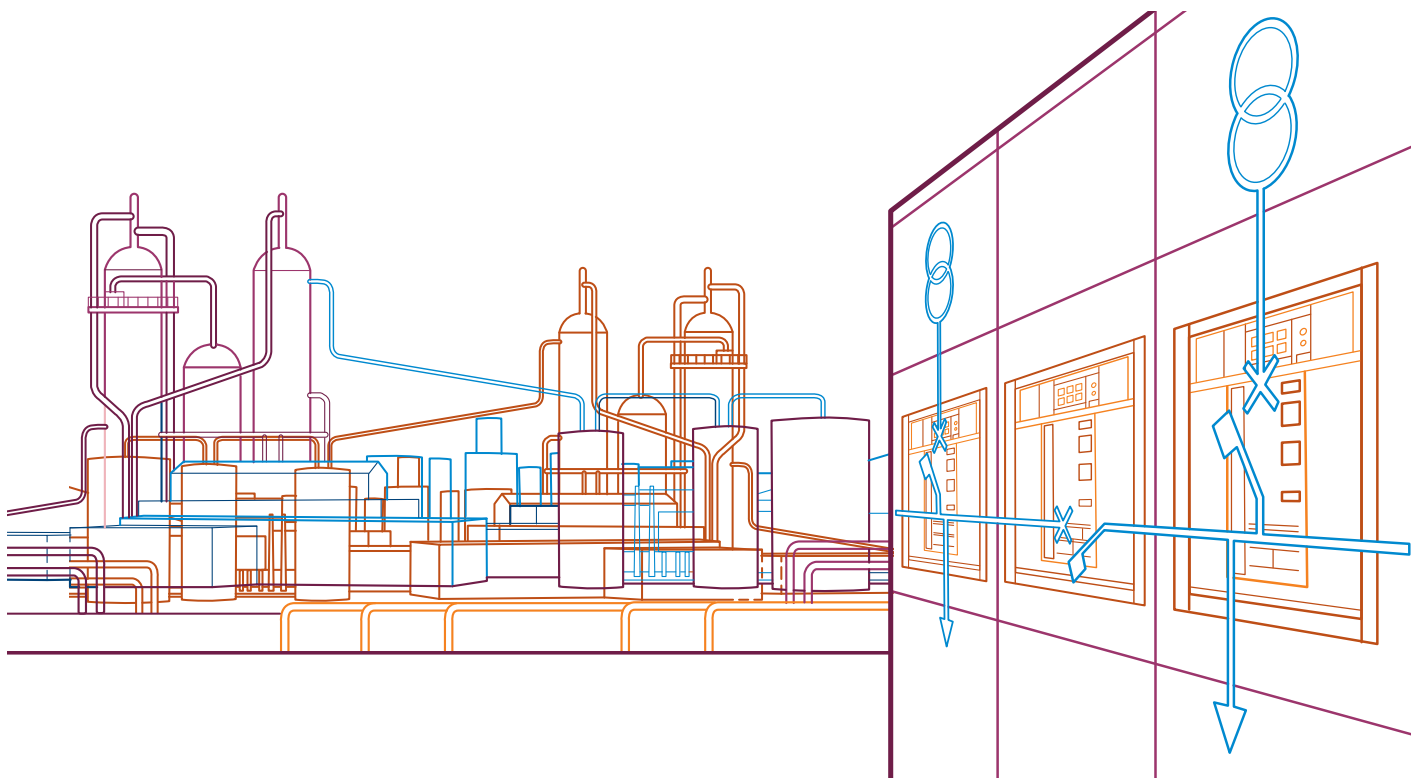
- Maximizes the service continuity of any process
- provides a power supply with high quality voltage if the main network is out of service
- manages microgrids connection and disconnection from main grid.
- reduces the effects caused by network faults on parts of the installation (voltage reduction leads to loss of stability in the rotating machines, a higher voltage drop, faults in the equipment, etc...)
- achieves a good compromise amongst reliability, simplicity and cost-effectiveness
- provides the maintenance staff and managing system with a power source able to supply the installation or part of it when the transformer is being serviced.

The ATS solution

The Embedded ATS is a high-performances energy automation system, easy to install and program.

In a world where digital communication is the predominant agent responsible for improved efficiencies and performances in industrial and power applications, ABB is moving to re-invent how digital systems are embedded.

ABB's ATS system takes advantage of the new capabilities provided by the new Ekip Connect 3 Software and the intelligent circuit breaker such as Emax 2 to deliver compact and reliable solution.



SACE 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, for the first time, Emax 2 and its intelligent protection units integrate in one single device protection features and automatic transfer switching programmable logics. Ekip Connect is the ABB commissioning and programming software that allows the potential of Ekip electronic trip units to be fully realized. Using Ekip Connect, the user can manage power, acquire and analyze electrical values, and test protection, maintenance and diagnostic functions. So, where are you going to use ABB's ATS and why?

Where can ATS be applied?

Automatic Transfer Switch systems is common in all application where service continuity is essential and where there are multi source supplies. The main applications are:

- Power supplies of UPS groups in general
- Oil & Gas
- Operating theatres and primary hospital services
- Emergency power supplies for civil building, hotels and airports
- Data banks and telecommunication systems
- Power supply of industrial line for continuous processes

Another case of use of ATS is in all cases where a portion of grid with local generation, called microgrid, can be disconnected from main grid.

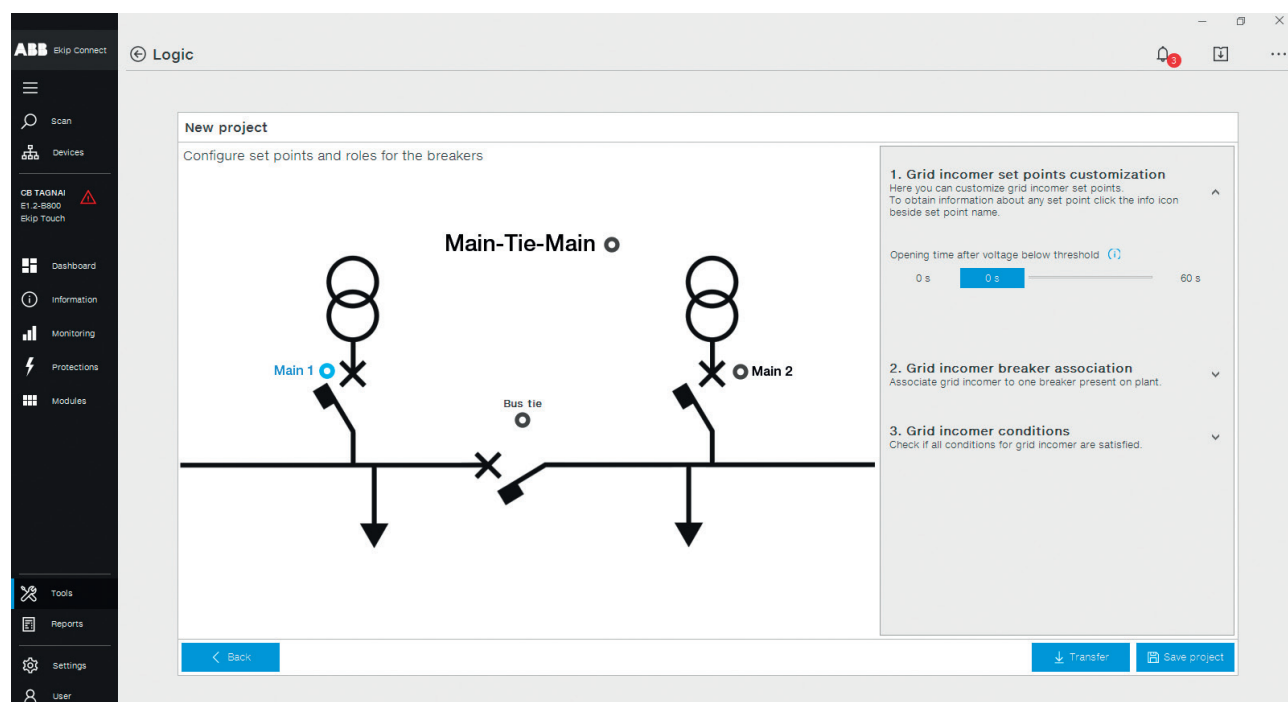
The benefits

ABB's ATS solution - ready-to-go

If you have ever programmed a power automation switchboard, you know that it requires PLC programming skills and electrical knowledge. Moreover, every custom-engineered system demands individual effort and personal responsibility. Moreover, if a setting needs to be changed the engineer may have to re-open the project, which has associated time and money costs. ABB's ATS now cuts this long story short by giving you general templates - tested and ready-to-go - that you can personalize by changing some basic settings via a graphical interface. When you are satisfied with how things look, a simple tool allows you to upload the template to the devices. And that is it. The system is up and running.

And if you need to change a parameter, just connect your laptop and do the changes with the same easy graphical interface.

Estimated time and cost savings on the ATS Engineering on the low voltage project: 95%

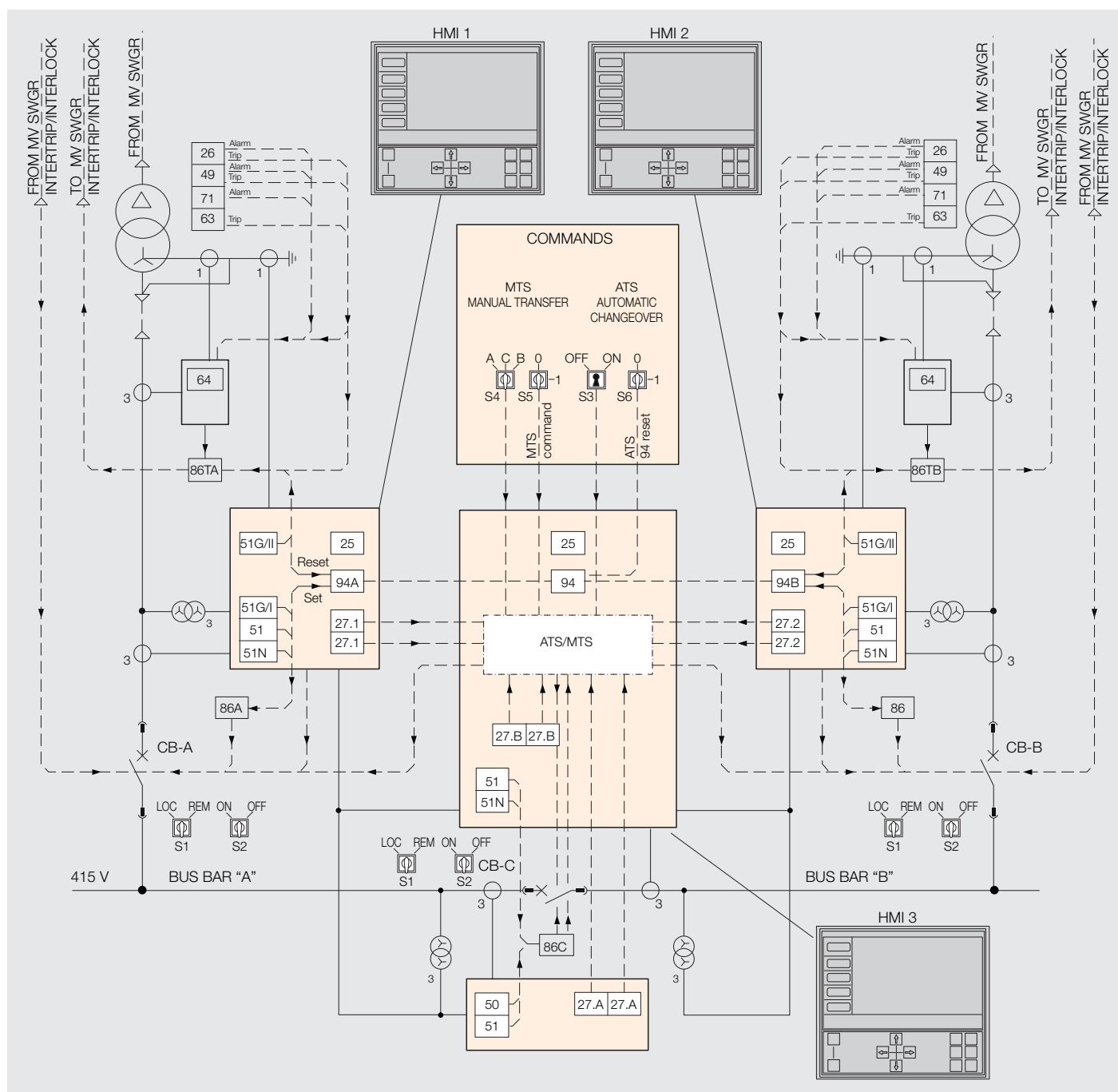


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Simplify the connections

The idea for the Embedded ATS solution emerged considering the complexity of the traditional solutions for power ATS. In the past, whether you were using a PLC or an external protection unit, you would have needed complex, hard-wired cabling between the protection devices, the operating devices (switch disconnectors) and the PLC, as well as the CTs (current transformers) and VTs (voltage transformers). See picture below.

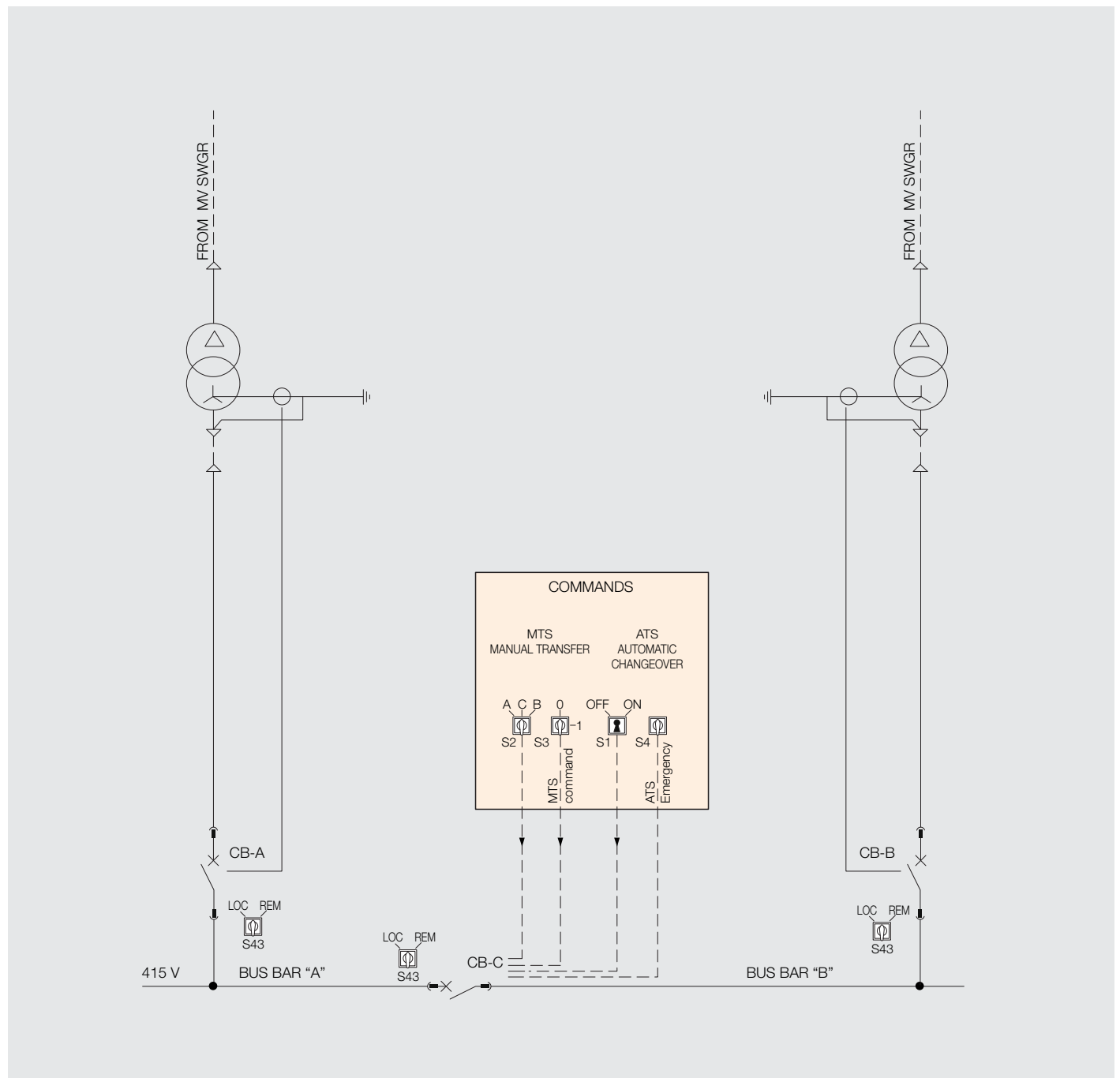


The introduction of the IEC 61850 communication standard for substation automation systems simplified things considerably by defining how devices should report their status and generally transfer data. This communication is usually physically achieved via an Ethernet cable or similar. However, even with an architecture based on IEC 61850, many external devices are still needed to manage the complexity of the system.

Enter ABB's Emax 2 ATS solution, which masters this complexity by harnessing the power of ABB's intelligent circuit breakers together with Ekip Connect 3 software.

And now there we are with the ABB ATS solution: With Emax 2 you can integrate the measures, the protections and the communication between the devices and to the network. See picture below.

Estimated time and cost savings on cabling and commissioning of the power switchboard: 50%



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Embedded ATS system

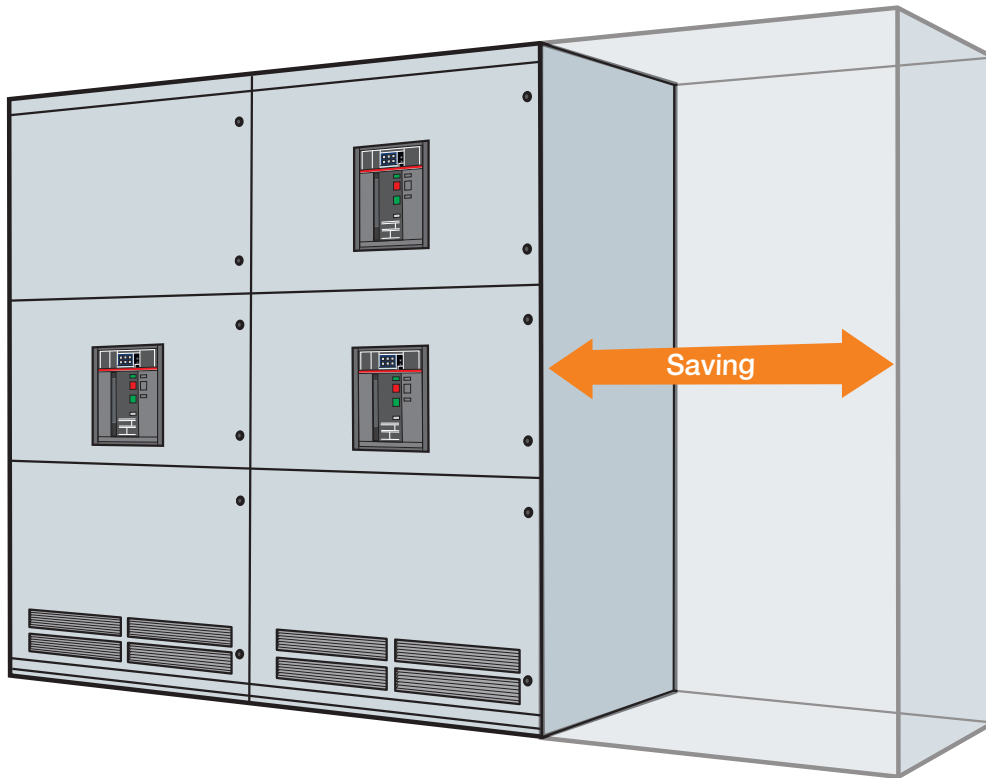
Emax 2 compactness

Emax 2, all-in-one solution, is the most compact air circuit breaker on the market, and it packs in a lot of functionality:

- Breaker
- HMI (human-machine interface)
- Protections
- Measurement (including the measurement transformers)
- Interlocking communication (horizontal) between devices
- Communication to the supervision system (SCADA)
- Communication to a cloud energy monitoring platform

The embedded ATS solution is as compact as the Emax 2 is. Nothing needs to be added.

Space saving on the power switchboard: up to 30%

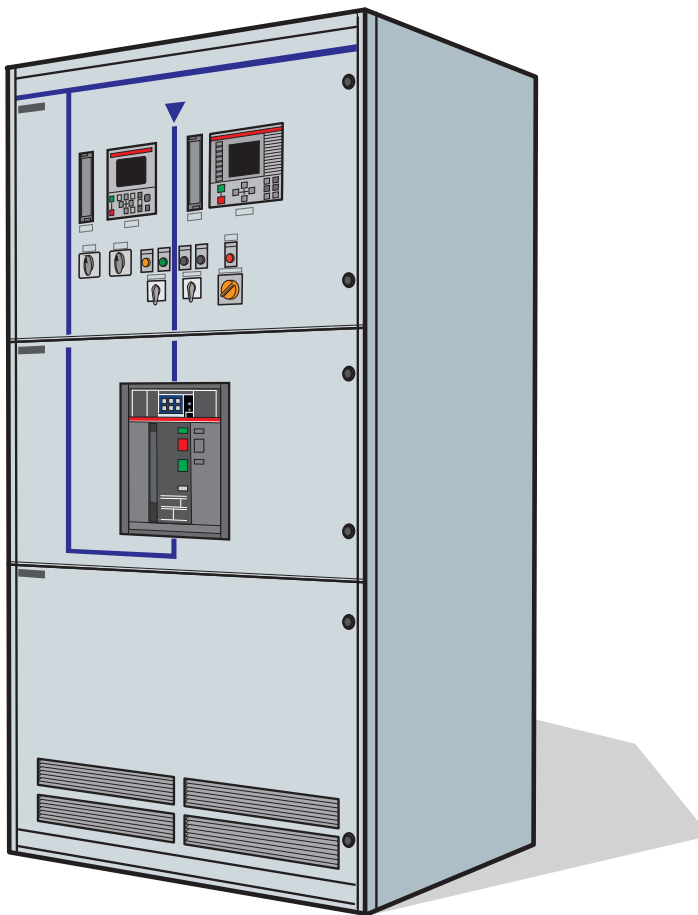


Top-rate reliability

Now, let's think of that complex switchboard, with many different devices connected. What do you do if one element brakes, or one cable disconnect? See Fig. A.

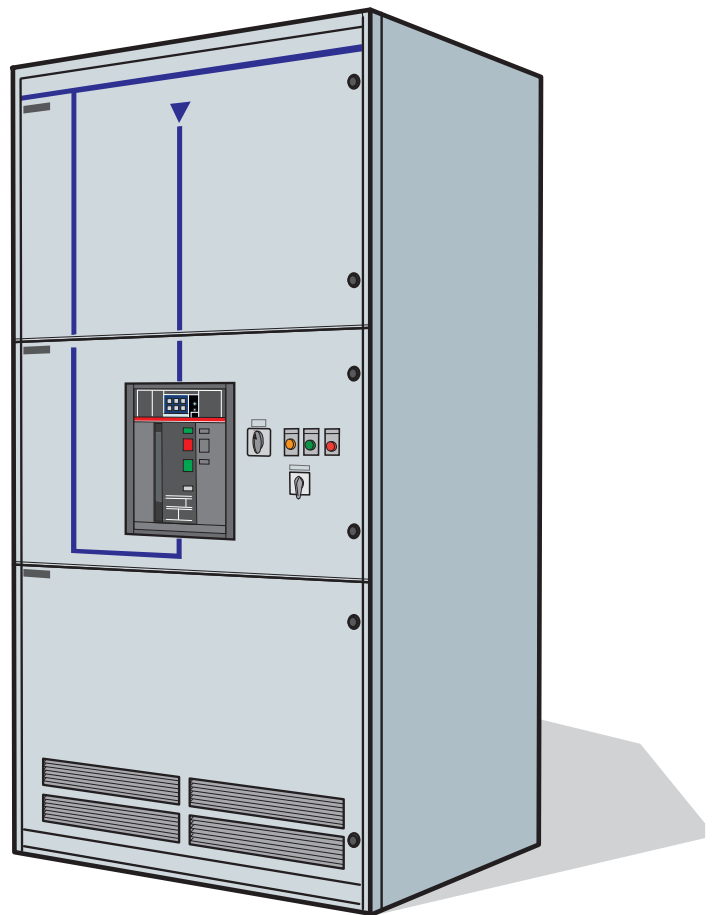
Emax 2's compactness does not preclude top-rate reliability. All the protection trip units in the Emax 2 family ensure high reliability by using an electronic circuit that periodically checks the continuity of the internal connections (trip coil, rating plug and current sensors). In the event of a malfunction, the LEDs indicate the corresponding - removable - alarm to enable the fault to be rapidly identified and rectified. See Fig. B.

Fig. A



- Traditional system:
- Switch disconnect
 - external protection units
 - Voltage sensors
 - Amperometric transformer
 - HMI
 - Cabling
 - Rotary selectors
 - Pushbuttons

Fig. B



- Emax 2 system:
- Circuit breaker
 - Rotary selector
 - Pushbuttons

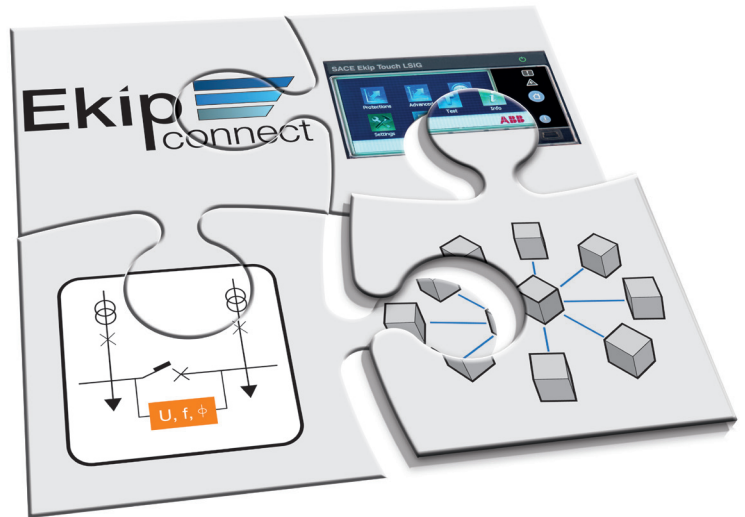
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Embedded ATS system

How it works

ABB's embedded ATS solution is based on four main elements:

- Ekip trip units that enable logic operations
- Ekip Link
- Ekip Synchrocheck (only in case of closed transition systems)
- The Ekip Connect 3 tool for ATS

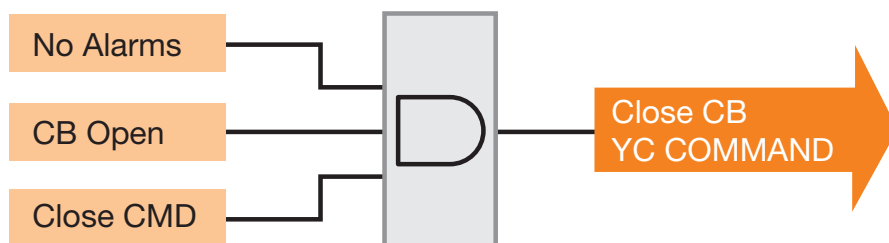


Logic operations with Ekip trip units

The capabilities of ATS can be achieved thanks to a variety of Emax 2 components. Two examples of these are the Ekip Touch and Ekip Hi-Touch trip units. Ekip Touch/Hi-Touch represent a new generation of protection trip units that are easy to program and read. They can be programmed via their HMI or by using Ekip Connect 3 software (see below) running on a laptop or mobile device. The Ekip Touch/Hi-Touch trip units measure power and energy with precision and save the most recent alarms, events and measurements to prevent faults to the installation and trip effectively when necessary. It is access to this type of data that makes ATS so powerful.

The Ekip Touch/Hi-Touch trip units (also in Generator Protection versions) have the capability of managing complex Boolean logic, rather like a PLC. Moreover, every physical, electrical and digital condition of the breaker is digitally mapped. This means that you have at your disposal thousands of parameters and statuses that can be shared with other devices and used to monitor the entire system. You can use this capability to automate the response of the system according to any circuit breaker status or event – and precisely this is the essence of what ATS does.

Let's show an example. Here you can see a very simple logic:



The basic elements are the input statuses (No Alarms, Circuit Breaker Open, Close Command), the Boolean AND operator and the output, which is active when all the input conditions are satisfied (this is the logic of the AND function). In other words, only if the breaker is open and it shows no alarms, will it close when a Close command is sent. This type of logic - and logic much more complex - is well within the capabilities of ABB's ATS.

Ekip Link

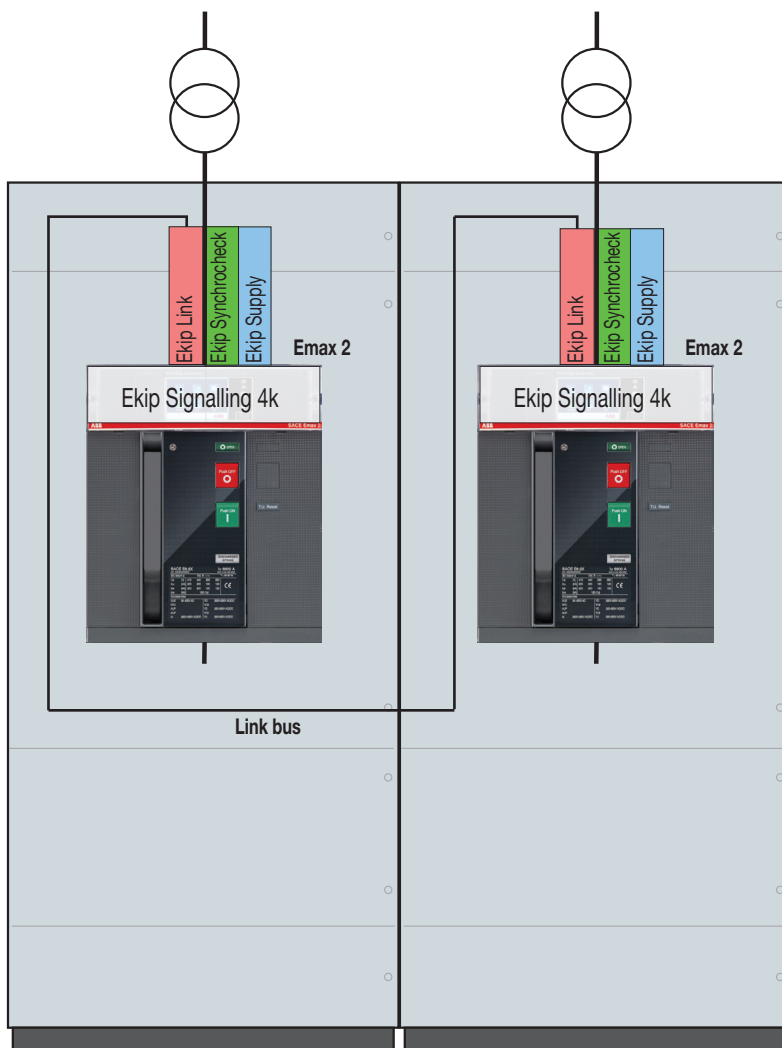
Everything described above about the computing power and logic capability of one circuit breaker can be extrapolated to realize a fast and powerful network of interconnected breakers that are able to exchange information with each other directly. This approach introduces a multiplier in terms of overall system capability that delivers unparalleled performance. Ekip Link is the ABB tool that lets this peer-to-peer communication happen.

Ekip Link enables Emax 2 circuit breakers to perform various tasks:

- Connect to the Ekip Control Panel operator panel
- Connect to build a logical selectivity
- Be part of a power controller system
- Enable horizontal communication between circuit-breakers

The horizontal (ie, direct) communication between the Emax 2 breakers eliminates the need for a supervising device or master and makes data exchange - concerning, for example, status and protection interlocks between circuit breakers - direct and fast¹.

¹ Another prominent method of horizontal communication is by the GOOSE messages described in the IEC 61850 standard.



Ekip Link module



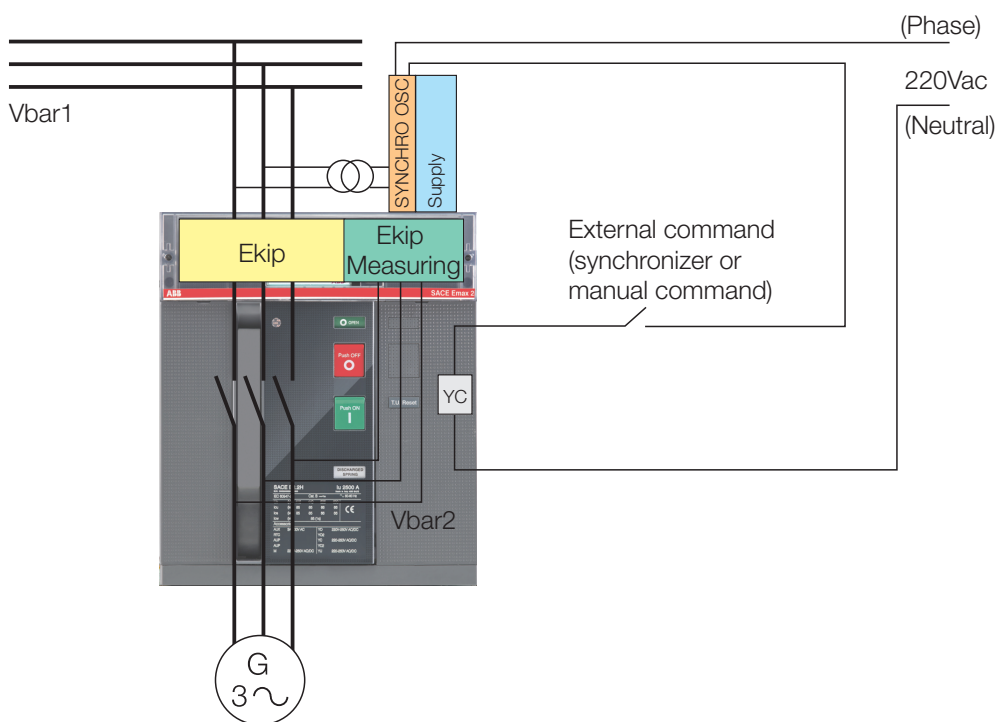
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Embedded ATS system

Ekip synchrocheck (Required only in case of closed transition)

A closed transition is when a load is switched from one power source to another and for a short, transitional time the two power sources both supply the load, in a parallel fashion. If you want to set up what is called a closed transition ATS, then you need an Ekip Synchrocheck module.

Conducting a closed transition is a delicate operation and many parameters must be checked and be within limits before the power sources can be paralleled. The ABB accessory that checks that all the conditions are satisfied for the transfer procedure is the Ekip Synchrocheck module, available with Emax 2 circuit breakers.



Fulfilling ANSI 25 protection, this module compares the angles, phases and frequencies of two voltages: One on the circuit breaker internal voltage plugs and the other on the line to be compared. When the results of the comparison match predetermined set ranges, a confirmation is generated by an analog and digital contact.

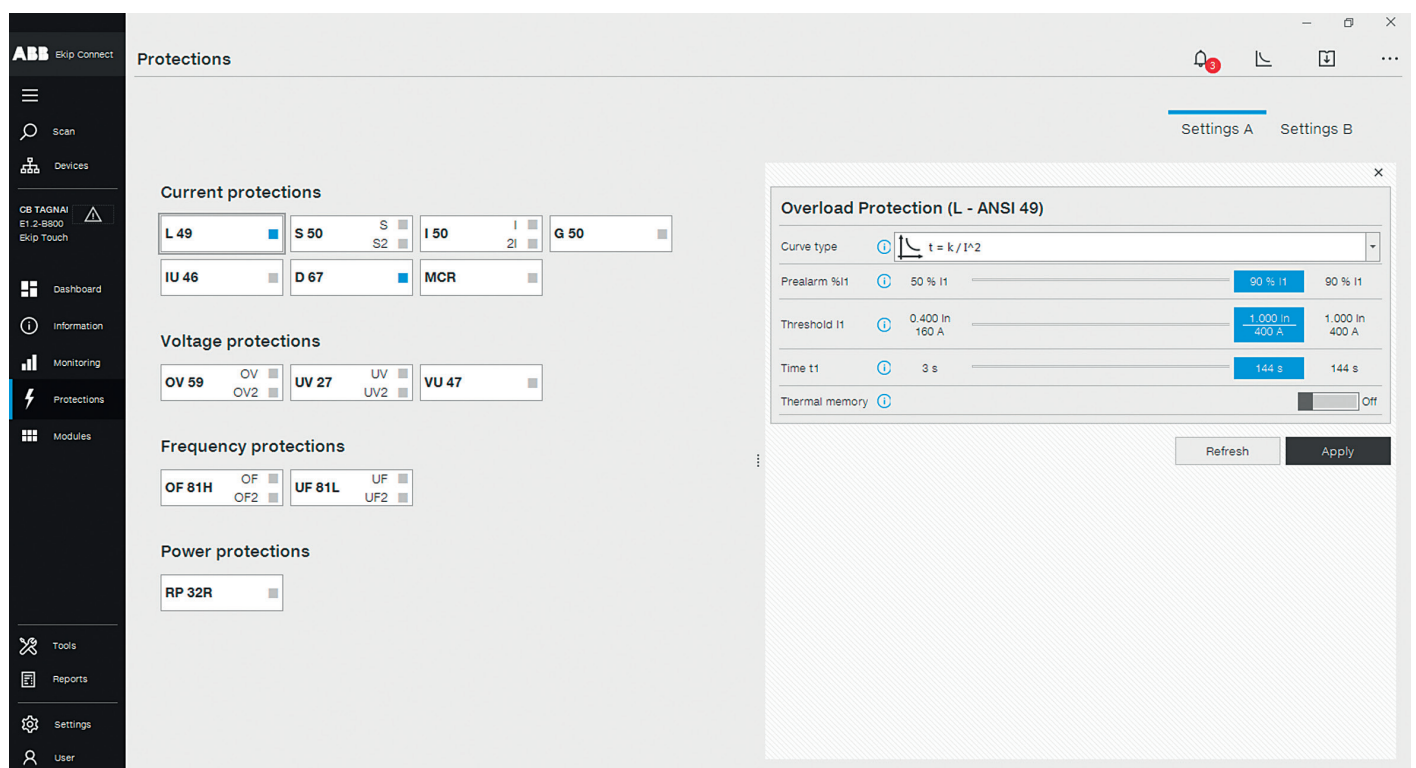
However, that is not the only function of the Ekip Synchrocheck module: It also acts as dead busbar detector. The Synchrocheck module automatically switches between these two functions.

Imagine you can take all the digital information it provides and use them inside the Logic system. That's how we are able to meet the challenge of the most complex ATS systems.

Ekip Connect 3 ATS tool

Up to now, we saw how we meet the complex technical requirements of the ATS systems, but how do we let our customers use all this functionality in the easiest possible way?

The Ekip Connect 3 software opens the door to the Ekip electronic trip units so their functionality can be fully exploited, in an easy-to-use manner. The Ekip Connect 3 software is built to facilitate and speed up the management of all the functions on offer: A simple and smart user interface and a thoughtful design of the programming processes make network configuration a breeze. Plus, you get measurement visualization, a freely configurable dashboard and various tools to manage information, signals, statuses and documents associated with your devices.



Inside Ekip Connect 3, the ATS software tool is a one-step wizard that lets you:

- Manage your ATS projects, including the ability to save, load and share projects
- Set up projects quickly, with an intuitive interface
- Upload projects to the trip units

This way you get a solution that is:

- Engineering-free
- Error-free
- Fast

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Embedded ATS system

How to use it

Once you order a code (See “How to Buy the license” chapter), you will receive a USB key containing the license that unlocks your ATS system.

Step 1: Open Ekip Connect 3

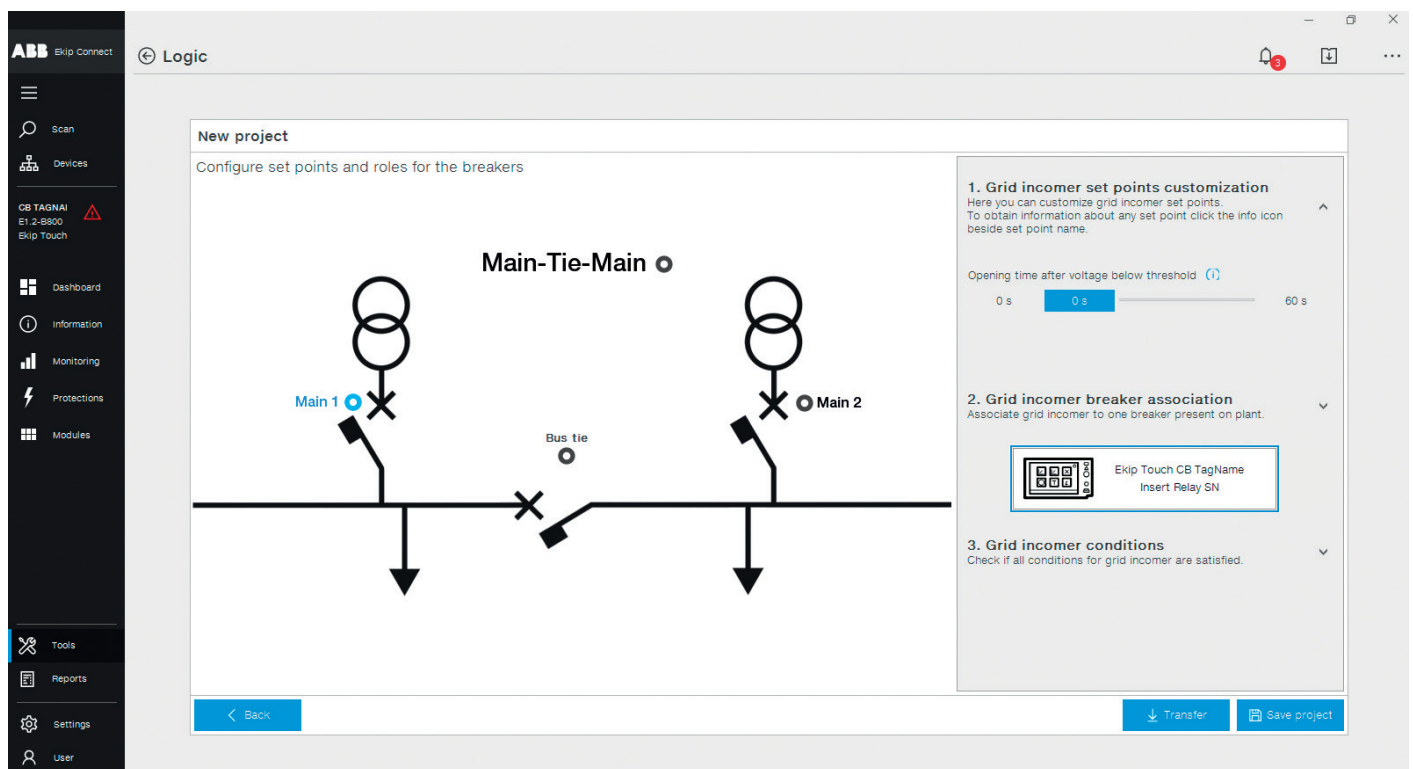
Step 2: Perform a scan of the network to find the available devices

Step 3: enter the Logic section and follow the contextual help to configure your ATS system.

Step 4: Once configured, use the lower right buttons to save the project or transfer the project to the circuit breakers.

You can transfer the project to multiple devices if you are connected through a Modbus TCP network. You can transfer the project to one device per time using the Ekip T&P or the Ekip Programming accessories. In case you are transferring the project one by one, you shall repeat the scan of the device each time; after the scan click again on Tools: the project will stay open and on hold, waiting for the next transfer command to be sent.

If you transfer a project, you permanently associate the project with the selected breakers. To break an association, you should contact ABB. To transfer a project to the circuit breakers you need to perform a Scan of the network clicking on the “Scan” section on the left column and following the procedure. After the scan the available circuit breakers will appear on the list of the ATS commissioning tool.



You will see a progress bar and a confirmation message will appear once operations are completed.

How to buy the license

Order the USB key containing the unlocking license.

Every license unlocks the whole system. You can swap the role of each authorized circuit breaker any time if you have the USB key inserted (eg. Main 1 become bus-tie and vice-versa). You can also change every setting with the USB key inserted.

You cannot substitute a breaker associated with the ATS system with a breaker not associated (eg, the Main 1 breaker needs to be changed in the switchboard, the new breaker cannot be associated automatically). Call ABB to break an association or to change a breaker into the system.

Annex A: Technical specification Main-Tie-Main Closed Transition

Scope

This specification describes the operating philosophy of the ATS Main-Tie-Main Closed transition system of Emax 2 low-voltage circuit breakers.

The system is a Main-Tie-Main. The two electrical power sources are transformers.

Glossary and acronyms

ATS	Automatic transfer switch
MTS	Manual transfer switch
CB	Circuit Breaker
Un	Nominal voltage of the system
RTC	Ready to close
-CB-A	Circuit breaker incomer from line A
-CB-B	Circuit breaker incomer from line B
-CB-C	Circuit breaker incomer from line C
IPCS	Embedded protection and control system
HMI	Human-machine interface

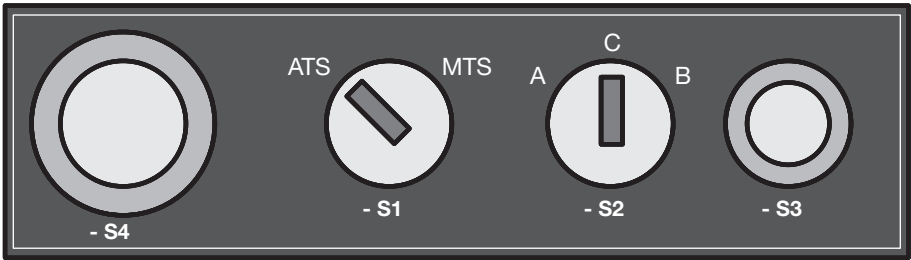
Modes of operation and controls

Four modes of operation and control are foreseen and are described in this document:

- Local (manual control)
- Remote control
- Automatic transfer switch (ATS)
- Manual transfer switch (MTS)

One of the operation modes is selected by means of one of the following switches:

- S1: ATS/MTS mode switch selector
- S2: A-C-B CBs selection for CB trip in MTS mode
 - A = -CB-A
 - C = -CB-C
 - B = -CB-B
- S3: Push-button for starting manual transfer mode.
- S4: Emergency latching push-button to exclude the automatic logic.
- S43: Local/remote-IPCS selector. (One for each circuit breaker. Can be wired by the customer by following the connection schemes in the Emax 2 installation manual.)



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Annex A: Technical specification Main-Tie-Main Closed Transition

The following table shows the combination of switches/selectors/push-buttons needed to get each condition ready to operate.

	Selector status						
	S1 (automanual)	S2 (A-C-B)	S3 (start MTS)	S4 (logic off)	S43 CBA (local/ remote)	S43 CBB (local/ remote)	S43 CBC (local/ remote)
ATS	ATS	#	#	0	Remote	Remote	Remote
MTS	MTS	#	#	0	Remote	Remote	Remote
Local CBA	#	#	#	#	Local	#	#
Local CBB	#	#	#	#	#	Local	#
Local CBC	#	#	#	#	#	#	Local
Automation OFF	#	#	#	1	Remote	Remote	Remote
MTS-open CBA	M	A	1	0	Remote	Remote	Remote
MTS-open CBB	M	B	1	0	Remote	Remote	Remote
MTS-open CBC	M	C	1	0	Remote	Remote	Remote

Main switchgear working philosophy

The main switchgear configuration (see fig.2) under normal operating condition is “TT”:

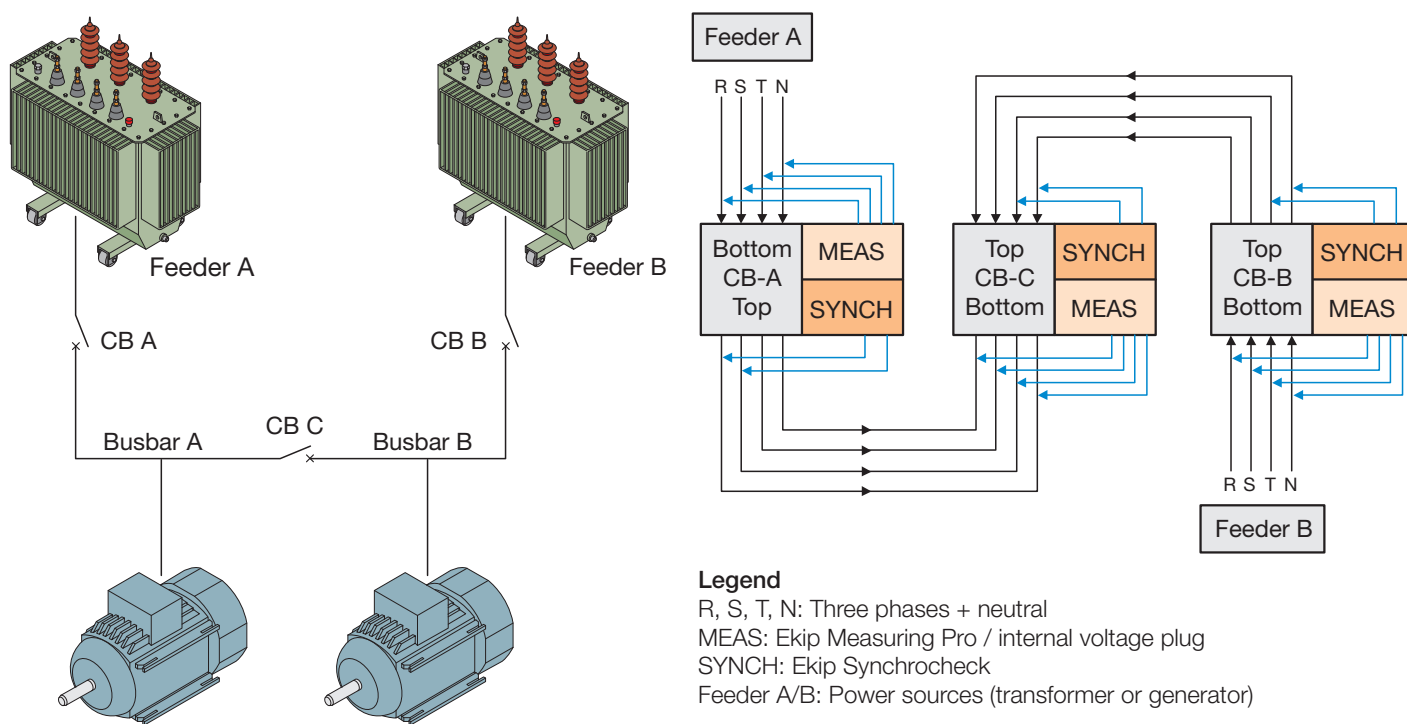
- Incomer lines from transformer (-CB-A and -CB-B): Close condition.
- Bus-tie (-CB-C): Open condition.

The circuit breakers shall be manually controlled locally (switchgear) or remotely (IPCS).

ATS “break-before-make” and MTS “make-before-break” systems are provided.

The local/remote mode selection shall be done using the selector switch S43 located in each incomer or bus tie cubicle.

Figure 2 - Main switchgear configuration

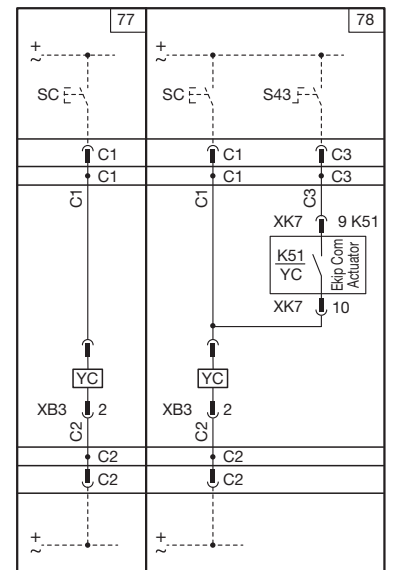
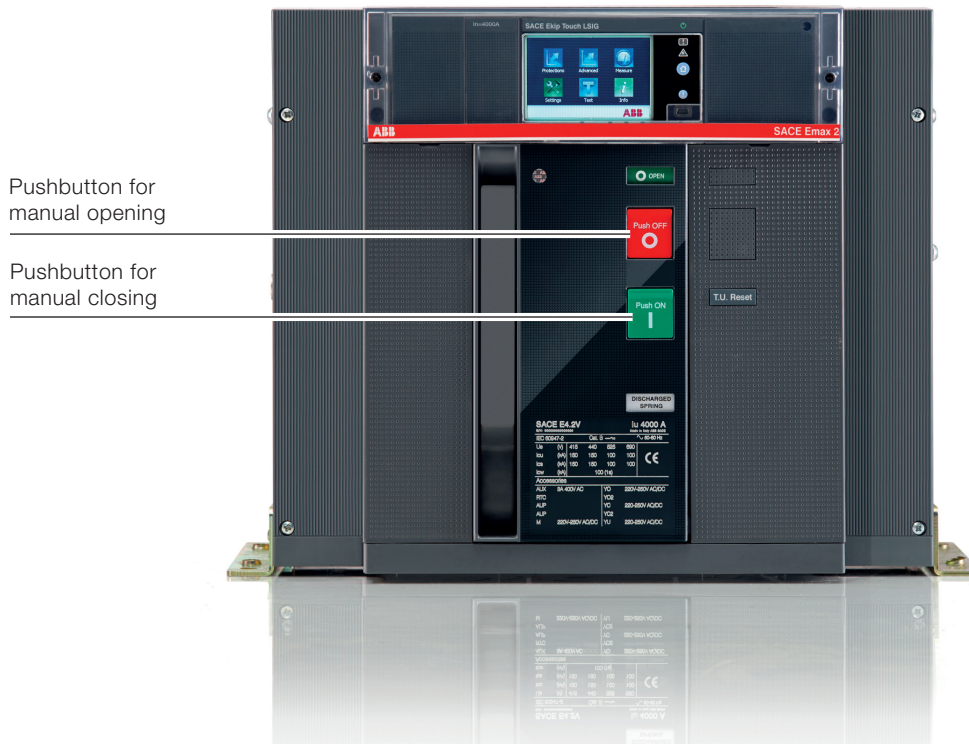


Note: ABB provide the internal voltage plug connected as standard to the bottom terminals. To obtain the breaker with the voltage plugs connected to the top terminals, please use the specific extra ordering code.

Local (manual controls)

When the local/remote selector S43 is set to “Local” at each corresponding CB, opening and closing operations are permitted by using the ON or OFF push-buttons provided with every CB (see fig.3).

Figure 3 - Emax 2 front



Scheme 1

The selector excludes any automatic logic (ATS or MTS) or IPCS remote operations.

In practice, the local/remote selector S43 activates the Emax 2 Ekip actuator or the YC/YO direct control.

See the scheme 1 for details.

The system permits the closing of every circuit breaker, if done manually. No Interlock are provided in Manual operations.

Remote control

-CB-A / -CB-B / -CB-C (incomers and bus tie) IPCS controls are allowed with local/remote switch S43 in the Remote position. The CBs can be controlled by the IPCS via the defined communication protocol.

In remote mode, the CB status can also be controlled by Ekip Connect.

If the Emergency latching push-button S6 is pushed, it is possible to open or close any circuit breaker.

It's not possible to start an MTS sequence in remote mode.

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Annex A: Technical specification Main-Tie-Main Closed Transition

ATS automatic transfer switch

The ATS logic works as follows:

Starting from a TT configuration (-CB-A and -CB-B closed, -CB-C open)

- In case of undervoltage (ANSI27) [set point] or Ekip Signalling 4K Digital Input 1, 2 or 3 activated on one line (A or B), the relevant CB opens within the set time [set point].
- After the pre-set time and checking for Ready to Close status, checking for dead busbar (under 10 percent of U_n), checking that no electric protection element caused the line to open, checking that the other line is available and healthy (Over 90 percent of U_n), -CB-C closes.

The ATS shall operate under the following conditions:

- ATS Emergency latching push-button not pressed
- Bus-tie open and RTC
- Other bus bar voltage level > 90 percent of U_n

The automatic changeover shall be locked in case of

- Any protection Trip or alarm (The protections activation and settings must be carried out by the customer)
- Emergency push-button pressed

After a current protection trip of any circuit breaker, the ATS logic is locked. The lock shall be removed by resetting the circuit-breaker locally or remotely.

When the “ATS Logic Disabled” normally closed pushbutton is pressed:

- The ATS logic is deactivated
 - The line breakers CB A and CB B can open for ANSI27
 - The bus-tie breaker CB C does NOT close after the opening by ANSI27 of one line
- The MTS logic is deactivated

When the “ATS Logic Disabled” normally closed pushbutton is reset after being pressed:

- If no events occurred (ANSI27 or digital input) the ATS system is restored and ready to operate
- If one line breaker opened for ANSI27 while the pushbutton was pressed:
 - If the line voltage is still absent, the ATS system starts the bus-tie closing procedure after the preset time.
 - If the line voltage is back over 90 percent of U_n , the system keeps the previous status (line breaker open, bus tie open) and the operator shall manually restore the desired condition.

Starting from an L configuration (-CB-A and -CB-C closed, -CB-B open / -CB-B and -CB-C closed, -CB-A open)

- In the case of undervoltage (ANSI27) on the healthy line, the relevant breaker and the bus-tie open. The system shall be manually restored.
- In the case of return of voltage (over 90 percent of U_n) on the previously faulty line, the system is locked. The operator shall activate the MTS operating mode to change the status of the system.

If the ATS system is working properly, the CB-A 4K Output 1 is lit. You can connect the output to a switchboard signalling system or you can communicate the contact status to the IPCS.

MTS manual transfer switch

MTS mode can:

- Restore the normal operating condition (TT) without loss of supply after an ATS operation
- Transfer the load from one transformer to another without loss of supply
- Change the system configuration from TT to L without loss of supply

The ANSI25 Syncrocheck function prevents the parallelling of out-of-synch sources

The "A-C-B" Selector has three positions. Each position acts as follow:

Position A : -CB-C or -CB-B will close and -CB-A will open;

Position C: -CB-A or -CB-B will close and -CB-C will open;

Position B: -CB-A or -CB-C will close and -CB-B will open;

The manual transfer shall be locked in case of:

- Emergency push-button S4 pressed
- The two power sources are out of sync as stated by ANSI25
- ANSI27 alarm on closing breaker
- Closing breaker not RTC
- Any alarm or timing protection on the opening line
- Any Loc/Rem selector on local

The manual transfer will happen if the operator follows the sequence:

1. Select the "Manual" mode with the "Auto/Manual" Switch S1
2. Select which breaker shall open with the "A-C-B" Selector S2
3. Press the "Open" pushbutton S3

And if:

- The two power sources are in sync as stated by the ANSI25
- There is no ANSI27 alarm on closing breaker
- The closing breaker is RTC
- There is no alarm or timing protection on the opening line
- All Loc/Rem selectors are on Rem

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Annex A: Technical specification Main-Tie-Main Closed Transition

Available setting points

CB-A			
Name	Description	Threshold	Step
Set point A	Opening time after a voltage drop below the ANSI27 threshold	[0 s...60 s]	1s
Set point B	Parallel time	[300 ms...10 s]	[300 ms, 500 ms, 800 ms, 1 s, 3 s, 5 s, 10 s]
UV (ANSI 27)	Undervoltage protection	$U_8=0.5...0.98 \times U_n$	$0.001 \times U_n$

UV setting available at the "Protection" section of Ekip Connect 3.

CB-B			
Name	Description	Threshold	Step
Set point A	Opening time after a voltage drop below the ANSI27 threshold	[0 s...60 s]	1s
Set point B	Parallel time	[300 ms...10 s]	[300 ms, 500 ms, 800 ms, 1 s, 3 s, 5 s, 10 s]
UV (ANSI 27)	Undervoltage protection	$U_8=0.5...0.98 \times U_n$	$0.001 \times U_n$

UV setting available at the "Protection" section of Ekip Connect 3.

CB-C			
Name	Description	Threshold	Step
Set point A1	Time elapsed before the bus-tie closes in ATS mode	[2 s...10 s]	1s
Set point A2	Time elapsed before the bus-tie closes in ATS mode	[2 s...10 s]	1s
Set point B	Parallel time	[300 ms...10 s]	[300 ms, 500 ms, 800 ms, 1 s, 3 s, 5 s, 10 s]

Fixed settings

Synchrocheck	ΔU threshold	voltage difference module	10%
	Δf threshold	frequency difference	0.2 Hz
	$\Delta \varphi$ threshold	phase angle difference	10°
	Dead busbar Threshold		$0.1 \times U_n$
	Live busbar threshold		$0.8 \times U_n$
	Synchro voltage	Reference voltage for the synchronism check	U_{12}
	Synchro Primary voltage		400 V
	Synchro Secondary voltage		100 V
SOS Opening Sequence: C - A - B			

Breakers configuration

Each Emax 2 CB involved shall be an E2.2 / E4.2 /E6.2 of the withdrawable type and equipped with the following accessories:

Ekip Hi-Touch or Touch + Measuring Pro
Ekip Supply
Ekip Link
Ekip Synchrocheck
Ekip Signalling 4K
Ekip Com Actuator
Spring charger Motor
YO
YC

The Ekip Connect 3 commissioning tool for ATS has an auto/manual system that check the correct configuration of the circuit breakers. The commissioning succeed only if the configurations are correct.

Compatibility

The Embedded ATS tool is compatible with all the Emax 2 electronic trip units starting from version v02.20.08 of the Ekip Main-board firmware.

To check the firmware version of your device you can:

- 1) use the "Information" section of Ekip Connect 3, Nominal Data field.
- 2) press the "I" button on the front of the trip unit until the page "Protection Unit" appears.

Notes on Ekip Sinchrocheck module

Insulation transformer

Between the external contacts of the circuit-breaker and the inputs of the module, an isolation transformer must always be installed that has the characteristics listed in the following table:

Characteristics	Description
Mechanical	<ul style="list-style-type: none">– Mounting: EN 50022 DIN43880 guide.– Material: self-extinguishing thermoplastic.– Protection class: IP30.– Electrostatic protection: with screen to be connected to earth.
Electrical	<ul style="list-style-type: none">– Precision class: ≤ 0.5.– Performance: ≥ 5 VA.– Overload: 20 % permanent.– Insulations: 4 kV between inputs and outputs, 4 kV between screen and outputs, 4 kV between screen and inputs.– Frequency: 45...66 Hz.

The standard Fixed Setting of the module is:

Primary voltage 400 V

Secondary voltage 100 V

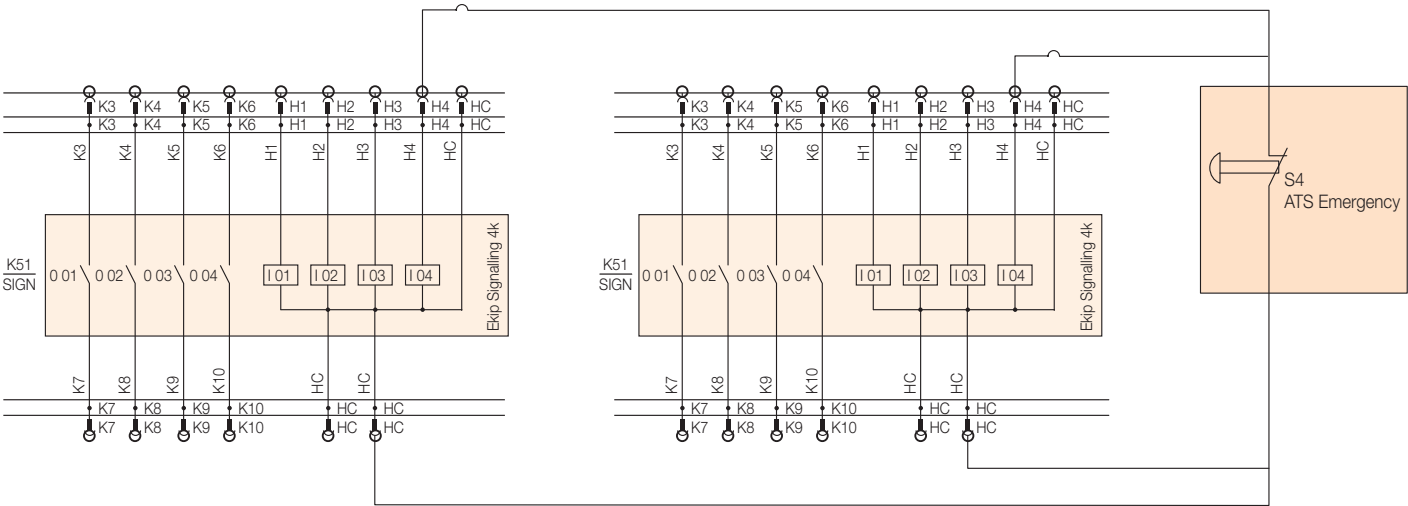
For more information about the Ekip Synchrocheck Module, please refer to the Emax 2 instruction manual.

Emax 2

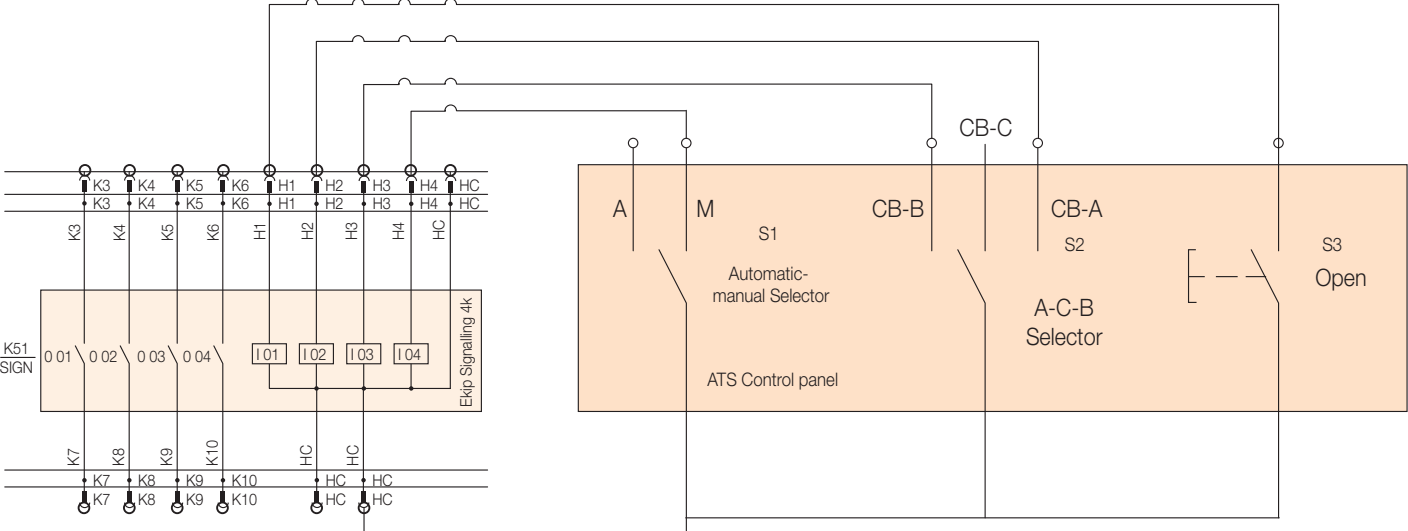
Embedded ATS system

Annex A: Technical specification Main-Tie-Main Closed Transition

Ekip Signalling 4K CB-A/CB-B

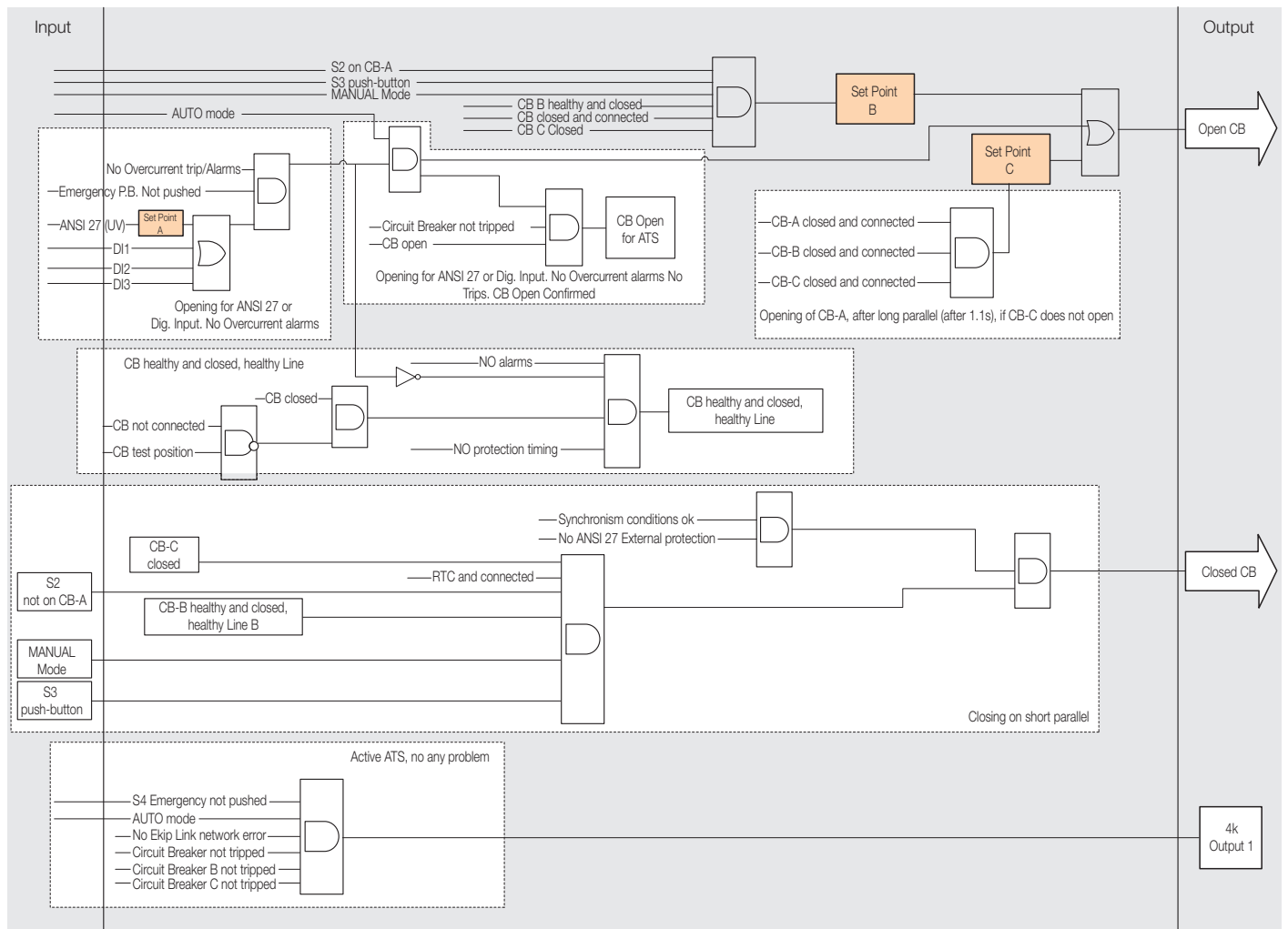


Ekip Signalling 4K CB-C



Logic diagrams

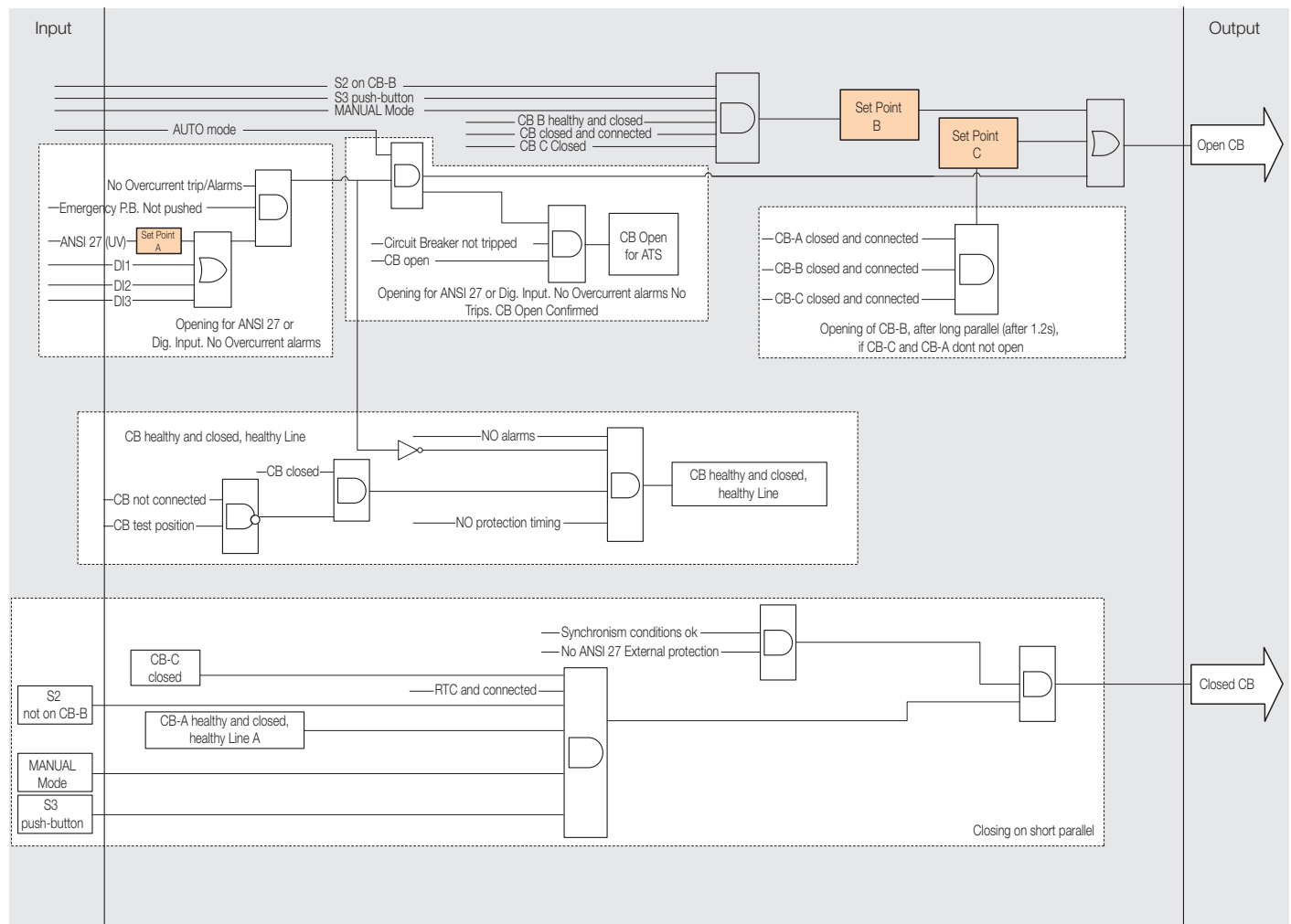
CB-A



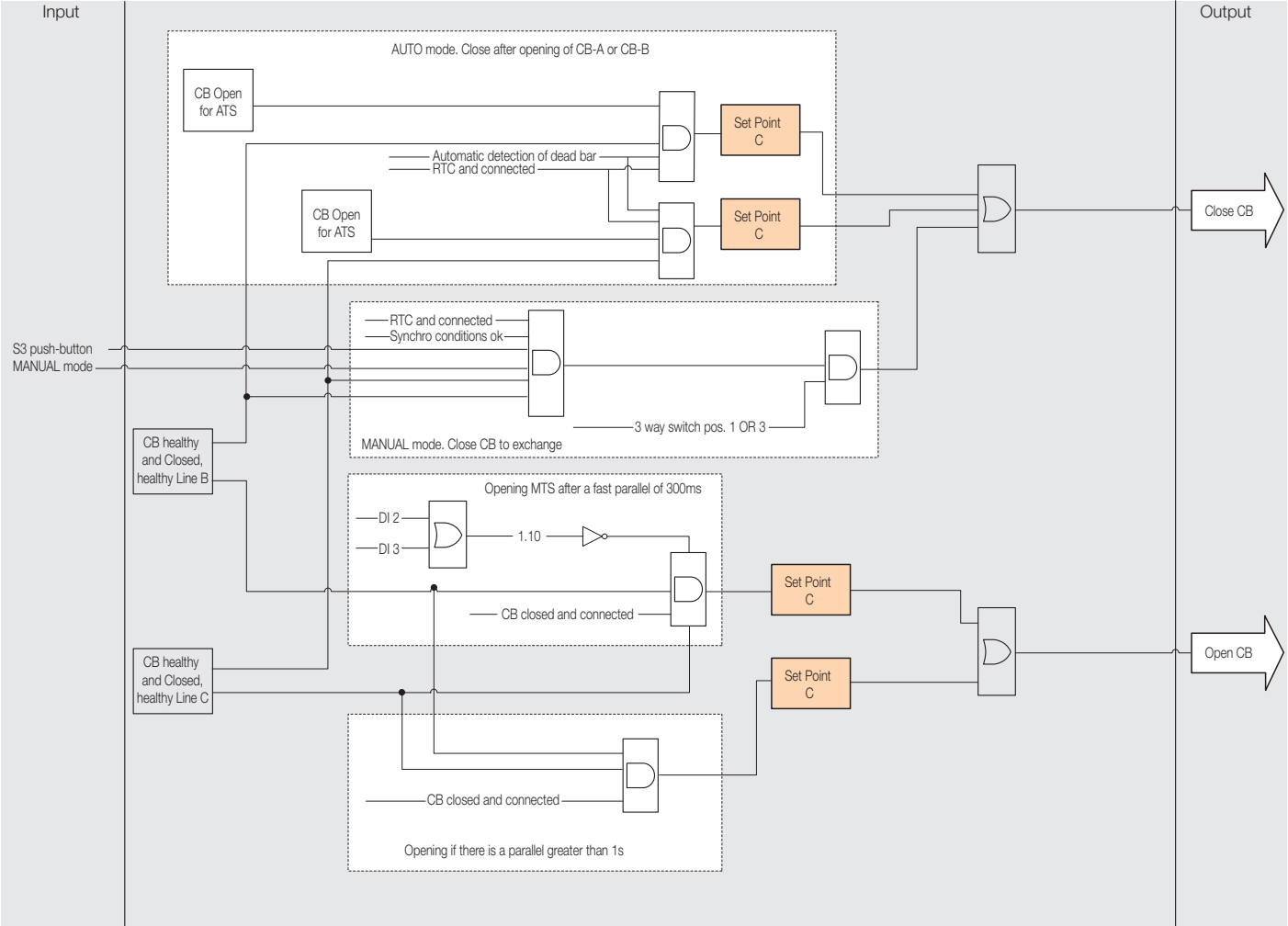
Emax 2

Embedded ATS system

Annex A: Technical specification Main-Tie-Main Closed Transition

CB-B

CB-C



Contact us

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