Product note
Migration from Emax to Emax 2 while maintaining certification according to the IEC 61439 series standards for assemblies

Generalities

A key point in the introduction of a new circuit breaker to the market is protection of investment, specifically by maintaining the certification of switchboards according to IEC 61439 2. The best way to make the migration is to follow the rules reported in the IEC documents “for replacing the original device in an assembly that has already been verified according to the IEC 61439 standards series, by an alternative component without repeating any assembly verification test ”.

It is important to note that:

- the main design characteristics and ratings of the functional unit and assembly cannot change: it is not possible to take advantage of the better performances of the devices of the new series;
- the relevant rules are defined in paragraphs 10.10.3.4, 10.10.3.5, 10.11.3, 10.11.4 and in table 13 of the IEC 61439-1;
- if it is not possible to verify compliance to all the requirements reported on the standard for the device substitution for a component, it does not mean that the substitution is impossible, but only that some new verification (calculations, assessments on already verified similar configurations, tests, etc.) have to be made on the functional unit or on the assembly to demonstrate that their performances are not impaired.

Devices substitution process description

1) Substituting component selection

Starting from an already tested functional unit where an Emax ACB is installed, the equivalent Emax 2 circuit breaker type and execution have to be selected:

a) with performances according to the assembly and application requirements (as rated current In, insulation voltage Ui, rated voltage Ue, impulse voltage Uimp, breaking capacity Icu, short circuit withstand current Icw);

b) with coordination characteristics (discrimination requirements, starter component coordination, etc.) and limitation characteristics (if coordinated with some passive component) not involving other component substitutions (if not yet forecast);

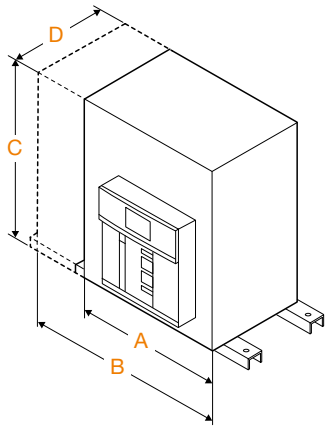
c) with installation requirements in the same physical arrangement of the reference design (e.g. the main cubicle dimensions and insulating distances, the insulation barriers requirements, etc.) and compatible with the cell geometry and characteristics;

d) without the need of heavy modifications on the power circuits interface (e.g. same terminal orientation).

All these requirements can be fulfilled with the correct Emax 2 type/size selection. In other words, in standard AC installations, there are not performances of an ABB Emax circuit breaker that cannot be fulfilled by an equivalent ABB Emax 2.

For example, comparing the withdrawable execution compartment dimension requirements (see figure F1), it is easy to demonstrate that the Emax 2 can be installed inside a cubicle designed for the the Emax without problems.

Figure F1



Emax

(mm)	A 3p	B 4p	C	D
E1	400	490	500	380
E2	400	490	500	380
E3	500	630	500	380
E4	700	790	500	380
E4/f	-	880	500	380
E6	1000	1130	500	380
E6/f	-	1260	500	380

SACE Emax 2

(mm)	A 3p	B 4p	C	D
E1.2	280	350	440*	252
E2.2	400	490	500	355
E4.2	500	600	500	355
E6.2	900	1000	500	355
E6.2/f	-	1200	500	355

*390 for voltages ≤ 440V AC

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The migration table that can be used as a reference to define the equivalent Emax 2 type is:

Table T1

		Icw[kA]				
		50	65	75	85	100
In@40C[A]	1250	E1N,X1N 12 => E1.2N 12	E2S 12 => E2.2N 12	E3S 12 => E2.2H 12	E3V 12 => E2.2H 12	V
	1600	E1N,X1N 16 => E1.2N 16	E2S 16 => E2.2N 16	E3S 16 => E2.2H 16	E3V 16 => E2.2H 16	V
	2000	E2N 20 => E2.2N 20	E2S 20 => E2.2N 20	E3S 20 => E2.2H 20	E3V 20 => E2.2H 20	E4H 32 => E4.2V 20
	2500	>>	E3N 25 => E2.2N 25	E3S 25 => E2.2H 25	E3V 25 => E2.2H 25	E4H 32 => E4.2V 25
	3200	>>	E3N 32 => E4.2N 32	E3S 32 => E4.2H 32	E3V 32 => E4.2H 32	E4H 32 => E4.2V 32
	4000	>>	E4S 40 => E4.2N 40	E4S 40 => E4.2H 40	E4H 40 => E4.2H 40	E4H 40 => E4.2V 40
	5000	>>	>>	>>	>>	E6H 50 => E6.2H 63
	6300	>>	>>	>>	>>	E6H 63 => E6.2H 63

For the terminals in the withdrawable version, the selection is shown in Table T2 below. It is based on the assumption that there is not a change in the cross section, material and type of conductors connected.

Table T2

Emax type	Emax terminals	→	Emax 2 type	Emax 2 terminals
X1	HR	→	E1.2	HR
	VR	→		VR
E1	HR	→		SHR
	VR	→		VR
E2	HR	→	E2.2	HR
	VR	→		VR
E3	HR	→	E2.2	SHR
	VR	→		VR (SVR)
	HR	→	E4.2	HR
	VR	→		VR
E4	HR	→	E4.2	HR
	VR	→		VR
E6	HR	→	E6.2	HR
	VR	→		VR

2) Temperature rise verification

According to the standard requirements reported in paragraph 10.10.3.5 of the IEC 61439-1, device substitution is possible when the power loss and terminal temperature rise of the Emax 2 circuit breaker are the same or lower than those of the Emax.

Taking into account the contents of annex G of the standard IEC 60947-2 (Low-voltage switchgear and controlgear - Part 2: Circuit-breakers), the power loss evaluation shall be made on new samples, under AC rated current steady-state temperature conditions in free air.
That also means that the power loss cannot be directly compared with the values indicated in the previous Emax technical documentation that, if not otherwise stated, were measured in DC at the ambient temperature.

The comparison of AC power losses below demonstrate that the Emax 2 circuit breaker has lower dissipation values that the Emax.

Table T3

Frame	Withdrawable execution power loss [W]			
Iu [A]	Emax		Emax 2	
1600	E1	623	400	E1.2
2000	E2	561	450	E2.2
2500	E3	595	550	E2.2
3200	E3	998	743	E4.2
4000	E4	1155	900	E4.2
6300	E6	1980	1550	E6.2

In the same way, if we compare the max over-temperature of the standard terminals in corresponding circuit breaker executions when tested according to the requirements of the IEC 60947-2 standard in free air, the data of the Emax 2 series are lower or equal to those of the Emax.
In regard to the segregation forms 3 and 4, the modification on the vertical segregation panel position related to the differences in the depth of the devices does not modify the thermal behavior of the system, on account of the air cooling flux.

In conclusion:
It is possible to substitute an Emax series circuit breaker with an Emax 2 series one that is correctly selected (e.g. according to the tables T1 & T2 and /or using the terminal adapter kits) without any derating and without any additional temperature rise test or verification.

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3) Short circuit verification

As required in item 6 and in note (a) of table 13 in the IEC 61439-1, Emax 2 series circuit breakers have the same or better performance characteristics in all relevant respects to the corresponding Emax series devices used for verification, in particular concerning breaking capacity and critical distances.

With regard to connections, if the condition is not worsened concerning:
- cross sections and conductors material (as stated in items 2 and 5 of table 13 in the IEC 61439-1)
- busbars supports characteristics, spacing and mounting structure (item 4 of table 13 in the IEC 61439-1)

the only assessment needed is related to the center line spacing of each circuit, which has to be greater than or equal to those of the reference design.

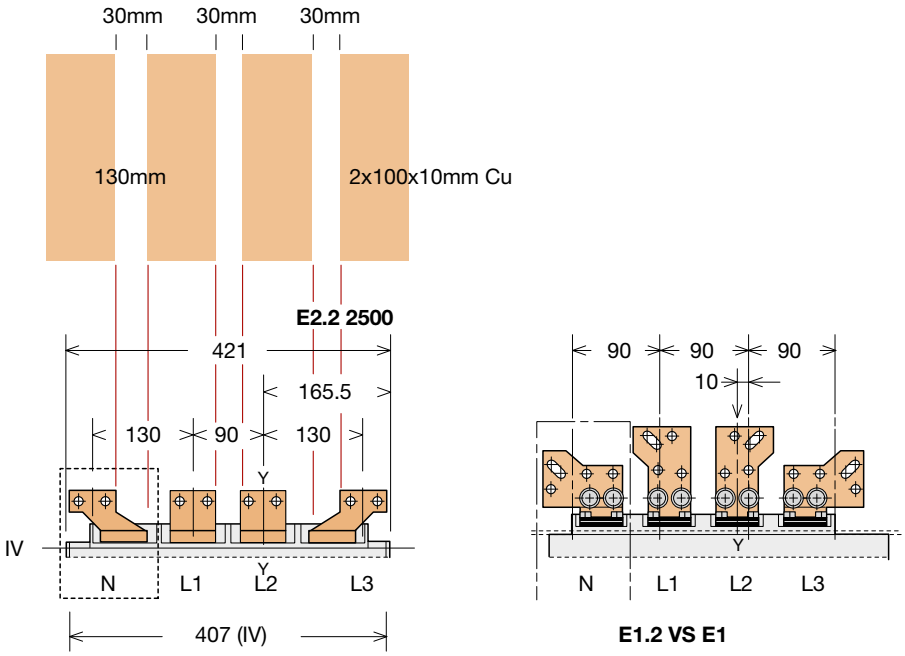
Without any other verification, this requirement could be fulfilled for the substitution of a correctly selected
- Emax X1 by Emax 2 E1.2 (or by another Emax 2 series circuit breaker with a larger frame),
- Emax E1 by Emax 2 E2.2 (or by another Emax 2 series circuit breaker with a larger frame),
- Emax E2 by Emax 2 E2.2 (or by another Emax 2 series circuit breaker with a larger frame),
- Emax E3 by Emax 2 E4.2 (or by another Emax 2 series circuit breaker with a larger frame),
- Emax E6 by Emax 2 E6.2,

With regard to the migration from
- Emax E1 to Emax 2 E1.2
- Emax E3 to Emax 2 E2.2
- Emax E4 to Emax 2 E4.2

In these cases, the center line distances of different poles' standard terminals are smaller than in the originally tested device. It is possible to fulfill the standard requirements if one of the following conditions is true:

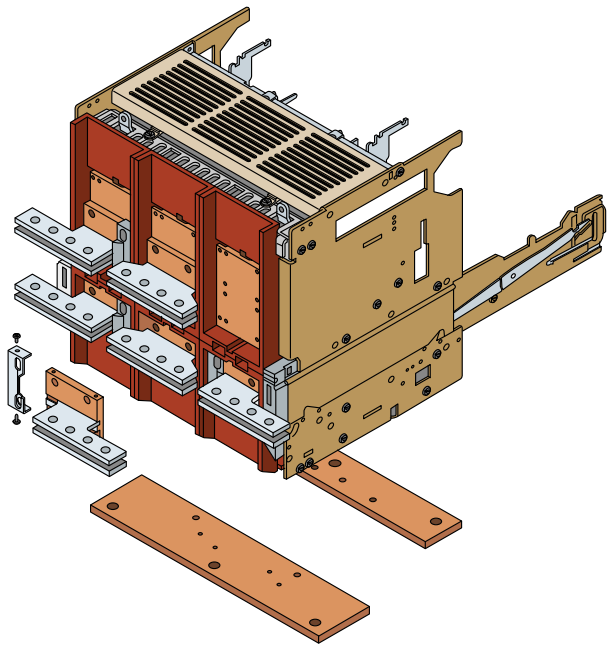
a) It is possible to connect the exiting busbar system to the terminals without modifying the main conductor's center line distance as in the figure F2

Figure F2



b) The specific terminal adapters kit, developed to permit Emax 2 installation into the design of an Emax functional unit without any other modification, is installed (see figure F3 related to the migration of Emax E4 to Emax 2 E4.2).

Figure F3



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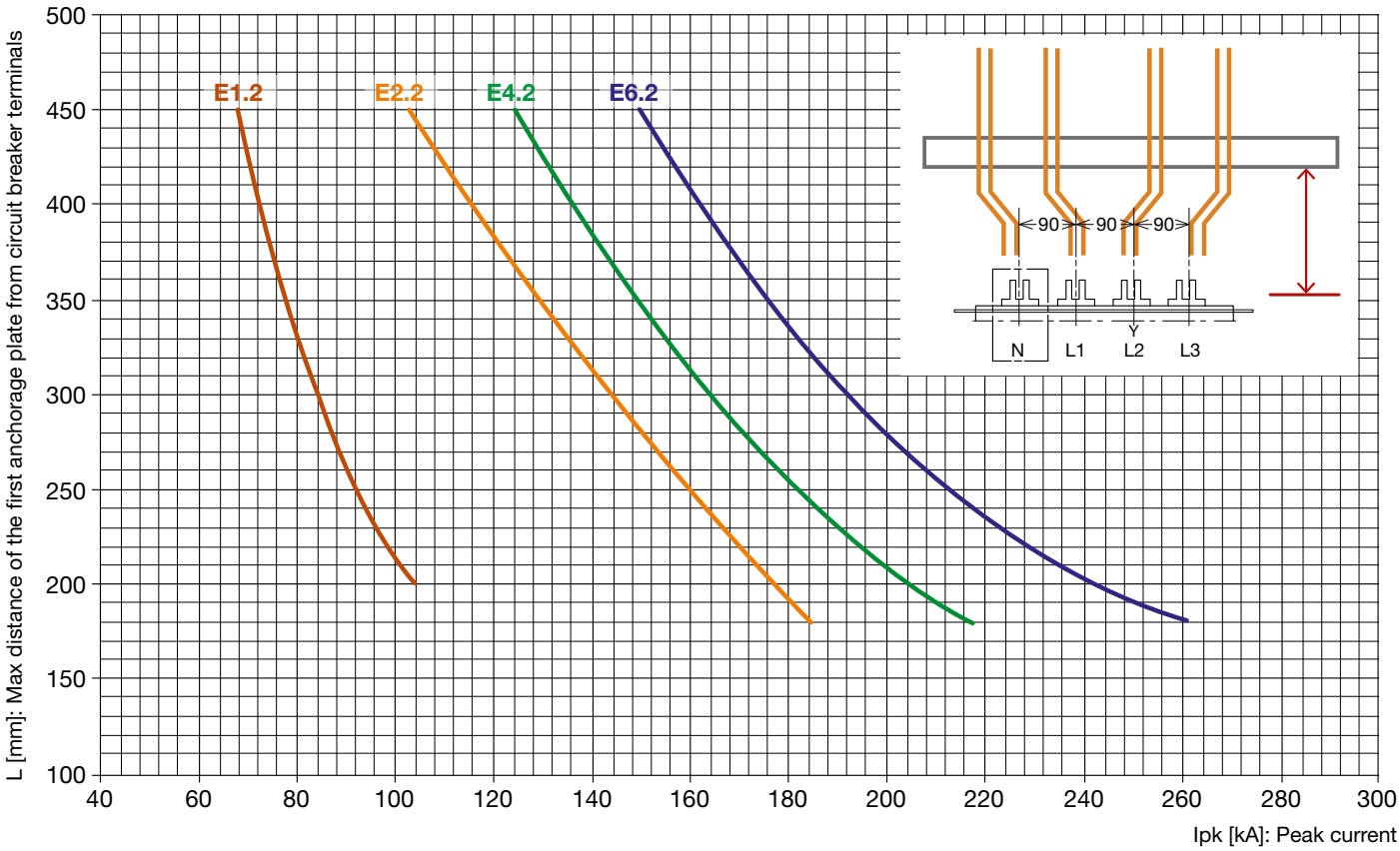
c) The modification needed to adapt the original center line distance to the terminal spacing is only in the busbar section between the terminals and the first insulated anchor installed according the ABB instructions (see figure F4 about the maximum distances admitted in this section and the figure's insert as an example). The short circuit behavior of the conductor on this section is verified by ABB in the test and calculation activities made to define the curves of the figure F4.

Figure F4



d) The reduced center line distances are still tested in a functional unit with a different device installed (e.g. for the substitution of an Emax E3 2500A with an Emax 2 E2.2, the Icw=65kA performances could be already tested with a center line spacing of 90mm in a functional unit where the Emax E2 is installed).

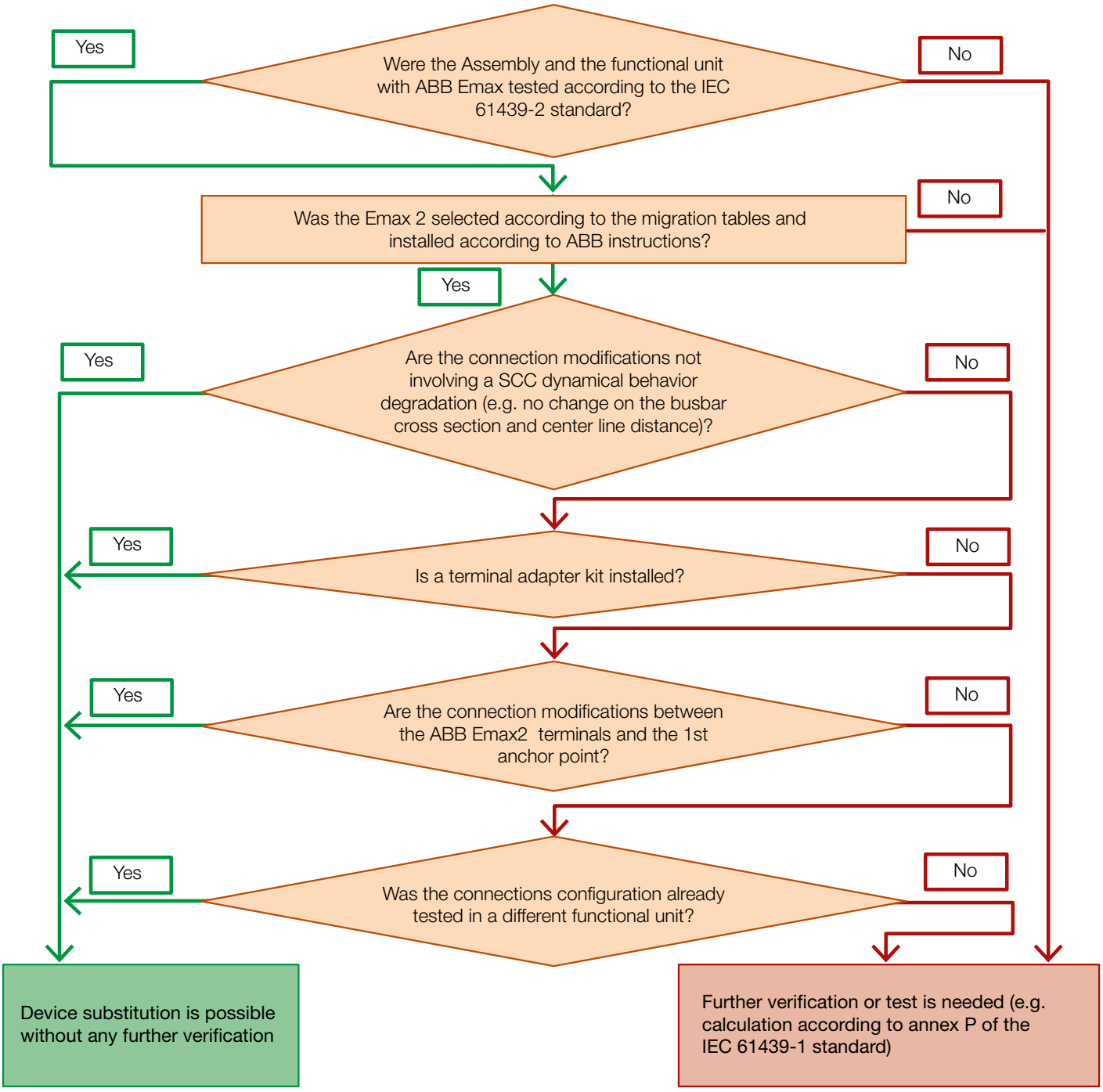
Conclusion

In general, it is possible to substitute an Emax series circuit breaker with an Emax 2 series circuit breaker without:

- *repeating the temperature and short circuit verifications required by the standards for the assembly certification*
- *any derating*

if

- *the Emax 2 circuit breaker is correctly selected according to the contents of paragraph 1 (e.g. using the tables T1 and T2)*
- *one of the alternative conditions reported in the paragraph 3 (either a, b, c, or d) is fulfilled.*


Were the Assembly and the functional unit with ABB Emax tested according to the IEC 61439-2 standard?
Yes
No
Was the Emax 2 selected according to the migration tables and installed according to ABB instructions?
Yes
No
Are the connection modifications not involving a SCC dynamical behavior degradation (e.g. no change on the busbar cross section and center line distance)?
Yes
No
Is a terminal adapter kit installed?
Yes
No
Are the connection modifications between the ABB Emax2 terminals and the 1st anchor point?
Yes
No
Was the connections configuration already tested in a different functional unit?
Yes
No
Device substitution is possible without any further verification
Further verification or test is needed (e.g. calculation according to annex P of the IEC 61439-1 standard)

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