PRODUCT NOTE

System pro E power
Assembly guidelines

Index

1. The switchboard system

System pro E power is the ABB range of low voltage power and distribution switchboards for indoor installation.
The products are designed for use as main or secondary switchboards in industry or the services-providing sector (e.g.: in hospitals, shopping malls, banks, infrastructure buildings). The ABB switchboard system is hardwearing and sturdily built from top quality materials able to withstand extremely high electrodynamic and mechanical stress.

ABB Power Centers are according to the standard IEC 61439-1/2 and they provide the highest level of safety for persons and things as well as high performance (e.g.: Icw 150kA 1s, IP65, form 4b).

All the components and kits are designed for easy, safe and rapid assembly.
The switchboards are built from modular components enabling single column or multiple column solutions to be created.
High-level operator safety is ensured since use of System pro E power allows all the forms of segregation envisaged by the standard.

Storage of kits and components
Keep the components in their original packing materials and store in a suitable place (e.g.: dry, protected from the rain and adverse weather conditions, protected from dust, from chemicals and from pollution) at a temperature between -25°C and +55°C.

Main characteristics

Compliance with standard	IEC 61439-1/2-IEC 62208- IEC TR 61641
	IEC 60068-2-57-IEEE 693-IEC 68-3-3
Rated current of switchboard (InA)	up to 6300 A (7000 A the main busbars)
Rated voltage (Un)	up to 1000VAC/1500 VDC
Rated impulse withstand voltage (Uimp)	up to 12 kV
Overvoltage category	IV
Pollution degree (of the installation environment)	3 (industrial) according to IEC 61439-2
Rated insulation voltage (Ui)	up to 1000VAC/1500 VDC
Rated frequency (fn)	50/60 Hz
Rated short-time withstand current (Icw)	up to 150 kA, 1s
rated peak withstand current (Ipk)	up to 330 kA
Mechanical impact	IK08 without door
	IK09 with glass door
	IK10 with blind door
Degree of protection IP	up to IP65
Forms of segregation	all, up to form 4b
Anti-seismic	up to 0.69g (standard version)
	up to 1g (anti-seismic kit)

2. Switchboard assembly

Instructions on how to assemble the switchboard are given in the System pro E power Instruction Manual.
When the equipment arrives, you will find the Instruction Manual in the packs with the yellow labels, which contain the depth-crosspieces of each column.

2.1. Preparation for assembly

You are advised to use the documents issued by the switchboard configuration software namely:

- The front view generated by DOC (switchboard configurator);
- The project file created by the CAT, which contains the bill of materials of the switchboard

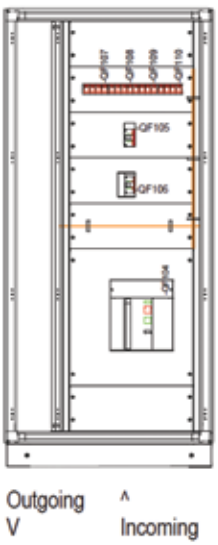
The project file contains all the components that form the switchboard along with their description, code and quantity (e.g.: busbar system and segregations, switchboard structure, columns with the equipment installed and the kits).
You are advised to print the bill of materials and switchboard front.

These printouts provide the panel builder with information about the specific configuration of the switchboard (e.g.: number of columns, type and number of apparatuses installed, presence or absence of cable containers, route of main busbars and distribution busbar branches).

Example of a bill of materials created by CAT

Description	Code	Sign	Q.ty	DIN
Estimate / Order				
Switchboard1			**1**	**48**
DistributionSystem			**1**	
SEGR.VER.LAT.LEXAN H=200MM D=700MM IN.UP	PLLS2070		2	
SEG.BUS.HOR.REAR +INT.UP.W600 FOR D700	PTHS6072		2	
SEG.BUS.VER.FRONT.H200+INT.UP.W600	PFVS2062		1	
SEGR.VERT.REAR H=200MM W=600MM INT.UP.	PRVS2061		1	
SEGR.VERT.REAR H=200MM W=600MM INT.UP.	PRVS2062		1	
FLAT CUPONAL BUSBAR 100X10 L=1750MM	PBFA1001		2	
N.2 galvanized sheet crosspieces W=238mm	PCRM0238		2	
N.24 insulated supports for busbars W=50mm	PBHB1125		1	
N.10 nylon tie rods W=195mm 4000A	PTRN1951		2	
N.2 galvanized sheet crosspieces W=438mm	PCRM0438		1	
8 UNIVERSAL BRACKETS	PBBU0008		1	
Col.1			**1**	**48**
2 SIDE PLINTH FLANGES H=100MM D=700MM	PPFM1070		1	
4 GALVANIZ. SHEET CROSSPIECES W=800MM	PCFM0800		1	
4 GALVANIZ. SHEET CROSSPIECES D=700MM	PCFM0700		1	
4 GALVANIZED SHEET UPRIGHTS H=1800MM	PUPM1800		1	
GALV. SHEET C.CONT. UPRIGHT H=1800MM	PUCM1800		2	
BLIND DOOR I CABLE CONT.H=1800MM W=200MM	PDCB1820		1	
FIXED FRAME FOR PANELS H=1800MM W=600MM	PFPF1860		1	
IP65 GL.DOOR 24 DIN H=1800MM W=800MM	PDLG1862		1	24
IP65 EXTERNAL PANEL H=1800MM W=800MM	PPEB1886		1	
IP65 EXTERNAL PANEL H=1800MM D=700MM	PPEB1876		2	
IP65 BLIND TOP BOTTOM W=800MM D=700MM	PTBB8076		1	
IP65 OPEN BOTTOM W=800(600+200) D=700 CC	PTBO8271		1	
CABLE ENTRY FLANGE W=600MM D=700MM	PFCF6070		1	
FIX.FLANGE IP65 IN.CAB.COM.W200MM D700MM	PFCF2071		1	
4 GALV. SHEET CORNERS PLINTH H=100MM	PPAM0100		1	
2 F R PLINTH FLANGES H=100MM W=800MM	PPFM1080		1	
INTERMEDIATE UPRIGHT INT.KIT H=1800MM	PUKI1800		3	
2 GALVANIZ. SHEET CROSSPIECES CC D=700MM	PCCM0700		1	
HORIZONTAL SHELF W=600MM	PSHS1906		1	
INTERMEDIATE UPRIGHT INT.KIT H=1800MM	PUKI1800		1	

Corresponding switchboard front view created by DOC



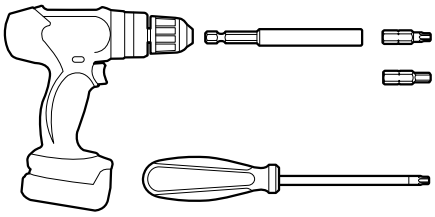
Switchboard assembly can proceed with the aid of the bill of materials, switchboard front-view and instruction manual.

2. Switchboard assembly

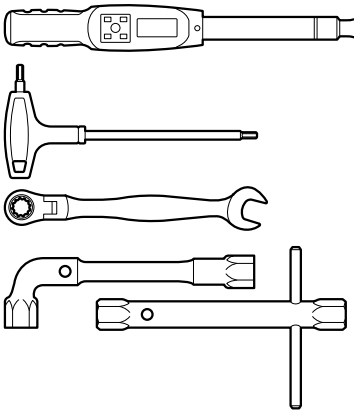
2.2. Assembly tools

The following tools are required to assemble System pro E power:

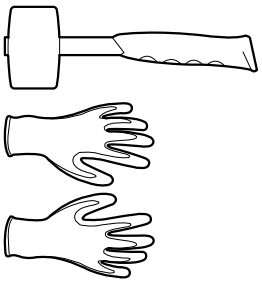
- Screwdriver equipped with:
  - extension for screwdriver bit inserts
  - inserts for 15/20/30 Torx screws
  - inserts for 5/8/10 hex screws
- Hand screwdrivers for Torx 15 screws



- Torque wrench for 5/8/10 mm hex screws
- Male setscrew wrench for 10 mm Allen screws; minimum length: 15 cm
- 10/17/19 mm socket wrench
- 10/17/19 mm combination ratchet wrench



- Rubber mallet
- Gloves



2.3. Tightening torque values

Tightening torque values for the structure and internal kits.

Component/diameter - screw/bolt	Torque [Nm]
Screws for kits (M6 thread-rolling)	6
M6 screws/nuts	8.9 to 9.9
Screws for structural uprights and crosspieces (M10)	20
Screws for external panels and hinges	5

Tightening torque values for busbar systems in copper, cuponal, aluminium and hex insulator.

Component/diameter - screw/bolt	Torque [Nm]
Nylon tie rod	4
AISI 304 stainless steel tie rod	15
Screws for shaped busbars	20
M6	8.9 to 9.9
M8	21.8 to 24.2
M10	43.2 to 48
M12	74.3 to 82.6

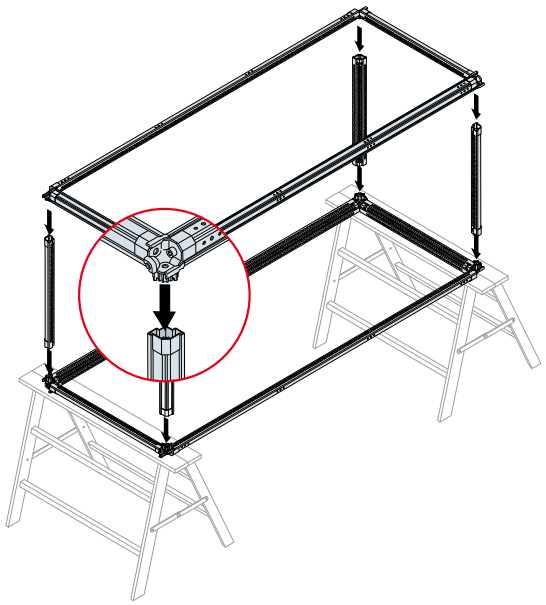
Tightening torque values for flexible bars.

Screw/bolt diameter	Torque [Nm]
M6	13
M8	30
M10	60
M12	100

2.4. Assembly sequence

1) Frame

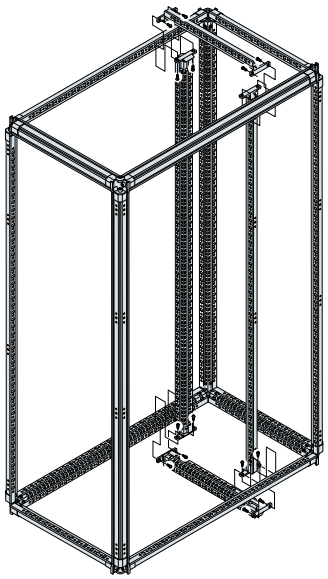
Assembly of vertical uprights and crosspieces of structure.



Assembly of the bottom and plinth (*)
Use the electrical continuity cable of the earthing system for the base with plinth

(*) consider the IP class. Consult the technical catalog and manual for the options available

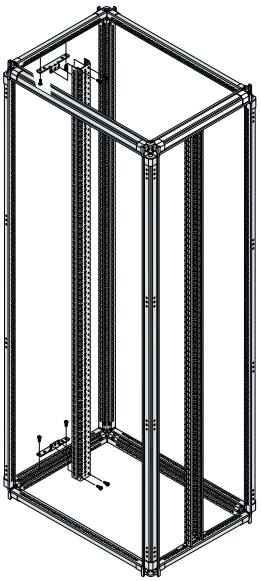
Assembly of internal cable container
If required, can be used in column widths: 600mm, 800mm, 1000mm.



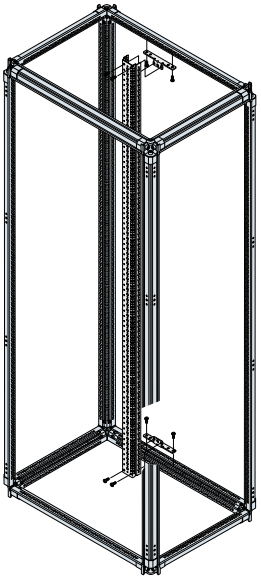
2. Switchboard assembly

Assembly of side intermediate uprights
Required for form 2a, 3a/b and 4b segregated switchboards.
Not required for installation of:

- Tmax XT1, XT2, XT3, XT4
- fixed versions
- Tmax XT1 and XT3 with direct
- crank handle
- Tmax T4, T5 and T6 fixed versions



Assembly of rear intermediate uprights
Required for form 3b and 4b segregated switchboards.

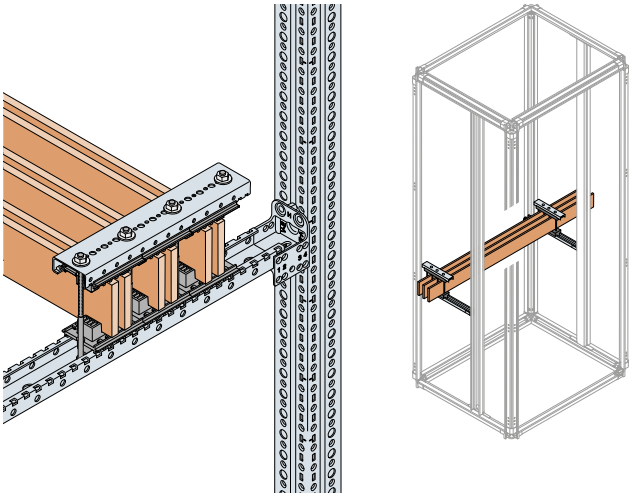


2) Busbars

Assembly of supports for main busbars

Assembly of supports for vertical distribution busbars

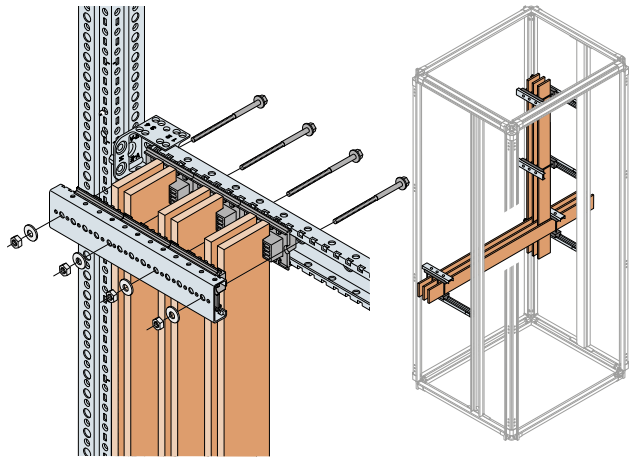
The number of supports and the distance between them depend on the number of busbars, their section and on the Icw.



Assembly of main busbars (horizontal)
In the case of In ≥ 4000 A, use 2 lower supporting crosspieces to bear the weight of the busbars.

Assembly of vertical distribution busbars and connection to main busbars.

For form 2b/4a, use of an internal or external side cable containeris mandatory for the vertical busbars

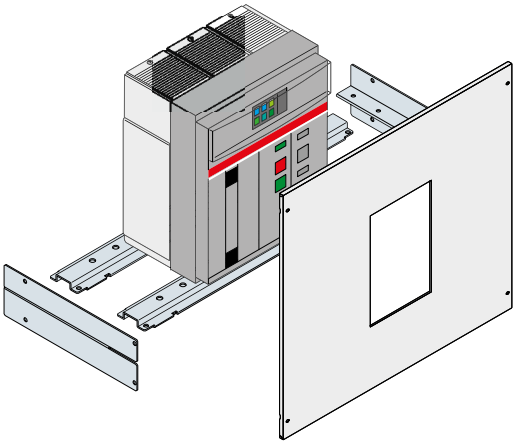


2. Switchboard assembly

3) Switching devices

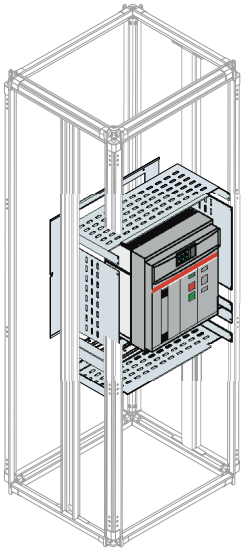
Emax 2 Air circuit-breakers

Asembly of kit for Emax 2 air circuit-breakers



Assembly of 2a-3a segregation kit
(if required)

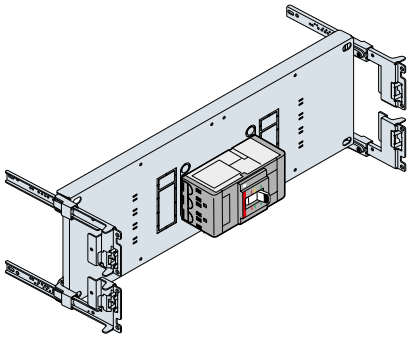
Assembly of circuit-breaker



Tmax T and Tmax XT moulded-case circuit-breakers

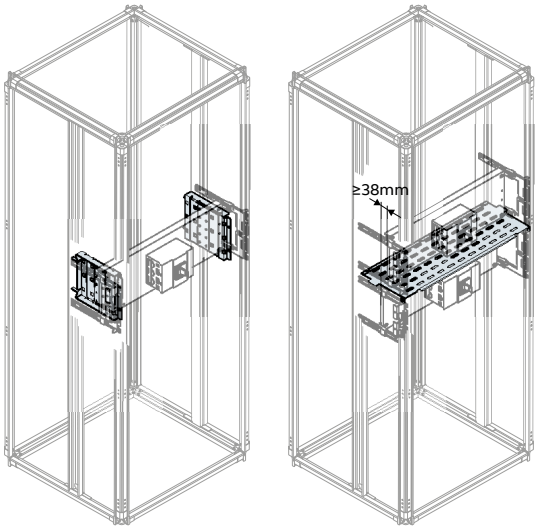
Assembly of kit for Tmax mouldedcase circuit-breakers

Assembly of circuit-breaker



Assembly of 2a-3a segregation kit
(if required) (*)
Horizontal separation is required when the plates of the circuit-breaker kits have a gap over 38mm in depth (with form 3a)

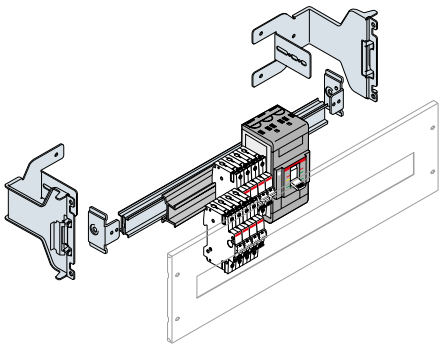
Horizontal separation is always required when installation is horizontal and the form is 3b-4b



(*) High terminal covers are required for the front terminals of the circuit-breaker if the segregation form is over 1.

Switching devices on DIN rail

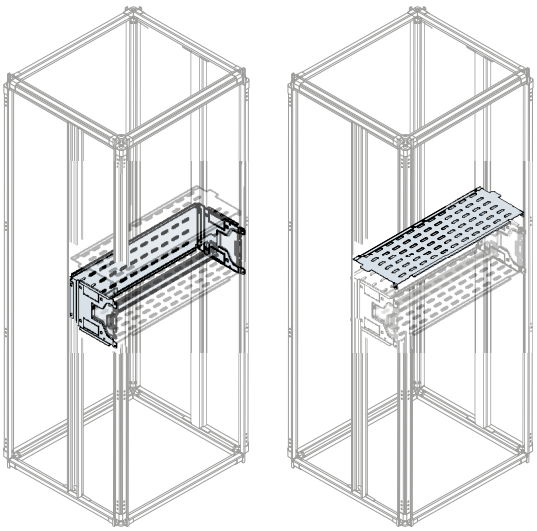
Assembly of DIN rail kit



Assembly of 2a-3a segregation kit
(if required)

Assembly of switching device (e.g.: modular circuit-breakers, XT1F, XT3F, DIN rail devices)

When necessary, horizontal separation is entered automatically by the configurator.

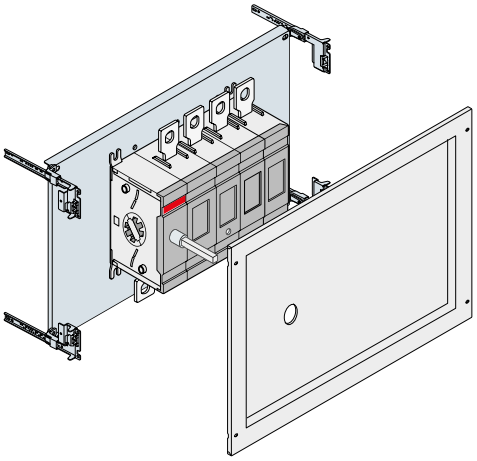


2. Switchboard assembly

OT disconnectors

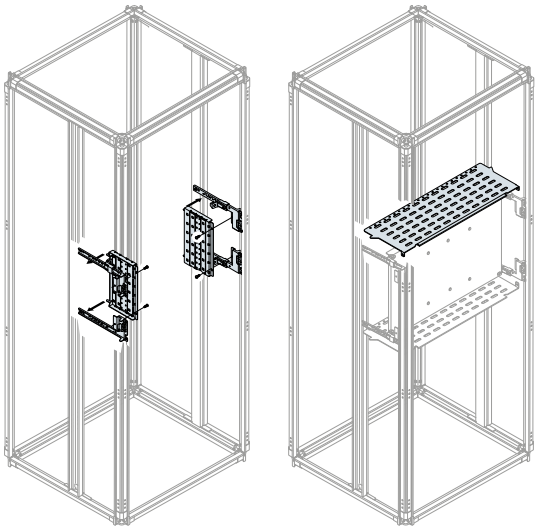
Assembly of kitfor OT disconnectors

Assembly of disconnector



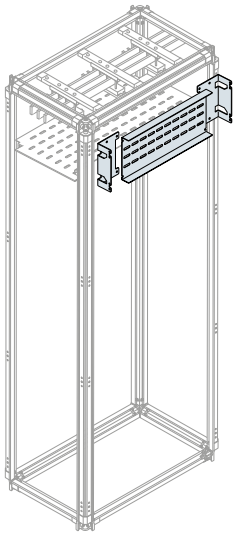
Assembly of 2a-3a segregation kit
(if required)

Horizontal separation is mandatory when the plates of the disconnector kits have a gap over 38 mm in depth (with form 3a)



4) Segregations

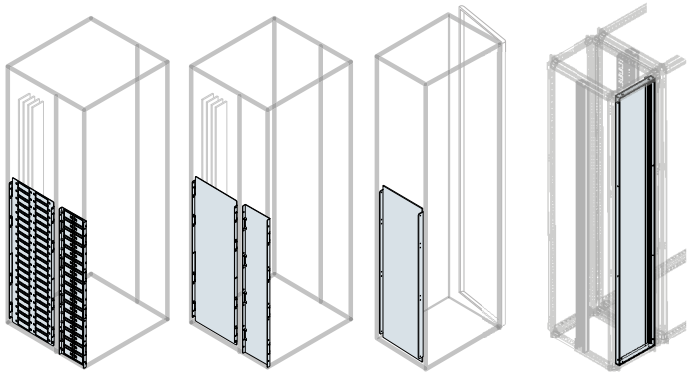
Assembly of 2b/4a segregation for horizontal busbars (if required)

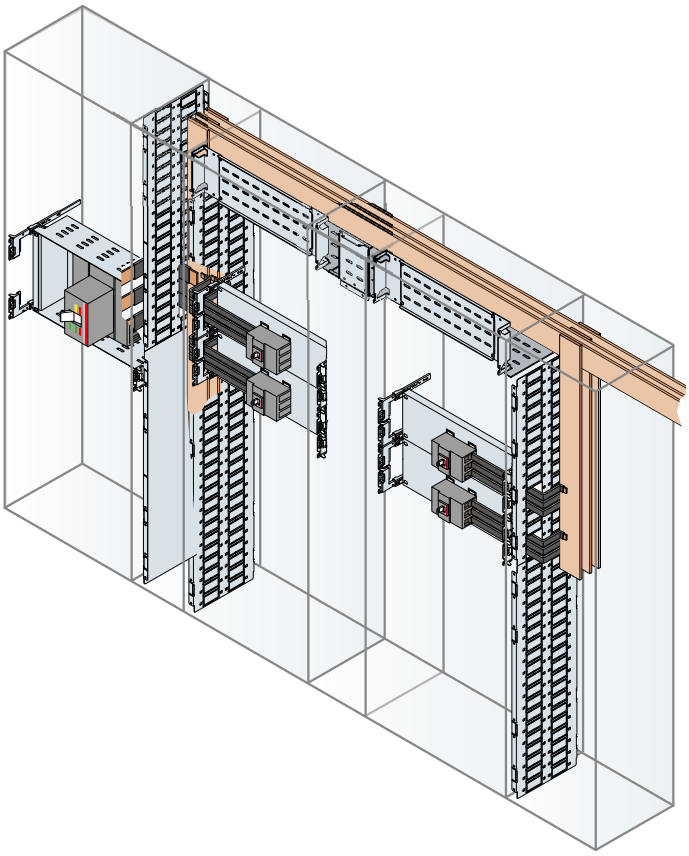


Assembly of 2b/4a segregation for vertical busbars (if required)

With form 2b/4a, use of an internal or external side cable container is mandatory for the vertical busbars.

Pre-cut lateral segregation allows the switching devices to be energized.



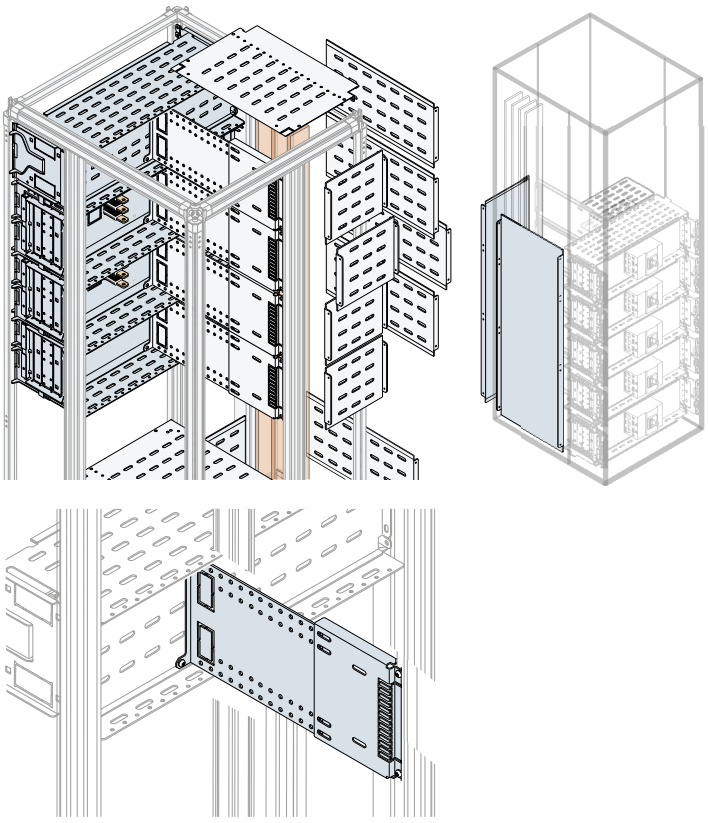


2. Switchboard assembly

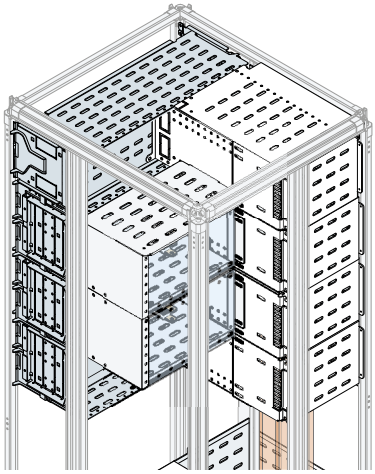
or
Assembly of 3b/4b segregation for vertical busbars
(if required)

+

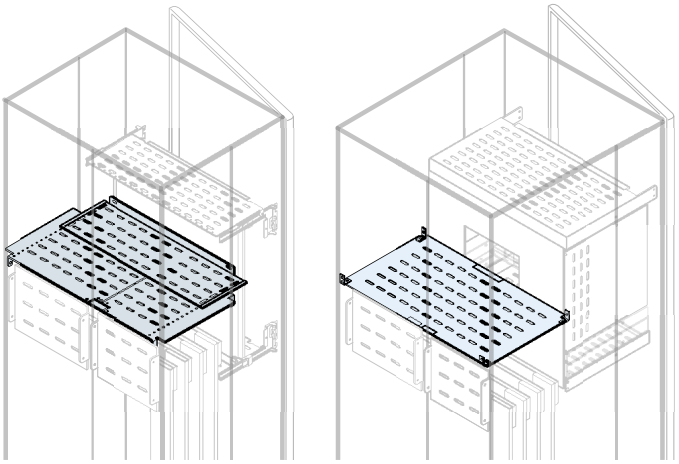
Assembly of the terminal separator, for segregation 3b, of the circuit-breakers installed horizontally and energized by the vertical busbars.



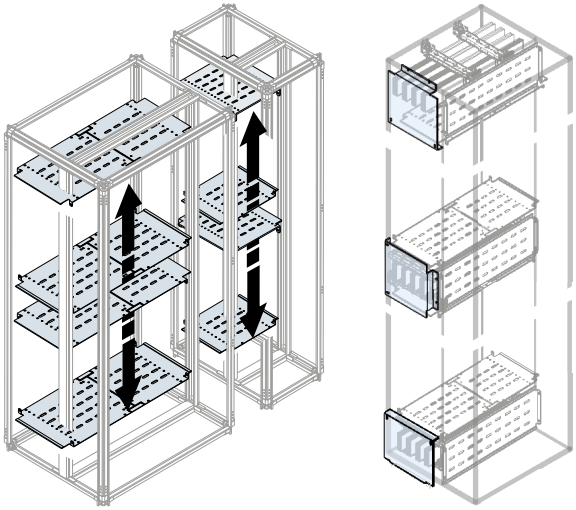
Assembly of segregation 4b for the output terminals of horizontal circuitbreakers energized by the vertical busbars



Assembly of the separator between the input terminals and output terminals for 3b segregation of circuitbreakers installed vertically

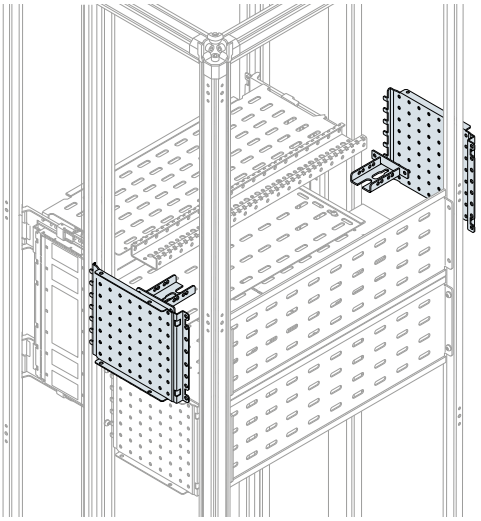


Assembly of 3b-4b segregation for horizontal busbars



Assembly of the connection module for the input terminals and output terminals (air circuit-breakers and large moulded-case circuitbreakers installed vertically)

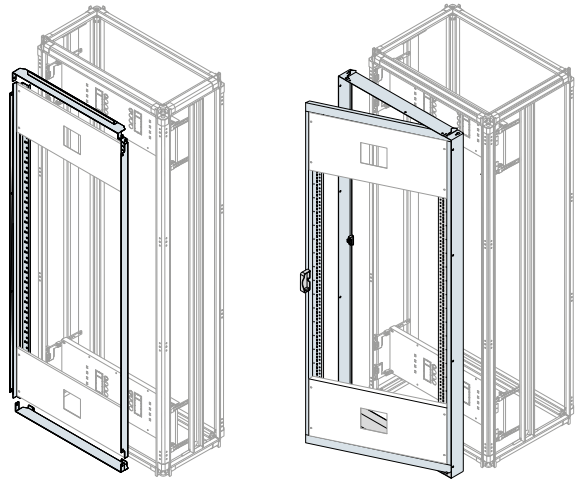
The connection module for the input terminals is part of 3b segregation of the circuitbreaker.
The connection module for the output terminals is part of 4b segregation of the circuitbreaker



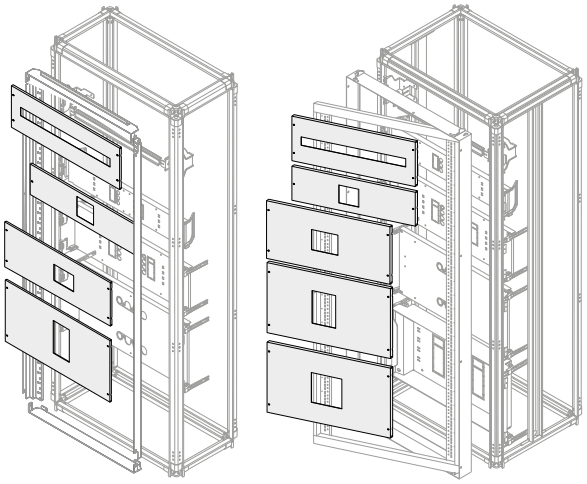
2. Switchboard assembly

5) Frame and internal panels

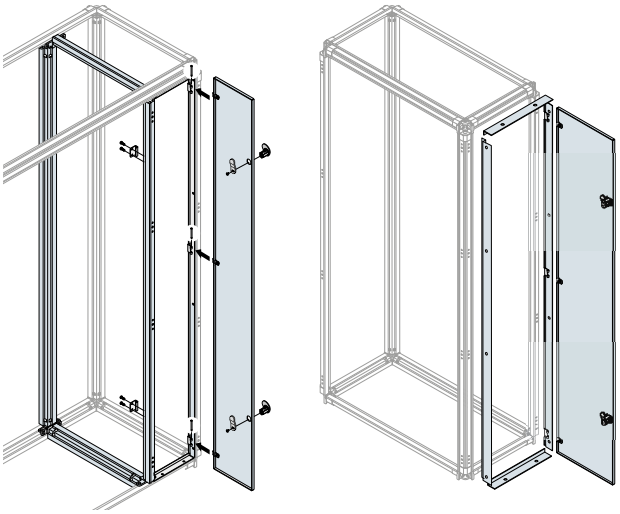
Assembly of frame (fixed or swing)
Use the earth continuity cable for the swing frame



Assembly of internal panels
Earth continuity for the internal panels is ensured without the use of any cable.
Use earthing cable/braid for internal panels fitted with electrical equipment differing from class 2 (e.g.: lamps or measuring instruments)



Assembly of door for internal/external cable containers



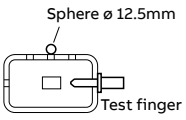
6) IP degree and external panels

The IP protection degree indicates the level of protection of the enclosure against access to dangerous parts, against the penetration of solid foreign bodies (1st digit) and against the ingress of water (2nd digit). The IP code is the system that identifies the protection class in compliance with the provisions established by Standard IEC 60529.

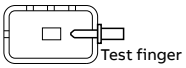
Unless specified differently by the manufacturer, the protection degree of switchboards applies to the entire switchboard, assembled and installed and used in the ordinary way (with the door closed). The manufacturer can also indicate the protection classes of particular configurations that may be present during operation, such as the protection class with the doors open. The protection class of System pro E power with the doors open is IP30/31.

According to IEC 61439-2, the protection degree of a closed switchboard for indoor use must be at least 2X after installation, in accordance with the instructions provided by the switchboard manufacturer. The IP class of the front and rear must be at least IP XXB. Protection class IP 2X covers protection class IP XXB.

IP2X: enclosure protected against access by fingers. The test finger (diameter 12mm and length 80 mm) must not be able to touch dangerous parts. The 12.5 mm ball must not be able to penetrate completely into the enclosure.



IPXXB: enclosure protected against access by fingers. The test finger (diameter 12mm and length 80mm) must not be able to touch dangerous parts.



The IP degrees which can be obtained with System pro E power are listed below.

IP30/31 (external panel without gasket)
Assembly of side panels (blind or with ventilation grille)
Assembly of rear panel (blind or with ventilation grille)
Assembly of front sealing profiles
Assembly of roof
Assembly of roof closing kit IPX1 (if required)

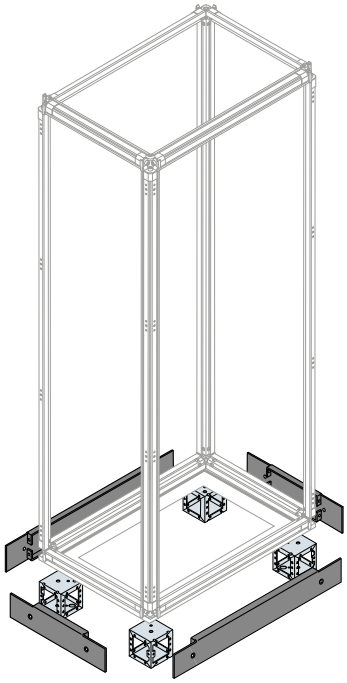
IP40/41 (external panel without gasket)
Assembly of side panels (blind or with ventilation grille IP4X)
Assembly of rear panel (blind or with ventilation grille IP4X)
Assembly of door (*)
Assembly of roof
Assembly of roof closing kit IPX1 (if required)

IP65 (external panel with gasket)
Assembly of blind side panels
Assembly of blind rear panel
Assembly of door (*)
Assembly of roof

(*) Use the earth continuity cable for the door. Use earthing cable braid for doors fitted with electrical equipment differing from class 2 (e.g.: lamps or measuring instruments)

7) Plinth flanges

Assembly of plinth flanges (*)



(*) plinth + flanges are mandatory for IP65

2. Switchboard assembly

2.5. Electrical continuity

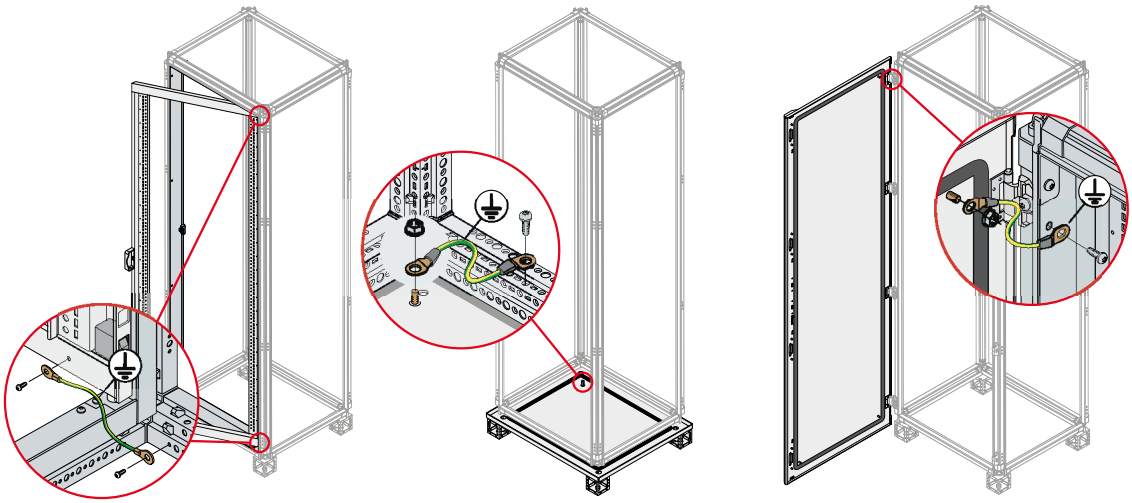
The exposed conductive parts of the switchboard must be electrically connected to each other and to the main protective conductor. These connections must be made using screwed, welded metal connections or other conductive connections, or a separate protective conductor. Generally speaking, electrical continuity in System pro E Power switchboards is automatically guaranteed by the screws and bolts (screws and nuts with sharp-toothed washers) and by the way the structure assembly is engineered.
In addition, the connections can be made using the earthing studs on the external panels (e.g.: the door and bottom) to which the earthing braid can be connected.

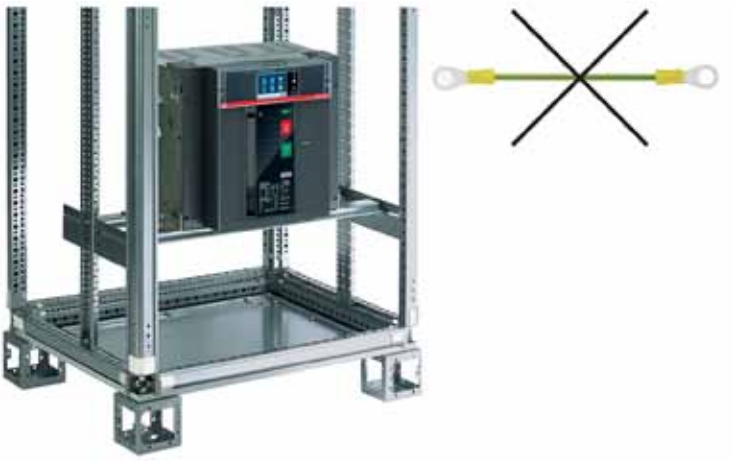
Electrical continuity of the structure and panels is obtained thanks to the fastening screws, as indicated in point b) of art. 8.4.3.2.2, of IEC 61439-1. Continuity is ensured for panels in the open position by the hinges (ABB patent) and in the closed position by both the hinges and 1/4 turn screws.

Remember that electrical continuity is provided by means of connections with metal hinges and screws when:

- only and exclusively screws, bolts and accessories supplied by ABB along with the components are used (e.g.: 1/4 turn screws, self-threading screws, screws and nuts with sharp-toothed washers that bite into the paint and hinges)
- assembly is performed in compliance with the instructions given in the manuals.

With System pro E power, the earth continuity cable is used for the door, the swing frame and the bottom with plinth





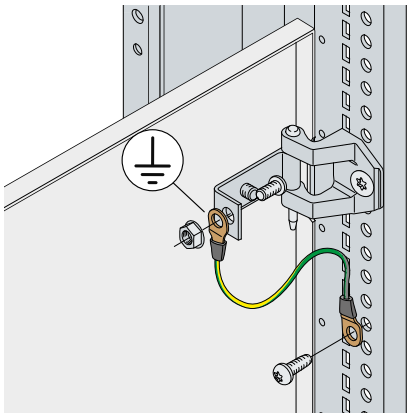
Since the internal parts and the assembly kits of the switching apparatus are made of unpainted galvanized steel, earth continuity is guaranteed without any additional earthing braid/cable. For example, earth continuity is automatically ensured for SACE Emax 2 air circuit-breakers by having assembled the installation kit, without any additional earthing cable being required.

In the case of movable metal parts like doors, swiveling or removable panels on which electrical apparatus differing from class 2 is installed (e.g.: lamps or measuring instruments), use of a cable/braid for the earth connection is mandatory.

The cable section must be chosen as indicated in Table 3 of IEC 61439-1.

Rated operational current I_e (A)	Minimum cross-sectional area of a protective conductor (mm²)
$I_e \leq 20$	S[a]
$20 < I_e \leq 25$	2,5
$25 < I_e \leq 32$	4
$32 < I_e \leq 63$	6
$63 < I_e$	10

[a] S is the cross-sectional area of the phase conductor (mm²)



2.6. Segregations

The form of segregation defines the physical separation between the characteristic components of a switchboard, which are: functional units, busbars and terminals for external conductors.

Segregation can be metallic or non-metallic and must enable at least one of the following conditions to be obtained:

- IPXXB protection against contact with dangerous parts;

or

- IP2X protection against the introduction of foreign bodies.

Protection class IP 2X covers protection class IP XXB.

The form of segregation is indicated on the basis of the degree of accessibility that needs to be obtained for maintenance or inspections.

Since a higher segregation rating implies certain increases in the construction of a switchboard (cost, space required, front or rear accessibility, functional unit accessories), it must be the result of an agreement between the customer and panel builder. In general, a switchboard that does not require any particular maintenance will have a low segregation form rating (form 1 or 2); the more complex is the function of the switchboard (e.g. a Power Center switchboard in an MV/LV substation) the higher will be the segregation form rating.

Form 1	No internal segregation
Form 2	Segregation of busbars from all functional units.
Form 3	Segregation of busbars from all functional units and segregation of all functional units from each other. Segregation of the terminals for external conductors and the external conductors from the functional units, but not from the terminals of other functional units.
Form 4	Segregation of busbars from all functional units and segregation of all functional units from each other. Segregation of the terminals for external conductors from the functional units, from the terminals of any other functional unit and from the busbars. Segregation of the external conductors associated with a functional unit from other functional units and from their terminals. The external conductors do not need to be separated from each other.

All the forms of segregation envisaged by standard IEC 61439-2 can be obtained with System pro E power.

Consult the technical catalog of the switchboard for further details.

3. Main distribution system

3.1. Introduction

The main distribution system of System pro E power is able to cover a broad range of values for nominal (In) and short-circuit (Icw/Ipk) performance. System pro E power offers the following options:

- Busbars in flat electrolytic copper Cu-ETP 99.9% UNI: 5649; In up to 7000 A, Icw up to 150 kA (1s).
- Flat busbars in Cuponal (coextruded aluminium and copper); In up to 3200 A and Icw up to 65kA (1s).
- Copper shaped busbarsfor the following In: 2860A (IP30/31), 2750A (IP40/41), 2500A (IP65); Icw up to 75kA (1s) Only use shaped busbars supplied by ABB.

3.2. Definition of the main distribution system

The power supply busbars must be sized to continuously carry rated current In without exceeding the temperature rise limits established by the standard. They must withstand the electro-dynamic stress deriving from short-circuit currents, which must not exceed the admissible short-circuit current rating of the switchboard (admissible short-time withstand current Icw or conditional short-circuit current Icc).
The System pro E power catalog contains tables for each type of busbar system, for the purpose of defining:

1. the section of the busbars and number of busbars for each phase, on the basis of the In and IP rating (Tamb=35°C);
2. the number of supports and the maximum center distance (Xmax) between the supports on the basis of the Icw, the section of the busbars and the number of busbars for each phase.

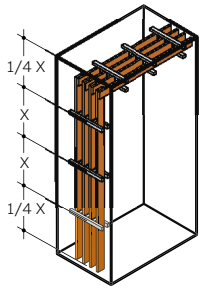
The tables have been defined following tests performed according to IEC 61439-1.
Example
Flat copper busbars
In = 4000 A; IP 40
Icw = 65 kA
Using the tables in the catalog, choose:

1. the section and number of busbars per phase;
2. the number of busbar holders in the busbar system and the maximum distance between them (Xmax).

Copper busbars

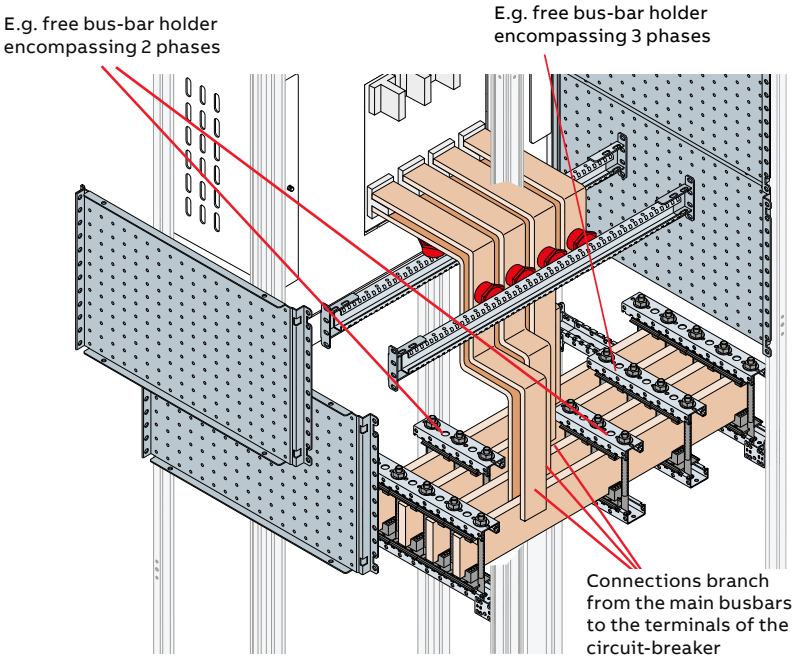
Description							No. busbar holders Lenght =1750mm in relation to Icw max													
Capacity In (A)			Number of busbars per phase	WxW (mm)	Busbar	Insulators	15 kA	X max	25 kA	X max	36 kA	X max	50 kA	X max	65 kA	X max	75 kA	X max	85 kA	X max
IP30/31	IP40/41	IP65																		
FLAT BUSBARS																				
250	250	250	1	20x5	PBFC2005	PBHB1125	7	275	-	-	-	-	-	-	-	-	-	-	-	-
400	-	-	1	25x5	PBFC2505	PBHB1125	7	300	9	200	-	-	-	-	-	-	-	-	-	-
-	400	400	1	32x5	PBFC3205	PBHB1125	5	450	7	275	-	-	-	-	-	-	-	-	-	-
630	-	-	1	40x5	PBFC4005	PBHB1125	5	450	7	300	9	200	-	-	-	-	-	-	-	-
-	630	630	1	50x5	PBFC5005	PBHB1125	5	475	7	300	9	225	-	-	-	-	-	-	-	-
800	-	-	1	30x10	PBFC3010	PBHB1125	4	525	5	450	7	300	-	-	-	-	-	-	-	-
-	800	800	1	63x5	PBFC6305	PBHB1125	4	525	5	425	6	325	-	-	-	-	-	-	-	-
1000	-	-	1	40x10	PBFC4010	PBHB1125	4	525	5	450	6	375	9	225	-	-	-	-	-	-
-	1000	1000	2	40x5	PBFC4005	PBHB1125	4	525	5	475	6	375	-	-	-	-	-	-	-	-
1000	-	-	1	80x5	PBFC8005	PBHB1125	4	525	5	475	6	375	9	225	-	-	-	-	-	-
1250	1250	1250	1	100x5	PBFC1005	PBHB1125	3	1000	4	525	6	375	7	275	-	-	-	-	-	-
1250	-	-	1	50x10	PBFC5010	PBHB1125	3	1000	4	525	6	375	8	250	9	200	-	-	-	-
-	1600	1600	1	100x10	PBFC1001	PBHB1125	3	1000	4	550	4	500	6	325	9	200	-	-	-	-
1600	-	-	1	80x10	PBFC8010	PBHB1125	3	1000	4	525	5	475	7	300	9	200	-	-	-	-
1600	-	-	2	80x5	PBFC8005	PBHB1125	3	1000	4	525	5	475	7	300	9	200	-	-	-	-
2000	-	-	2	100x5	PBFC1005	PBHB1125	3	1000	4	550	4	500	6	325	9	200	-	-	-	-
-	2000	2000	1	120x10	PBFC1201	PBHB1125	3	1000	4	550	4	500	6	325	9	200	-	-	-	-
2000	-	-	2	50x10	PBFC5010	PBHB2145	3	1000	4	525	6	375	8	250	9	200	-	-	-	-
-	2000	2000	2	60x10	PBFC6010	PBHB2145	3	1000	4	525	6	375	8	250	9	200	-	-	-	-
2500	-	-	2	80x10	PBFC8010	PBHB2145	3	1000	3	1000	4	525	5	400	7	275	9	200	-	-
2500	-	-	4	80x5	PBFC8005	PBHB2145	3	1000	3	1000	4	525	5	400	7	275	9	200	-	-
3200	2500	2500	2	100x10	PBFC1001	PBHB2145	3	1000	3	1000	4	525	5	400	7	300	7	275	8	250
3200	-	-	4	100x5	PBFC1005	PBHB2145	3	1000	3	1000	4	525	5	400	7	275	9	200	-	-
4000	3200	3200	3	100x10	PBFC1001	PBHB3121	3	1000	3	1000	3	750	4	500	5	400	6	350	7	275
-	4000	4000	3	120x10	PBFC1201	PBHB3121	3	1000	3	1000	3	750	4	500	5	400	6	350	7	275
5000	5000	-	3	160x10	PBFC1601	PBHB3121	3	1000	3	1000	3	1000	3	750	5	400	6	350	7	275
7000	7000	-	3	200x10	PBFC2001	PBHB3121	3	1000	3	1000	3	1000	3	750	5	400	6	350	7	275

- In = 4000 A (IP40) => 3 ×(120 ×10) mm busbars per phase
- Icw = 65 kA => 5 busbar holders ; maximum distance between busbar holders Xmax = 400mm
- X ≤ Xmax
- The distance between the first bus bar holder and the end of the busbar must be = X/4



Fixed busbar holders, able to encompass all the phases and the neutral, cannot be positioned where there are the connections branch from the main distribution busbars to the terminals of the circuit-breaker.
Thus, free bus bar holders are used to encompass the bus bars.

Use the busbar holders supplied by ABB for the main busbar system.
Comply with the number and distances indicated in the catalog.



Do not modify the components (e.g.: do not remove parts of the busbar holders). Do not replace parts of the busbar holders (e.g.: tie rods, crosspieces, brackets or insulating supports for busbars) with components not supplied by ABB. When the ABB software configurator is used, the busbar system (busbars + insulated supports) is automatically defined in accordance with the technical catalog rules.

For further details about the busbar system, please consult the technical documentation available at the following link: https://new.abb.com/low-voltage/products/system-proe/system-pro-e-power/system-pro-e-power

Generally, not all the devices connected to the busbars are used at full load or at the same time.

Thus, sizing the busbars to carry the sum of the rated current values of all the devices continuously is not always necessary. Rated current "In" in the busbars is calculated:

- by adding together the rated current values of all the devices connected to the output circuits
- by multiplying the result by the rated diversity factor (RDF)

In the absence of an agreement between the switchboard manufacturer and user as to the real load currents, the loads assigned to the output circuits of the switchboard can be based on the rated diversity factor values given in IEC 61439-2.

Type of load	Assumed loading factor
Distribution - 2 and 3 circuits	0,9
Distribution - 4 and 5 circuits	0,8
Distribution - 6 to 9 circuits	0,7
Distribution - 10 or more circuits	0,6
Electric actuator	0,2
Motors ≤ 100 kW	0,8
Motors > 100 kW	1,0

3. Main distribution system

3.3. Clearances and creepage distances

According to IEC 61439-1, clearances and creepages include:

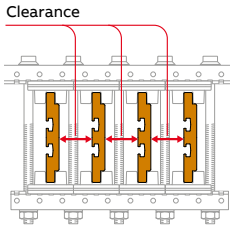
- clearance: the shortest distance in the air between two conductive parts.
- creepage distance: the shortest distance along the surface of a solid insulating material between two conductive parts.

Clearances

The clearances of System pro E power are guaranteed by tests, provided the instructions for assembling the structure, the busbar system, the kits and devices of ABB SACE have been complied with.

In accordance with Table 1 of IEC 61439-1, the guaranteed minimum clearances are 14 mm with 12kV Uimp.

Table 1



Rated impulse withstand voltage U_{imp} (kV)	Minimun clearance (mm)
≤ 2,5	1,5
4,0	3,0
6,0	5,5
8,0	8,0
12,0 →	14,0

a Based on inhomogeneous field conditions and pollution degree 3.

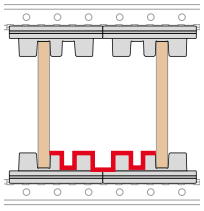
Creepage distances

The creepage distances of System pro E power are guaranteed by tests at pollution degree 3 and material group II.

In accordance with Table 2 of IEC 61439-1, the guaranteed minimum creepage distances are 14 mm with Ui = 1000 VAC/1500 VDC.

The panel builder is responsible for checking the clearances and creepage distances by means of routine tests (consult chapter 5 of the document).

Table 2



Rated Insulation voltage U_i	Minimum creepage distance (mm)							
	Pollution degree							
	1	2			3			
	Material group[c]	Material group[c]			Material group[c]			
V[b]	All material groups	I	II	III and IIIb	I	II	IIIa	IIIb
500	1,5	2,5	3,6	5	6,3	7,1	8,0	8,0
630	1,8	3,2	4,5	6,3	8	9	10	10
800	2,4	4	5,6	8	10	11	12,5	
1000	~~3,2~~ →	~~5~~	~~7,1~~	~~10~~	~~12,5~~ →	14	16	a
1250	4,2	6,3	9	12,5	16	18	20	
1600	5,6	8	11	16	20	22	25	

3.4. Protective conductor (PE, PEN)

The protective conductor (PE, PEN) must be fixed inside the switchboard and be sufficiently sized to withstand the thermal and electrodynamic stress caused by phase-earth current faults.

According to IEC 61439-1, the section of the protective conductor must not be less than the value indicated in Table 5.

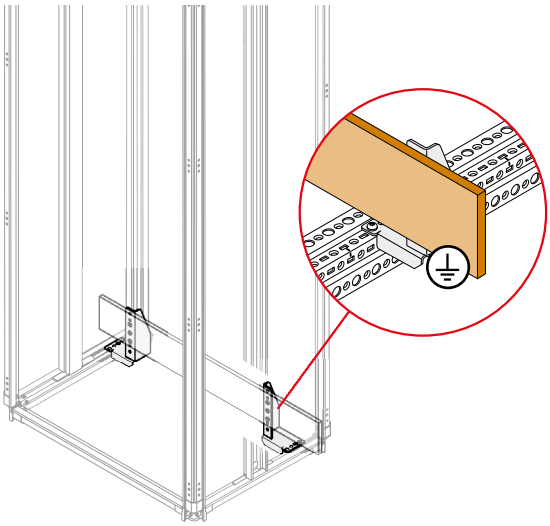
Cross-sectional area of phase conductors S	Minimum cross-sectional area of the corresponding protective conductor (PE, PEN) S_p [a]
(mm^2)	(mm^2)
S ≤ 16	S
16 < S ≤ 35	16
35 < S ≤ 400	S/2
400 < S ≤ 800	200
800 < S	S/4

The larger standard section nearest to the calculated value must be used if application of this table produces a non-standard value.
The algorithm used by the software configurator to calculate the section of the protective conductor is based on this table.

The characteristics of the protective conductor for System pro E power are guaranteed by type-tests performed on different switchboard configurations, using phase-earth fault currents = 60% of the three-phase short circuit current (10.11.5.6.1 of IEC 61439-1).

It is advisable to:

- position the earthing busbar in an easily accessible place so that the fastenings can be checked and the connections made in the workshop
- ensure that electrical continuity of the protective conductor is maintained along the entire switchboard, especially from one column to the next
- use a protective conductor with the same section along the entire switchboard.



The following additional requirements apply to the PEN conductor:

- 10 mm^2 is the admissible minimum section for a copper conductor;
- the section of the PEN conductor is established by the same procedure as the one used for the neutral conductor (N);
- is not necessary to insulate the PEN conductors inside the switchboard;
- structure parts must not be used as PEN conductors. However, the copper or aluminium assembly guideways can be used as PEN conductors;
- in certain applications, for which the current in the PEN conductor may reach high values, it may be necessary to use a PEN conductor with the same current carrying capacity as the phase conductors or even higher. This condition is subject to special agreement between the panel builder and end user.

4. Installation of the apparatuses

Chapter 8.5.5 of IEC 61439-1 provides indications about the accessibility and positions of the apparatus and external connections using cables and conductors. In the case of floor-mounted switchboards, it is good practice for:

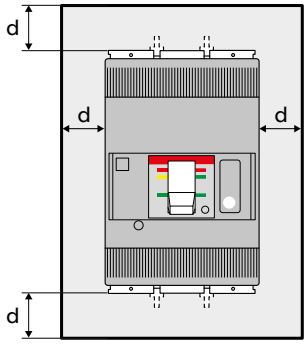
- the terminals, excluding terminals for protective conductors, to be situated at least 0.2 m above the base of the switchboard and be so placed that the cables can be easily connected to them;
- indicating instruments, that need to be read by the operator, to be located within a zone between 0.2 m and 2.2 m above the base of the switchboard;
- operating devices such as handles, push-buttons or similar, to be located at such a height that they can be easily operated; this means that they must be within a zone between 0.2 m and 2 m above the base of the switchboard;
- actuators for emergency switching devices to be accessible within a zone between 0.8 m and 1.6 m from the base of the switchboard.

4.1. Installation kits and safety perimeter

High temperatures, ionized gases and high pressure values are generated above the arc chamber during an interruption due to a short-circuit.
This means that safety distances are required for the purpose of:

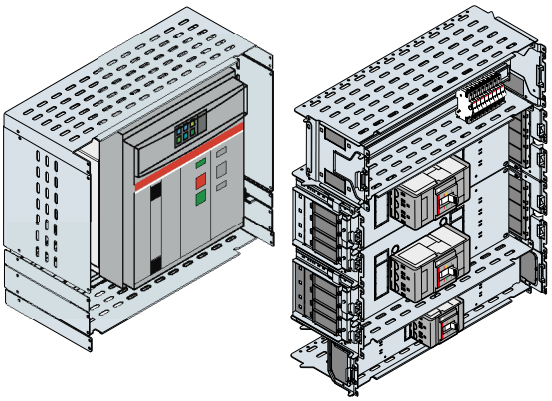
- allowing the pressure to be reduced without damage
- avoiding damage caused by the discharged hot ionized gas
- prevent discharge affecting the surrounding components/parts
- prevent discharges between conductive parts with different potentials due to the discharged ionized gases and metal vapors.

Safety distances “d” given in the technical documentation of the circuit-breakers must be complied with when the circuit-breakers are installed in the switchboard.



The various configurations of System pro E power have undergone the interruption tests according to IEC 61439-1. For this reason, the circuit-breaker assembly kits guarantee the required safety perimeter.

Installation kit for ABB SACE circuit-breakers



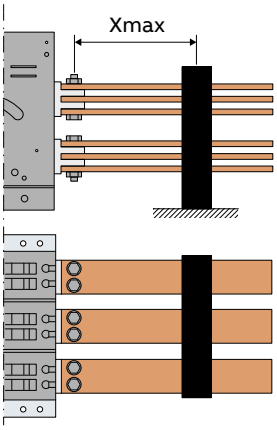
Comply with the instructions in the technical documentation of the switchboard when assembling the kits. Comply with the instructions in the technical documentation of the apparatuses when assembling the circuitbreakers.

4.2. Connection of circuit-breakers to main distribution system

The power circuits for connecting incoming and outgoing equipment are usually composed of insulated cables or bare or insulated copper busbars fixed to the structure by insulated supports.

The connections are sized to continuously carry rated current without exceeding the temperature rise limits established by the standard and to withstand the electrodynamic stress created by the prospective short-circuit current, which must not exceed the admissible rated short-circuit current of the switchboard (admissible short-time withstand current Icw or conditional short-circuit current Icc).

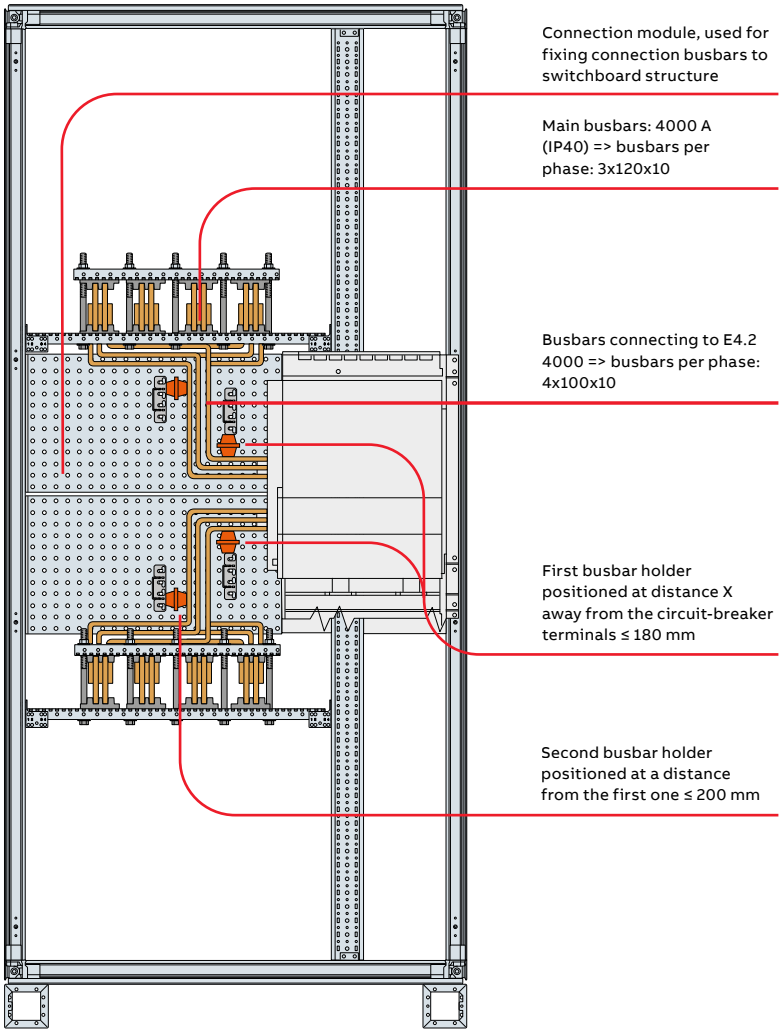
The rating (section and number of conductors per phase) and short-circuit characteristics (number of busbar holders and distance between them) for connections from the main busbars to the circuit-breakers are established by tests performed according to IEC 61439-1 and by the indications in the technical documentation of the circuit-breakers and switchboard.

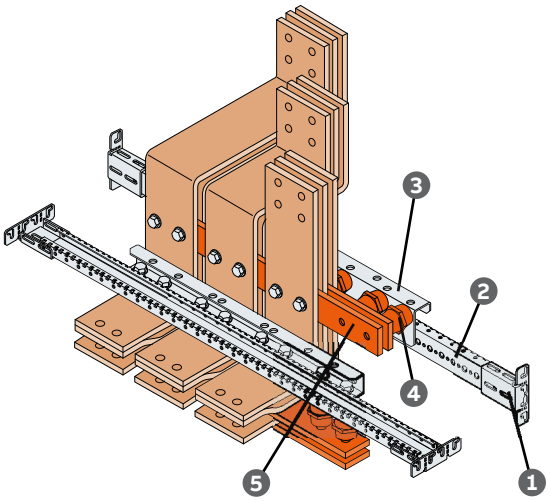


Xmax: Maximum distance, which must not be exceeded, between busbar holder and circuit-breaker terminals.

Comply with the indications given in the technical documentation of the circuit-breakers (e.g.: SACE Emax 2, Tmax XT, Tmax T) for the values of Xmax.

Example: connection of an E4.2V4000 air circuit-breaker to a busbar system with In = 4000 A; IP40; Icw = 100 kA.





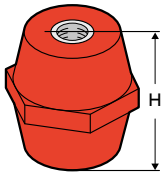
1. Brackets for fixing to the connection module
2. Crosspieces for fixing the busbars
3. Anchor plate for Emax 2 (use class 8.8 M10×16 hex bolts)
4. M10H40 hex insulators. Screw: (class 8.8 M10 hex bolt);
   H: 40 mm
5. fiber-glass reinforcement

The technical drawings of the circuit-breaker connections to the main busbars can be found at the following link:
“Documentation” / “MBBS connection drawings”

4. Installation of the apparatuses

Hexagonal spacer insulators
The hexagonal spacer insulators, are made in polyester resin stiffened with glass fibers to ensure high endurance to electrical and mechanical stress.

Technical features:
- operating tenperature: -40/+130 °C
- dielectric strenght (UNI 4291): > 12 KV/mm
- clasification of reaction to fire (CATEGORY I°-Class 1)



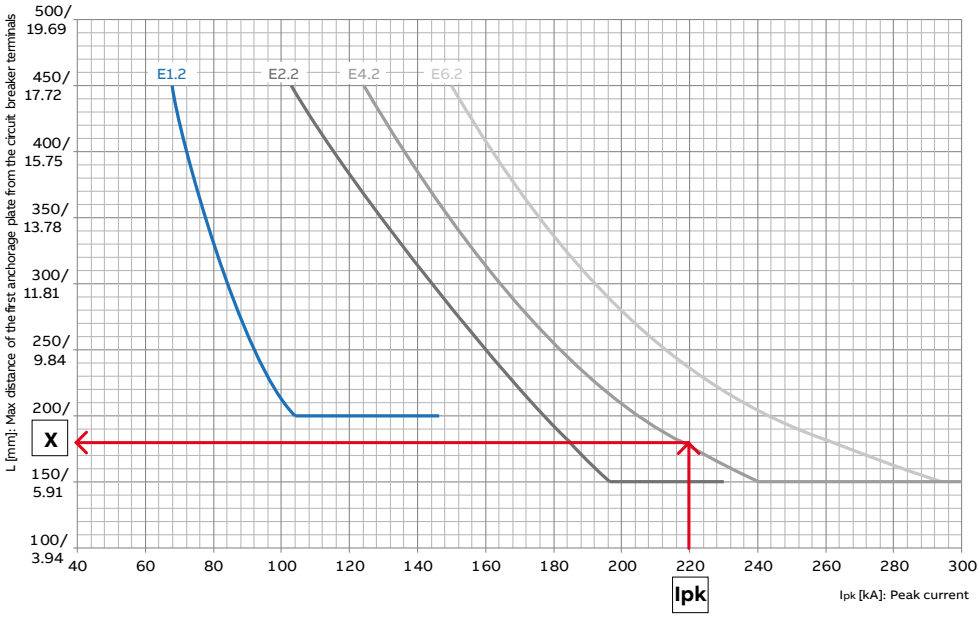
Screw	H (mm)	Tensile stress (daN)
M6	30	300
M6	50	700
M8	30	300
M8	35	800
M8	40	800
M8	50	800
M10	35	800
M10	40	450
M10	45	650
M10	50	850
M10	60	1000

Example on how to know distance X for the first busbar holder:
1) known the value of Ipk
or
2) according to IEC 61439-1, in the majority of applications, the following relation is applicable:
Ipk = Icw × n (consult 9.3.3 of the standard for further details)
The standard values for “n” are obtained from Table 7 of the standard.

r.m.s value of short-circuit current kA	cosϕ	n
I ≤ 5	0,7	1,5
5 < I ≤ 10	0,5	1,7
10 < I ≤ 20	0,3	2
20 < I ≤ 50	0,25	2,1
50 < I	0,2	2,2

a Values of this table represent the majority of applications. In special locations, for example in the vicinity of transformers or generators, lower values of power factor may be fount, whereby the maximum prospective peak current may become the limiting value instead of the r.m.s. value of the short-circuit current.

Ipk = 100 kA × 2.2 = 220 kA

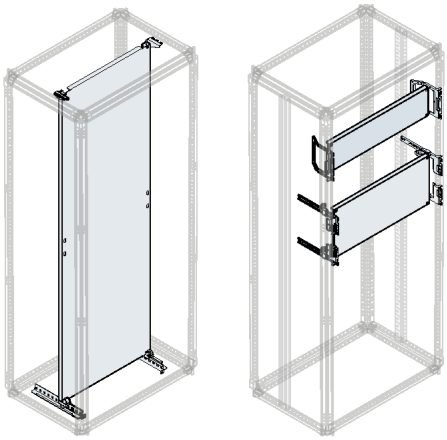


Consult the technical catalog of the circuit-breakers for further details: Link

4.3. Installation of devices and components without specific kits

Protective and switching devices and components can also be assembled in the switchboard without the use of specific kits so long as they conform to the respective product Standards and, especially, are installed and cabled according to the instructions of their manufacturer.

Installation on blind mounting plates: System pro E power can be fitted with low voltage devices, such as contactors, drives and ATS which, depending on the instructions provided by the manufacturer of the product, can be installed on blind mounting plates of an adequate dimension.



With the aid of the technical documentation of the switchboard and instructions supplied with the device, make sure that there is enough available space in the switchboard to house the device. Also consider the weight of the device that must be installed.

Installation on DIN rail: the DIN rail kit (35 mm) or a blind mounting plate together with a DIN rail can be used to install DIN-rail-compatible equipment such as surge arresters, energy meters, measuring devices, insulation monitors and other devices.

Consult the technical documentation of the switchboard for further details.

01
Drives installed on total height blind mounting plate.
02
Contactors installed on blind mounting plates.

01

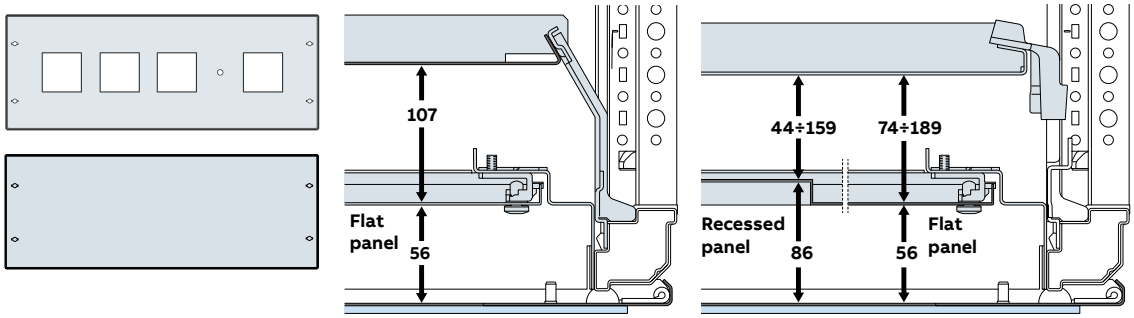
02

4. Installation of the apparatuses

Installation on the front panel : panels for measuring instruments (72×72) or (96×96) can be used to install measuring instruments; for other devices (e.g. lamps or push buttons), is possible to make adequately sized openings in the blind panels or in the blind door, in accordance with the instructions provided by the manufacturer of the device to be installed.

The panel builder is responsible for installing components with the correct IP rating.

With the aid of the technical documentation of the switchboard and instructions supplied with the device, make sure that there is enough available space/depth in the switchboard to house the device.



5. Routine verification

The panel builder must perform individual tests of the non-destructive type on each switchboard made for the purpose of identifying material defects, manufacturing defects or defects caused by the assembly process, and to make sure that the switchboard functions correctly.

The panel builder must establish whether the individual test is performed during and/or after assembly.

At the end of the individual tests, make sure that nothing has been left inside the switchboard (tools, screws, bolts, cables or connections which could lead to shortcircuits).

In addition, all the parts that may have been removed (e.g.: segregations, barriers, panels) must be restored.

A "Routine verification check list", proposed by ABB, is given below by way of example.

Project information
Panel Builder
End Client
Consultant
Contractor
Project name / plant
Project reference
Routine test date

Technical information	
Enclosure	System pro E power
SLD* reference	
Front layout reference	
Earthing system	◻ TT / ◻ TN-S / ◻ TN-C / ◻ IT
Rated voltage (Un)	..... V ◻ AC / ◻ DC
Auxiliary voltage	..... V ◻ AC / ◻ DC
Rated current (In)	..... A
Rated short circuit (Icw)	..... kA
Rated frequency	..... Hz
Protection degree	IP.....

* single line diagram

Contents

[subclause of IEC 61439-1/2]

1 Degree of protection of enclosure [11.2]

Verification	**Procedure**	**Criteria**	**Tick if passed**	**Remark / Examiner name**
IP enclosure (external covers)	Visual inspection	IP..... IEC 60529	◻	
IP of devices installed on the panel cladding	Use of certified items	Same or higher than enclosure external covers IP	◻	
Verification of the measures taken to achieve the degree of protection	Visual inspection	Cable entries, flanges fastened correctly and closed	◻	
IP enclosure (inside)	Visual inspection	IPxxB	◻	

5. Routine verification

2 Clearances and creepage distances [11.3]

Useful information:
Minimum clearance distances
Uimp = 8 kV -> 8mm
Uimp = 12 kV -> 14mm

Minimum creepage distances
Ui = 1000V, mat group II -> 14 mm

Verification	Procedure	Criteria	Tick if passed	Remark / Examiner name
Clearance distances	Visual inspection, caliper	All distances between live parts and conductive parts are equal or more than …… mm	☐	
Creepage distances	Visual inspection, caliper	All distances between live parts and conductive parts are equal or more than …….mm	☐	

3 Protection against electric shock and integrity of the protective circuits [11.4]

Verification	Procedure	Criteria	Instrument	Tick if passed	Remark / Examiner name
Connection to all nonactive metal conductive parts to the ground	Visual inspection	All parts connected to the ground		☐	
Continuity test	Apply 10A between exposed parts of the panel and the external PE terminal	Resistance measurement < 0.1Ω	….	☐	
Torque check	Torque wrench random check (or visual inspection of marked bolts)	Tightening torque as per manufacturer documentation	….	☐	
PE /PEN connection	Visual inspection	Continuous connection of the protective circuit		☐	
PE/ PEN marking	Visual inspection	Complete marking of protective conductors PE/ PEN		☐	

4 Integration of connection devices and components [11.5]

Verification	Procedure	Criteria	Tick if passed	Remark / Examiner name
Compliance to the specifications	Visual inspection	The products and their identification comply with the assembly specifications - Voltage - Current - Frequency - Making/breaking capacity - Short circuit	☐	
Compliance to documentation	Visual inspection	The products installation complies with the data provided by original manufacturer	☐	
Use of equipment	Visual inspection	Complies with wiring diagram	☐	
Equipment arrangement, position	Visual inspection	The arrangement complies with the assembly plan	☐	

5 Internal electrical circuits and connections [11.6]

Verification	Procedure	Criteria	Instrument	Tick if passed	Remark / Examiner name
Compliance of busbar section	Spot check and visual inspection	According to data provided by original manufacturer		☐	
Compliance of distance between busbar supports	Spot check and visual inspection	According to data provided by original manufacturer		☐	
Torque and bolts/washers marking	Spot check and visual inspection	Bolts tightened as per data provided by original manufacturer Torque wrench random check (or visual inspection of marked bolts)	Torque wrench	☐	

6 Terminals for external conductors [11.7]

Verification	Procedure	Criteria	Tick if passed	Remark / Examiner name
Identification of terminals	Visual inspection	Compliance with manufacturing documentation	☐	
Outgoing terminals	Visual inspection	Compliance with manufacturing documentation - cross-section - clamping - capacity	☐	
Suitability for copper / aluminum connections	Visual inspection	Adapted for copper or aluminum cables as prescribed	☐	

5. Routine verification

7 Mechanical function (actuation elements, interlocks) [11.8]

Verification	Procedure	Criteria	Tick if passed	Remark / Examiner name
Interlocks / locks operation	Functional and visual inspection	Compliance with manufacturing documentation	☐	
Internal and external doors couplings / switch actuators	Functional and visual inspection	Compliance with manufacturing documentation	☐	
Ventilation grid, assembled, if necessary	Visual inspection	Compliance with manufacturing documentation	☐	

8 Dielectric properties [11.9]

Useful information

Dielectric test - IEC 61439 1 standard requirements- control circuits:

- Rated insulation voltage Ui ≤12V -> dielectric test voltage 250V AC, min duration 1 sec
- Rated insulation voltage 12<Ui ≤60V -> dielectric test voltage 500V AC, min duration 1 sec
-

Dielectric test - IEC 61439 1-2 standard requirements- power circuits:

- Rated insulation voltage Ui ≤60V -> dielectric test voltage 1000V AC, min duration 1 sec
- Rated insulation voltage 60<Ui ≤300V -> dielectric test voltage 1500V AC, min duration 1 sec
- Rated insulation voltage 300<Ui ≤690V -> dielectric test voltage 1890V AC, min duration 1 sec
- Rated insulation voltage 690<Ui ≤800V -> dielectric test voltage 2000V AC, min duration 1 sec
- Rated insulation voltage 800<Ui ≤1000V -> dielectric test voltage 2200V AC, min duration 1 sec

Verification	Procedure	Criteria	Instrument	Tick if passed	Remark / Examiner name
1 - Insulation test					
N <-> L1-L2-L3-PE	1000V 50Hz	Min resistance 1 MΩ	...	☐	
L1 <-> N-L2-L3-PE	1000V 50Hz	Min resistance 1 MΩ	...	☐	
L2 <-> N-L1-L3-PE	1000V 50Hz	Min resistance 1 MΩ	...	☐	
L3 <-> N-L1-L2-PE	1000V 50Hz	Min resistance 1 MΩ	...	☐	
2 – Dielectric test					
N-L1-L2-L3 <-> PE	Voltage: .....V Duration: .....sec	Max current 10mA	...	☐	
N <-> L1-L2-L3-PE	Voltage: .....V Duration: .....sec	Max current 10mA	...	☐	
L1 <-> N-L2-L3-PE	Voltage: .....V Duration: .....sec	Max current 10mA	...	☐	
L2 <-> N-L1-L3-PE	Voltage: .....V Duration: .....sec	Max current 10mA	...	☐	
L3 <-> N-L1-L2-PE	Voltage: .....V Duration: .....sec	Max current 10mA	...	☐	
Auxiliary circuit to main circuits	Voltage: .....V Duration: .....sec	Max current 10mA	...	☐	
Auxiliary circuit to encl./ constr. parts	Voltage: .....V Duration: .....sec	Max current 10mA	...	☐	

9 Wiring, operational performance and function [11.10]

Verification	Procedure	Criteria	Tick if passed	Remark / Examiner name
Cable colors and marking main circuits , PE, Neutral	Visual inspection	Example: L1-2-3: red, yellow, blue Neutral: black PE: green / yellow	☐	
Wiring /cables / cable and fastening type	Visual inspection	No installation to sharp-edged corners and edges	☐	
Settings (e.g. motor protection switch, circuit breaker)	Setting	Compliance with manufacturing documentation	☐	
Main circuit functional test	Functional test	Compliance with manufacturing documentation	☐	
Measurement instruments functional test	Functional test	Compliance with manufacturing documentation	☐	
Control devices functional test	Functional test	Compliance with manufacturing documentation	☐	
Auxiliary circuits functional test	Functional test	Compliance with manufacturing documentation	☐	
Wiring and equipment arrangement with regard to interferences / EMC (check for shielded cables, grounding, etc.)	Visual inspection	Compliance with manufacturing documentation	☐	
RCD trip test	Functional test	Compliance with manufacturing documentation	☐	

Verification	Procedure	Criteria	Tick if passed	Remark / Examiner name
Designation label - Name of the manufacturer or trade mark - Type designation or identifier - Date of manufacture - Applied standard IEC 61439-1/2 - Rated voltage (Un) - Rated current of the assembly (InA) - Rated frequency (fn)	Visual inspection	Completed with all numerals and values	☐	

5. Routine verification

Recorded in the documentation, in hard or soft copy

Verification	Procedure	Criteria	Tick if passed	Remark / Examiner name
Rated operating voltage	Visual inspection	Ue=.....VAC	☐	
Rated impulse withstand voltage	Visual inspection	Uimp=.....KV	☐	
Rated insulation voltage	Visual inspection	Ui=.....V	☐	
Rated short-time withstand current	Visual inspection	Icw=.....KA	☐	
Peak short circuit value	Visual inspection	Ipk=.....KA	☐	
Diversity factor	Visual inspection	RDF=.....	☐	
Assembly plan	Visual inspection	In documents	☐	
Design verification	Visual inspection	In documents	☐	
Assembly, operating instructions	Visual inspection	In documents	☐	
System pro E power brochure 1STC860056 LINK	Visual inspection	In documents	☐	
Link to ABB products webpage LINK low voltage products LINK System pro E power	Visual inspection	In documents	☐	

Final testing

Verification	Procedure	Criteria	Tick if passed	Remark / Examiner name
Cleanliness of the installation	Visual inspection	No shavings, cable residues, pollution	☐	

Declaration of conformity

Panel builder details

Assembly	
Assembly name	
Project number	
Enclosure	ABB System pro E power
Earthing system	☐ TT / ☐ TN-S / ☐ TN-C / ☐ IT
Rated voltage (Un)	..... V ☐ AC / ☐ DC
Auxiliary voltage	..... V ☐ AC / ☐ DC
Rated current (In)	..... A
Rated short circuit (Icw)	..... kA
Rated frequency	..... Hz
Protection degree	IP.....

Declaration

The Assembly Manufacturer declares the conformity of the above mentioned panel(s) as per IEC 61439-1-2 standards after completing the required routine verifications.

Routine verification summary

	Passed
Degree of protection of enclosure - section 11.2	☐
Clearances and creepage distances - section 11.3	☐
Protection against electric shock and integrity of the protective circuits - section 11.4	☐
Integration of connection devices and components - section 11.5	☐
Internal electrical circuits and connections - section 11.6	☐
Terminals for external conductors - section 11.7	☐
Mechanical operation (actuation elements, interlocks) - section 11.8	☐
Dielectric properties - section 11.9	☐
Wiring, operational performance and function - section 11.10	☐
Notes:	

Signatures	Name	Company	Signature	Date
Tested by (assembly manufacturer)				
Witnessed by				

6. Designation label and information about the switchboard

The panel builder must provide each switchboard with a designation label, marked indelibly and affixed in a position where it is visible and legible when the switchboard is installed and operating.

The designation label and verification of its conformity to the Standard (according to paragraph 10.2.7) are at the charge of the panel builder.

The following information must be given on the label:
- panel builder's name or trademark;
- identification number of the switchboard (allowing further information to be obtained from the panel builder)
- year of manufacture
- product standard: IEC 61439-2 for System pro E power
- CE marking (for supplies within the European Union)

Name of the switchboard manufacturer	
Identification No.	
Manufacture date	
IEC61439-2	
Rated voltage (Un)	
Rated current (InA)	
Rated frequency (fn)	

The technical documentation of the switchboard contains information about:
- transport
- installation
- putting into service
- switchboard maintenance.

7. Installation conditions

System pro E power is classified as a switchboard for indoor installation. This means that the columns cannot be installed outdoors even if they are positioned under a shelter. Installation conditions and environmental characteristics:

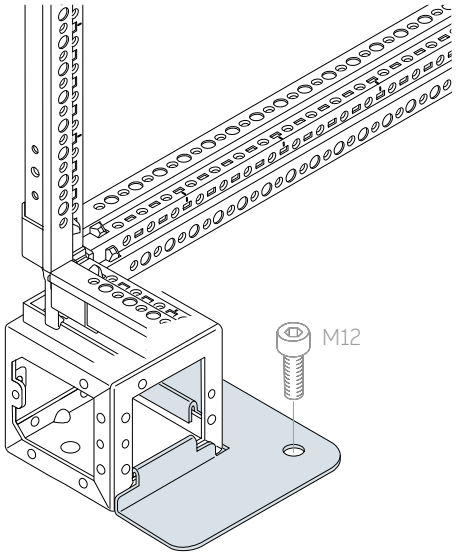
Installation conditions	Indoor on floor
Climatic conditions (t°/Rh%)	constant 23°C/83%; 40°C/93% variable 23°C/98%; 40°C/98%
Ambient temperature limits	for operation: -5°C +40°C Normal usage conditions (Ref. sect. 7.1 of the Standard IEC 61439-1-2) for storage: -25°C +55°C
Level of pollution (of the installation site)	Industrial: 3
Altitude	≤ 2000 m

The position in which the switchboard is installed must ensure that both switchgear/controlgear and parts liable to require maintenance can be conveniently accessed.
Regarding the external dimensions of the switchboard, it is advisable to make sure that there is nothing to prevent the doors (also the rear door if present), swiveling frames and panels from being fully opened, especially if the switchboard is installed in a trafficked area. The installation site must allow the personnel present to reach the emergency exits without difficulty.

System pro E power should be installed at least 600 mm:

- from the wall at the back of the switchboard (without rear door)
- from the side wall of the switchboard
- from the ceiling above the roof of the switchboard

Install the switchboard on the floor on a leveled base (unevenness less than 2 mm), which should be as smooth as possible. Fix the switchboard to the floor with class 8.8 M12 bolts.



Consult the technical documentation of the switchboard for further information about:

- installation
- putting into service
- maintenance

Useful links:
Web page System pro E power
Web page Low Voltage Circuit breakers

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