



EMPAC

Metal enclosed capacitor bank for wind applications



Introduction

The EMPAC is a Metal Enclosed Capacitor Bank suitable for voltages between 1 kV and 36 kV for reactive compensation in MV networks (especially for wind applications).

The EMPAC is suitable for both indoor and outdoor locations.

The EMPAC consists of single phase capacitor units in a double star configuration, one unbalance protection current transformer, three pole (five pole on request), grounding switch and three inrush reactors as standard. A SF6 Circuit Breaker, fast discharge reactors, protection relay as well as three current transformers are available on request. Also for safety reasons, the EMPAC offers live line indicators and interlocking as an option.

It is designed and manufactured in accordance with IEC-60871 standards.

The EMPAC is assembled and factory tested in an ISO 9001 and ISO 14001 environment.

Reactive Power Compensation

Power factor correction in electrical networks has the following advantages:

- Compliance with utility grid codes
- Reduction of energy losses
- Reduction of voltage drop
- Improve network efficiency
- Improve network quality
- Increase network capacity

Features & Benefits

- Compact design resulting in a small footprint and height
- IP 23 (EMPAC w/o CB) and IP 44 (EMPAC)
- Fully enclosed design protecting live parts
- Natural cooling
- Easy access
- Easy replacement of components in the event of failure or malfunction
- Anticondensation vents
- Same footprint & volume in case of MVar expansion
- Optional standard SF6 circuit breaker or SF6 circuit breaker mechanically staggered for synchronized switching, especially for wind farms (up to 24 kV)
- No additional assembly required on site

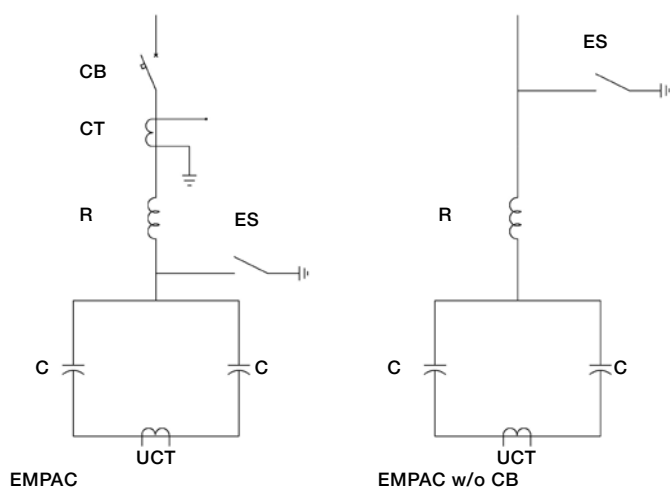
Components

Single Line Diagram

The EMPAC family consists of two versions: EMPAC and EMPAC w/o CB.

The EMPAC integrates: capacitor units, SF6 circuit breaker, three line current transformers for protection and metering, one current transformer for unbalance protection, three inrush reactors and a three pole earth switch (five pole on request).

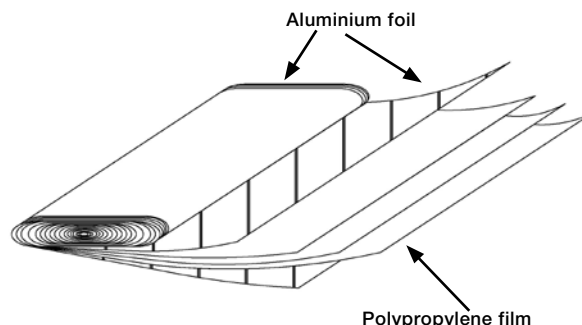
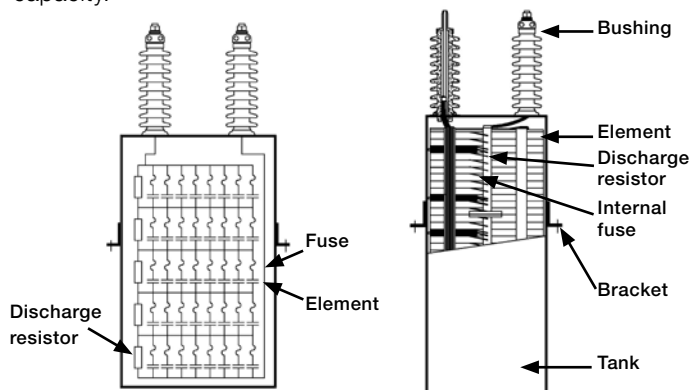
The EMPAC w/o CB integrates: capacitor units, three inrush reactors, one current transformer for unbalance protection and a three pole earth switch.



Capacitor

Capacitor units are the main component of a capacitor bank. ABB is the market leader in the design. All ABB capacitors are designed and manufactured by ABB. Each capacitor is made up of smaller capacitor elements, which are connected in series and parallel groups in order to reach the output and voltage required.

Each capacitor element contains two aluminum foils as electrodes and three polypropylene films as dielectric material wound itself in order to increase the area and therefore the capacity.



Impregnation fluid

The capacitors are impregnated with a biodegradable, non-PCB fluid with high insulation strength to ensure excellent electrical performance.

Discharge resistors

All capacitor units are equipped with internal discharge resistors. The resistors are an important safety aspect and are designed to reduce the voltage to a specified maximum level within a certain time after disconnection. Normal values, 75 V in 600 s, acc IEC-60871-1, other values on request.

Internal fuse protection

In case of element failure, an operating internal fuse disconnects only the failed element. The influence on the continuing operation of the capacitor unit is negligible.

Tank

The capacitor tank is made of stainless steel providing excellent corrosion resistance.

Bushings

Porcelain bushings are used for both outdoor and indoor locations. They are fully welded to the lid providing an excellent seal and no risk of leakage.

Tests

All capacitors are tested in accordance with IEC-60871-1 standard.

The following routine tests are performed in ABB facilities for all capacitors:

- Capacitance measurement
- Measurement of the tangent of the loss angle
- Voltage test between terminals
- AC voltage test between terminals and container
- Test of internal discharge device
- Sealing test

Components

Capacitor features

Type	Single-phase / Three-phase
Highest voltage for equipment	12 kV - 28/75 kV BIL 24 kV - 50/125 kV BIL 17.5 kV - 38/95 kV BIL 36 kV - 70/170 kV BIL
Output	From 83 kVAr to 900 kVAr (50/125 kV BIL) From 100 kVAr to 900 kVAr (10/170 kV BIL)
Frequency	50 Hz / 60 Hz
Discharge time	75 V in 600 s acc IEC 60871 50 V in 300 s acc ANSI C37.0731
Protection	Internal fuse
Discharge resistors	Yes
Electrical losses Rated voltage @ 20 °C	< 0,2 W/kVAr
Dielectric	Polypropylene film
Impregnation fluid	Faradol 810-non PCB
Tank	Stainless steel
Bushings	Porcelain
Location	Indoor / Outdoor

Medium Voltage circuit breaker

Medium Voltage circuit breaker, HD4 type utilizes SF6 gas technology as an interrupting as well as isolating medium. During interruption SF6 gas performs to remove arc draws, restrikes and recovery voltages. These skills guarantee a long lifetime service. This circuit breaker has been specifically tested for reactive loads especially back to back connection in accordance with IEC 62271-100.

The EMPAC also offers the Syncro solution, consisting in a SF6 circuit breaker mechanically staggered for synchronized switching. This option is available in 24 kV. For voltages up to 36 kV ABB offers an EMPAC w/o CB along with an external circuit breaker prepared for this application.

Air Core Inrush reactors

Three single-phase inrush reactors limit inrush current on energisation. Inrush reactors protect capacitors during back to back connection by limiting inrush current. Inrush reactors are epoxy resin encapsulated. All inrush reactors are tested in accordance with IEC 60076-6.

Line current transformers

Three current transformers are used for protection and metering functions. They are connected in series between the circuit breaker and inrush reactors. These current transformers are tested in accordance with IEC 60044 and they offer a wide range in terms of accuracy as well as rated current. These current transformers are copper wound and epoxy resin encapsulated.

Unbalance current transformer

Current transformer for unbalance protection (EMPAC & EMPAC w/o CB).

One current transformer is used for unbalance protection. It connects the neutrals of both stars. This current transformer can detect the change of capacitance from one faulty element. It is tested in accordance with IEC 60044. This unbalance current transformer is copper wound and epoxy resin encapsulated.

Earth switch

A grounding switch is used for operator protection. It is mechanically interlocked with the SF6 circuit breaker, as well as having three auxiliary contacts (3 NO + 3 NC). Once it is operated, the earth switch ensures busbars are effectively earthed. It is tested in accordance with IEC 62271-102.

Components

Protection relays

ABB relays for protection can be built-in the circuit breaker cubicle. The relays will send the order to the SF6 circuit breaker to extinguish the fault in the even of failure. Relays will provide: short-circuit, ground fault, overload, undervoltage and unbalance protection. Available in EMPAC.

Fast discharge reactors

The installation of two fast discharge reactors between phases of the bank allows capacitor discharge time to be reduced significantly. These fast discharge reactors are tested and manufactured in accordance with IEC 60076-6. These fast reactors are available in EMPAC on request.

Standard accessories

- Anti-condensation heaters to assist in controlling the effects of fluctuating ambient temperatures and humidity.
- Low voltage circuit breakers for low voltage circuit protection
- Interior lighting for SF6 circuit breaker module.
- Auxiliary terminals for control and protection circuits.

Optional accessories

- Interlocking scheme to eliminate the possibility to access live.
- Live line indicators for human safety.
- Solenoid interlocking scheme.

EMPAC features

Capacitor banks

Rated voltage	From 1 kV to 36 kV
Maximum Output	10,6 MVAR at 24 kV / 16 MVAR at 36 kV
Capacitor configuration	Double Star / single star (on request)
IP rating	23 / 44
Frequency	50 Hz / 60 Hz
Standard	IEC or equivalent
Location	Indoor / Outdoor
Temperature	-25 °C up to +55°C EMPAC -25 °C up to +55°C EMPAC w/o CB
Short circuit current	40 kA for 1s

Circuit breaker

Type	SF6 , 3 pole
Control voltage	125 V d.c. (other voltage on request)
Rated current	630 A
Short circuit current, 1 s	16 kA, 25 kA (other values on request)
Mechanism	Spring

Inrush reactors

Container	Epoxy resin cast
Rated current	1,43* capacitor bank rated current
Inductance	Specific to application
Short circuit current, 1 s	16 kA (different values on request)

Current transformers

Container	Epoxy resin cast
Primary rated current	Specific to application
Secondary rated current	5 A (1 A on request)
Class	Up to 5P30
Burden	Up to 20 VA

Earth switch

Type	Air insulated
Rated current	400 A
Short circuit current, 1 s	16 kA (different values on request)
Altitude	< 1.000m above sea level

EMPAC features

Fast discharge reactors (voltage transformer)	
Enclosure	Epoxy resin cast
Discharge capability	Specific to application
Primary	Specific to application
Secondary	Not applicable
Live line indication	
Voltage rating	3 kV to 75 kV
Indication type	LED
Connection method	Busbar clamp
Viewing	Enclosure window
Protection relay	
ABB Model	SPAJ/REF
Current input	1 or 5A
Alarm/Trip signal	Volt-free contacts



EMPAC



EMPAC w/o CB

EMPAC 24 kV 1 level

Capacitors	Capacitor Output (kVAr)	Capacitor Bank Output (MVAR)	Highest Voltage (kV)	A (mm)	B (mm)	C (mm)	D (mm)
6	83	0.5	12	2000	1600	2150	1885
12	83	1	24	2000	1600	2150	1885
6	100	0.6	12	2000	1600	2150	1885
12	100	1.2	24	2000	1600	2150	1885
6	100	0.6	17.5	2000	1600	2150	1885
6	150	0.9	12	2000	1600	2150	1885
6	150	0.9	17.5	2000	1600	2150	1885
12	150	1.8	24	2000	1600	2150	1885
6	200	1.2	12	2280	1600	2150	1885
6	200	1.2	17.5	2280	1600	2150	1885
6	200	1.2	24	2280	1600	2150	1885
6	300	1.8	12	2280	1600	2150	1885
6	300	1.8	17.5	2280	1600	2150	1885
6	300	1.8	24	2786	1600	2150	1885
6	400	2.4	12	2580	1600	2150	1885
6	400	2.4	17.5	2580	1600	2150	1885
6	400	2.4	24	2580	1600	2150	1885
6	500	3	12	2786	1600	2150	1885
6	500	3	17.5	2786	1600	2150	1885
12	500	6	17.5	2786	1600	2150	1885
6	500	3	24	2786	1600	2150	1885
12	500	2	24	2786	1600	2150	1885
6	600	3	12	2940	1600	2150	1885
9	600	4	12	2940	1600	2150	1885
6	600	3.6	17.5	2940	1600	2150	1885
6	600	3.6	24	2940	1600	2150	1885
12	600	7.2	24	2940	1600	2150	1885
6	700	4.2	12	3180	1600	2150	1885
6	700	4	17.5	3180	1600	2150	1885
9	700	6.3	17.5	3180	1600	2150	1885
6	700	4.2	24	3180	1600	2150	1885
9	700	6.3	24	3180	1600	2150	1885
12	700	8.4	24	3180	1600	2150	1885
6	800	4.8	12	3600	1600	2150	1885
6	800	4.8	17.5	3600	1600	2150	1885
9	800	7.2	17.5	3600	1600	2150	1885
6	800	5	24	3600	1600	2150	1885
9	800	7	24	3600	1600	2150	1885
12	800	10	24	3600	1600	2150	1885
12	880	10.6	24	3600	1600	2150	1885
6	900	5	17.5	3600	1600	2150	1885
6	900	5	24	3600	1600	2150	1885
9	900	8	24	3600	1600	2150	1885

Other configurations on request.

EMPAC 24 kV 2 levels

Capacitors	Capacitor Output (kVAr)	Capacitor Bank Output (MVar)	Highest Voltage (kV)	A (mm)	B (mm)	C (mm)	D (mm)
18	83	1.5	24	2000	1600	2150	2345
24	83	2	24	2000	1600	2150	2345
18	100	1.8	17.5	2000	1600	2150	2345
24	100	2.4	17.5	2000	1600	2150	2345
18	100	1.8	24	2000	1600	2150	2345
24	100	2.4	24	2000	1600	2150	2345
18	150	2.7	17.5	2000	1600	2150	2345
24	150	3.6	17.5	2000	1600	2150	2345
18	150	2.7	24	2000	1600	2150	2345
24	150	3.6	24	2000	1600	2150	2345
18	200	3.6	17.5	2280	1600	2150	2345
24	200	4.8	17.5	2280	1600	2150	2345
18	200	3.6	24	2280	1600	2150	2345
24	200	4.8	24	2280	1600	2150	2345
18	300	5.4	17.5	2280	1600	2150	2345
24	300	7.2	17.5	2280	1600	2150	2345
18	300	5.4	24	2786	1600	2150	2345
24	300	7.2	24	2786	1600	2150	2345
18	400	7.2	17.5	2580	1600	2150	2345
18	400	7.2	24	2580	1600	2150	2345
24	400	9.6	24	2580	1600	2150	2345
18	500	9	24	2786	1600	2150	2345
18	590	10.6	24	2940	1600	2150	2345

Other configurations on request.

EMPAC 36 kV

1 level

Capacitors	Capacitor Output (kVAR)	Capacitor Bank Output (MVAR)	Highest Voltage (kV)	A (mm)	B (mm)	C (mm)	D (mm)
12	100	1.2	36	2380	1700	2500	2150
12	150	1.8	36	2380	1700	2500	2150
12	200	2.4	36	2380	1700	2500	2150
12	300	3.6	36	2680	1700	2500	2150
12	400	4.8	36	2680	1700	2500	2150
12	500	6	36	2886	1700	2500	2150
12	600	7.2	36	3040	1700	2500	2150
12	700	8.4	36	3280	1700	2500	2150
12	800	9.6	36	3700	1700	2500	2150
12	900	10.8	36	3700	1700	2500	2150

2 levels

Capacitors	Capacitor Output (kVAR)	Capacitor Bank Output (MVAR)	Highest Voltage (kV)	A (mm)	B (mm)	C (mm)	D (mm)
18	100	1.8	36	2380	1700	2500	2610
24	100	2.4	36	2380	1700	2500	2610
18	150	2.7	36	2380	1700	2500	2610
24	150	3.6	36	2380	1700	2500	2610
18	200	3.6	36	2380	1700	2500	2610
24	200	4.8	36	2380	1700	2500	2610
18	300	5.4	36	2680	1700	2500	2610
24	300	7.2	36	2680	1700	2500	2610
18	400	7.2	36	2680	1700	2500	2610
24	400	9.6	36	2680	1700	2500	2610
18	500	9	36	2886	1700	2500	2610
24	500	12	36	2886	1700	2500	2610
18	600	10.8	36	3040	1700	2500	2610
24	600	14.4	36	3040	1700	2500	2610
18	700	12.6	36	3280	1700	2500	2610
18	800	14.4	36	3700	1700	2500	2610
18	890	16	36	3700	1700	2500	2610

Other configurations on request.

EMPAC w/o CB 24 kV 1 level

Capacitors	Capacitor Output (kVAr)	Capacitor Bank Output (MVar)	Highest Voltage (kV)	A (mm)	B (mm)	C (mm)	D (mm)
6	83	0.5	12	2000	1220	2225	1710
12	83	1	24	2000	1220	2225	1710
6	100	0.6	12	2000	1220	2225	1710
12	100	1.2	24	2000	1220	2225	1710
6	100	0.6	17.5	2000	1220	2225	1710
6	150	0.9	12.0	2000	1220	2225	1710
6	150	0.9	17.5	2000	1220	2225	1710
12	150	1.8	24	2000	1220	2225	1710
6	200	1.2	12.0	2280	1220	2225	1710
6	200	1.2	17.5	2280	1220	2225	1710
6	200	1.2	24.0	2280	1220	2225	1710
6	300	1.8	12	2280	1220	2225	1710
6	300	1.8	17.5	2280	1220	2225	1710
6	300	1.8	24	2786	1220	2225	1710
6	400	2.4	12	2580	1220	2225	1710
6	400	2.4	17.5	2580	1220	2225	1710
6	400	2.4	24	2580	1220	2225	1710
6	500	3	12	2786	1220	2225	1710
6	500	3	17.5	2786	1220	2225	1710
12	500	6	17.5	2786	1220	2225	1710
6	500	3	24	2786	1220	2225	1710
12	500	2	24	2786	1220	2225	1710
6	600	3	12	2940	1220	2225	1710
9	600	4	12	2940	1220	2225	1710
6	600	3.6	17.5	2940	1220	2225	1710
6	600	3.6	24	2940	1220	2225	1710
12	600	7.2	24	2940	1220	2225	1710
6	700	4.2	12	3180	1220	2225	1710
6	700	4	17.5	3180	1220	2225	1710
9	700	6.3	17.5	3180	1220	2225	1710
6	700	4.2	24	3180	1220	2225	1710
9	700	6.3	24	3180	1220	2225	1710
12	700	8.4	24	3180	1220	2225	1710
6	800	4.8	12	3600	1220	2225	1710
6	800	4.8	17.5	3600	1220	2225	1710
9	800	7.2	17.5	3600	1220	2225	1710
6	800	5	24	3600	1220	2225	1710
9	800	7	24	3600	1220	2225	1710
12	800	10	24	3600	1220	2225	1710
12	880	10.6	24	3600	1220	2225	1710
6	900	5	17.5	3600	1220	2225	1710
6	900	5	24	3600	1220	2225	1710
9	900	8	24	3600	1220	2225	1710

Other configurations on request.

EMPAC w/o CB 24 kV 2 levels

Capacitors	Capacitor Output (kVAr)	Capacitor Bank Output (MVA _r)	Highest Voltage (kV)	A (mm)	B (mm)	C (mm)	D (mm)
18	83	1.5	24	2000	1220	2225	2210
24	83	2	24	2000	1220	2225	2210
18	100	1.8	17.5	2000	1220	2225	2210
24	100	2.4	17.5	2000	1220	2225	2210
18	100	1.8	24	2000	1220	2225	2210
24	100	2.4	24	2000	1220	2225	2210
18	150	2.7	17.5	2000	1220	2225	2210
24	150	3.6	17.5	2000	1220	2225	2210
18	150	2.7	24	2000	1220	2225	2210
24	150	3.6	24	2000	1220	2225	2210
18	200	3.6	17.5	2280	1220	2225	2210
24	200	4.8	17.5	2280	1220	2225	2210
18	200	3.6	24	2280	1220	2225	2210
24	200	4.8	24	2280	1220	2225	2210
18	300	5.4	17.5	2280	1220	2225	2210
24	300	7.2	17.5	2280	1220	2225	2210
18	300	5.4	24	2786	1220	2225	2210
24	300	7.2	24	2786	1220	2225	2210
18	400	7.2	17.5	2580	1220	2225	2210
18	400	7.2	24	2580	1220	2225	2210
24	400	90.6	24	2580	1220	2225	2210
18	500	9	24	2786	1220	2225	2210
18	590	10.6	24	2940	1220	2225	2210

Other configurations on request.

EMPAC w/o CB 36 kV

1 level

Capacitors	Capacitor Output (kVAr)	Capacitor Bank Output (MVar)	Highest Voltage (kV)	A (mm)	B (mm)	C (mm)	D (mm)
12	100	1.2	36	2310	1320	2500	1710
12	150	1.8	36	2310	1320	2500	1710
12	200	2.4	36	2310	1320	2500	1710
12	300	3.6	36	2610	1320	2500	1710
12	400	4.8	36	2610	1320	2500	1710
12	500	6	36	2816	1320	2500	1710
12	600	7.2	36	2970	1320	2500	1710
12	700	8.4	36	3210	1320	2500	1710
12	800	9.6	36	3630	1320	2500	1710
12	900	10.8	36	3630	1320	2500	1710

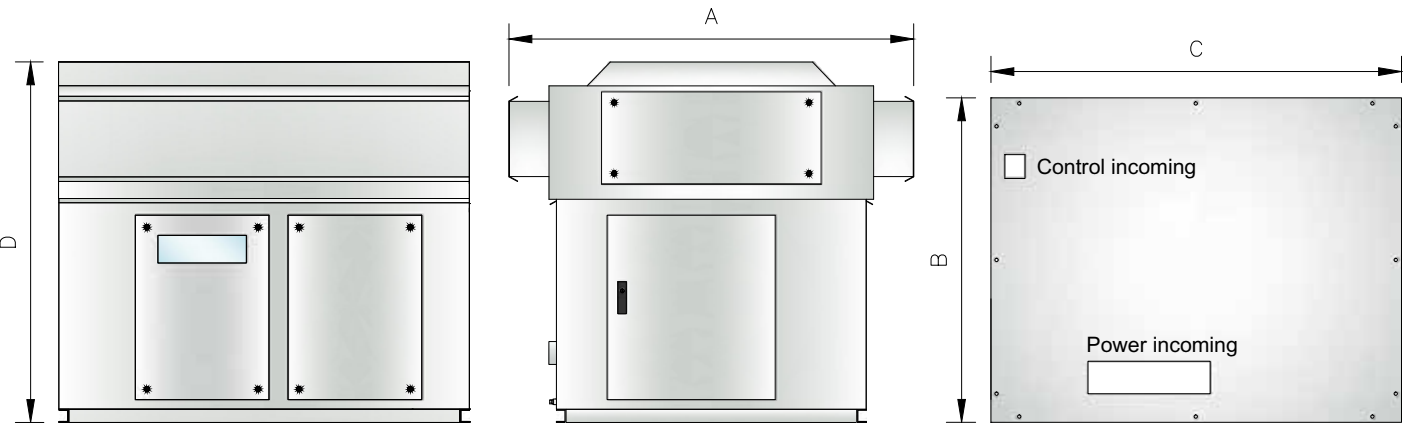
2 levels

Capacitors	Capacitor Output (kVAr)	Capacitor Bank Output (MVar)	Highest Voltage (kV)	A (mm)	B (mm)	C (mm)	D (mm)
18	100	1.8	36	2310	1320	2500	2210
24	100	2.4	36	2310	1320	2500	2210
18	150	2.7	36	2310	1320	2500	2210
24	150	3.6	36	2310	1320	2500	2210
18	200	3.6	36	2310	1320	2500	2210
24	200	4.8	36	2310	1320	2500	2210
18	300	5.4	36	2610	1320	2500	2210
24	300	7.2	36	2610	1320	2500	2210
18	400	7.2	36	2610	1320	2500	2210
24	400	9.6	36	2610	1320	2500	2210
18	500	9	36	2816	1320	2500	2210
24	500	12	36	2816	1320	2500	2210
18	600	10.8	36	2970	1320	2500	2210
24	600	14.4	36	2970	1320	2500	2210
18	700	12.6	36	3210	1320	2500	2210
18	800	14.4	36	3630	1320	2500	2210
18	890	16	36	3630	1320	2500	2210

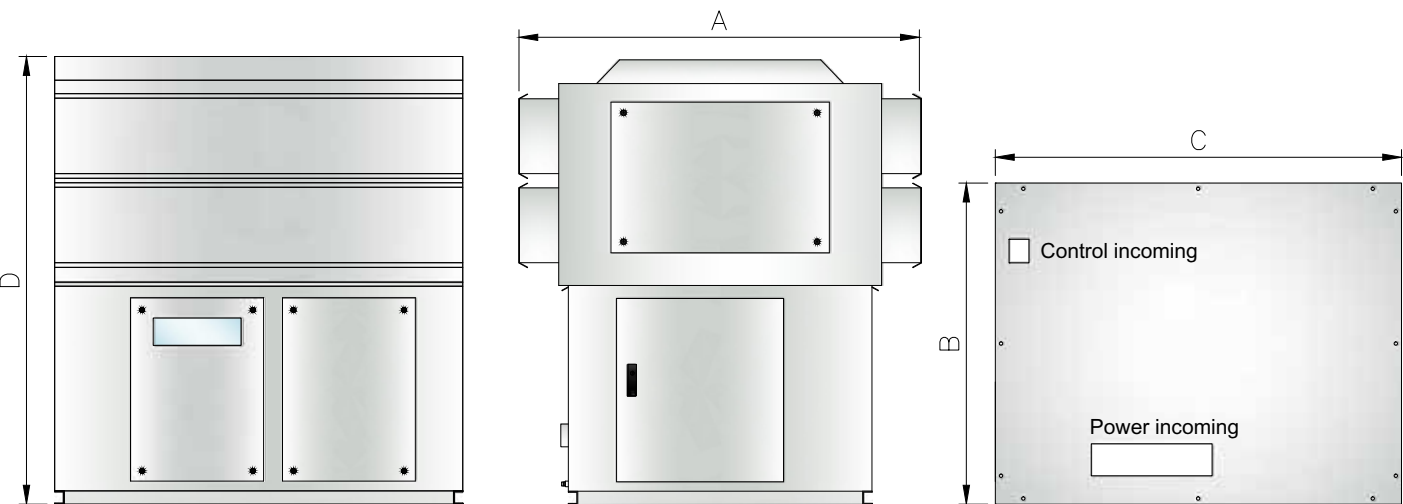
Other configurations on request.

Drawings

EMPAC 24kV and 36kV 1 level

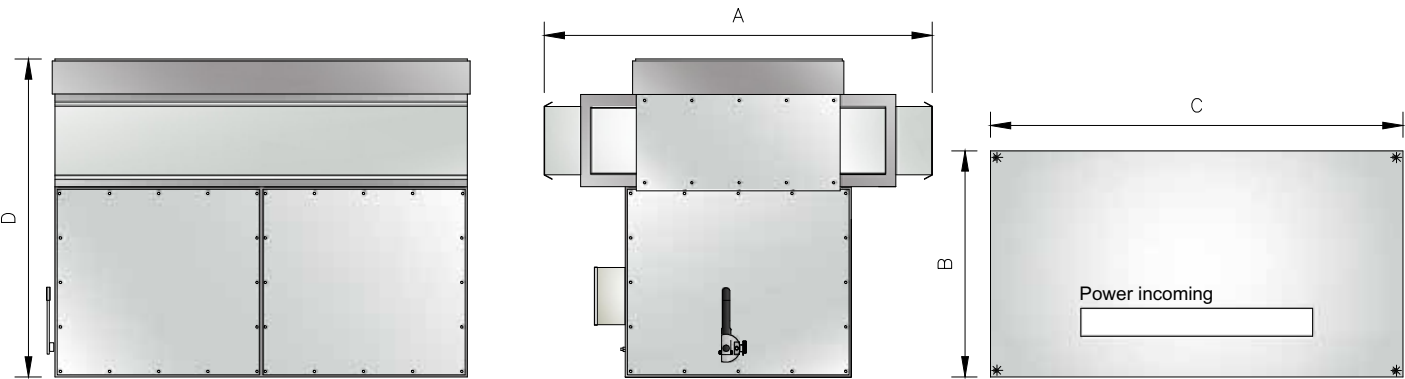


EMPAC 24kV and 36kV 2 levels

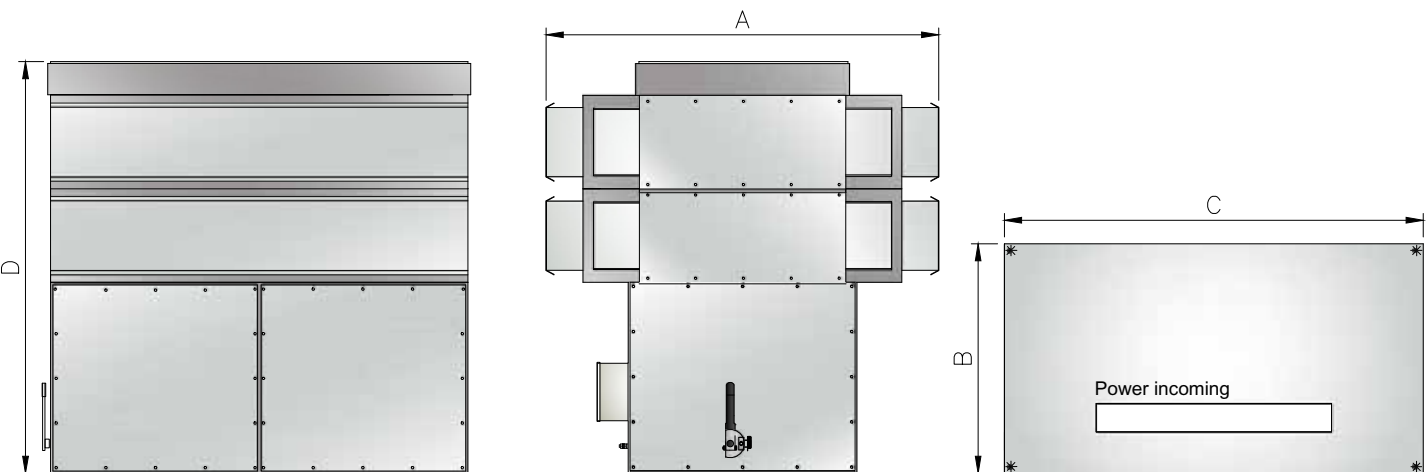


Drawings

EMPAC w/o CB 24kV and 36kV 1 level



EMPAC w/o CB 24kV and 36kV 2 levels



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