MULTIFUNCTION ROOF UNIT
Vacuum Circuit Breaker 22CB-NG-E and 38KS-M

TECHNICAL DESCRIPTION

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CONTENTS

1. INTRODUCTION 2

2. DESCRIPTION 3

2.1 Description of VCB 22CB-NG electric control type 3
2.2 Description of Control Panel 3
2.3 Description of Earthing Switch 4
2.4 Variants and Accessories 4

3. INTEGRATION / INTERFACES 5

3.1 Recommended roof opening 5
3.1 Interfaces 5

4. CHARACTERISTICS 7

4.1 Standards 7
4.1 General features 7
4.2 Power circuit 7
4.3 Coil Voltage variants 7
4.4 Withstand / Breaking features 7
4.5 Control Panel 8
4.6 Auxiliary contacts 8

5. DIMENSIONS 9

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1. INTRODUCTION

This multi-function roof unit is a new device which associates several products on the same base plate. The two base elements are: a new Vacuum Circuit Breaker called 22CB-NG *(NG = New Generation)* and a new earthing switch called 38KS. As option, a–surge arrester 42kV and a ferrite are possible.

By the fact, its main advantages are:

> *1) to reduce the number of operations during integration phase on the roof of the vehicles.*
> *2) to save space on roof for the car builder.*
>
> *3) to reduce the LCC (Life Cycle Cost) (thanks to design simplification and high robustness).*

The role of the circuit breaker, based on vacuum switch technology, is to protect the downstream power circuits during the operation of the AC network *(25kV, 15kV or 11kV)*. It can be controlled by pneumatic drive *(traditional)* or by electric drive *(new)*.

The earthing switch is used to protect train operators against injuries. It is equipped with KABA keys (other key can be adapted in option)

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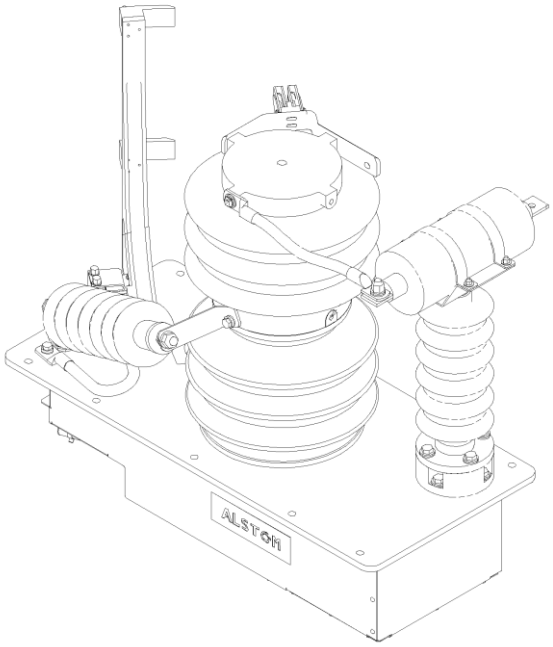
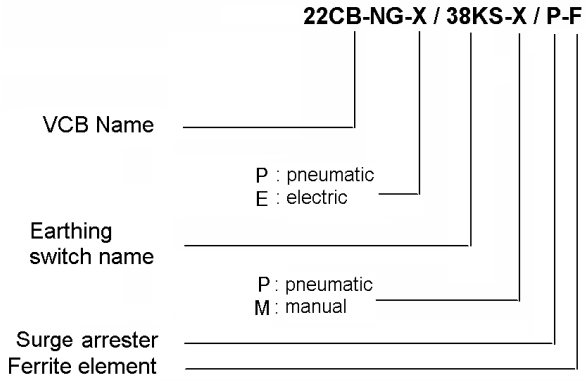


Fig.1.1 – Multifunction roof unit *(electric control drive) with optional surge arrester and ferrite*

Optionally joined to this is over voltage protection (surge arrester).

The products are fitted onto a base plate of standard dimensions which allows the device to replace any single phase circuit breaker, particularly the 22CB. Robustness and design simplification compared to actual VCBs guarantee the reliability of the product and the reduction of LCC.

Fig.1.2 – Identification mode



2. DESCRIPTION

2.1 Description of VCB 22CB-NG electric control type *(see Fig.2.1)*

The vacuum interrupter is overmoulded inside the top insulator (1). The top insulator is sealed with the bottom one to avoid water ingress. Inside the bottom insulator, which is fixed on the base plate, is the vertical actuator rod (2).

The movement of the actuator rod is given by a link which ensures the mechanical transmission between the 2 actuator rods (vertical and horizontal). When it is energized, the electromagnet (4) supplies the necessary mechanical force to move the rods (2 & 3) and close the main contact of the interrupter. When the coil of the electromagnet is de-energized, the return spring allows the opening of the main contact. The control of the electromagnet is given by an electronic panel (5). The auxiliary contacts (6) give the state of the main contact to the train monitoring system.

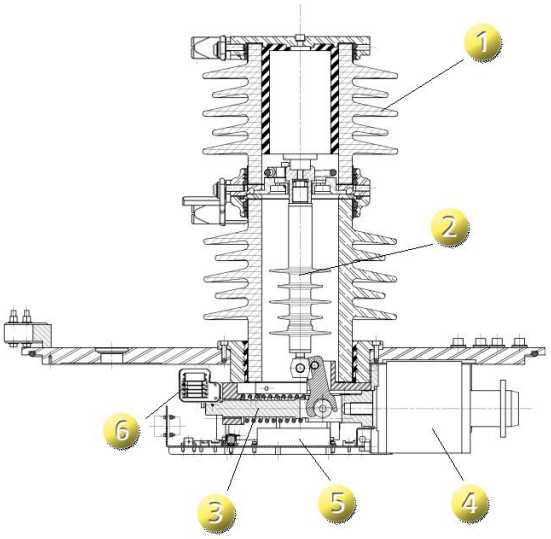
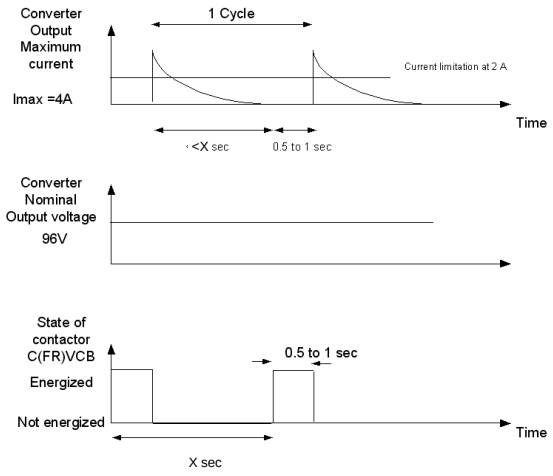


Fig.2.1 – VCB 22CB-NG-Electric control type

2.2 Description of Control Panel *(see Annex.1 and Fig.2.2)*

Capacitors load at a controlled and regulated voltage to allow the VCB to close its main contacts with the right parameters (speed and shock management when closing).

At t=0, the battery voltage is applied to the DC/DC converter and to the holding coil. The contactor CFR (VCB) is in closed position and allows the load of the capacitors through a 24 Ohms resistor. When the capacitors load is finished (t=Xs), the closing can be controlled by the train control system. The capacitors load is then switched inside the in-rush coil via the contactor CFR (VCB). When the capacitors discharge is done, the electromagnet is in closed position and stays in the same position until its holding coil is de-energized via the train control system.



For 24V command voltage : X=16s
For 72V command voltage : X=10s
For 110V command voltage : X=10s

Fig.2.2 – Functional description

2.3 Description of Earthing Switch *(see Fig.2.3 and 2.4)*

When the earthing switch is in “service” position, the handle (4) is locked in open position.
To unlock the handle, the input key (KABA20 type key coming from the cab desk) must be introduced in the locking device (2) and turned.
The locking device (2) can be turned (the input key is then locked in the device)
Then the handle is free and can be rotated by the operator to put the arm of the earth switch inside the VCB clips.
The locking device (3) can be turned. It locks the earthing arm in the VCB clips.

The operator can turn and take the output key and have access to other devices of the train such as key boxes.

Keys must be used only manually.

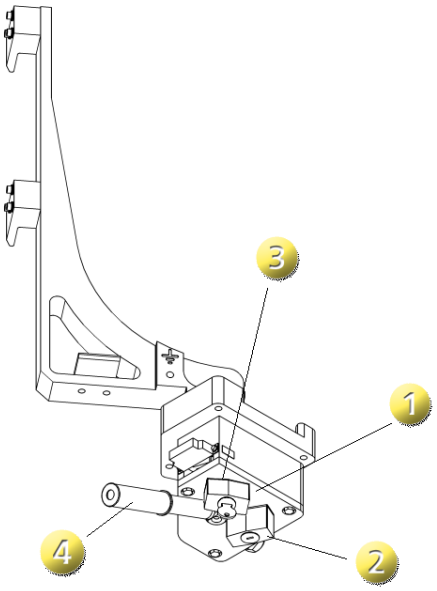


Fig.2.3 - Bottom view – indoor part of the 38KS-M

To come back to the earth switch in “service” position, the reverse process must be applied.

If applied effort on handle (4) overpasses 80daN, then handle breaks in order to protect mechanical parts of earthing switch.

The arm (5) rotates around a fixing point (6). In “service” position, the arm is inside the “service” clip by the contact (8). In “earth” position, the arm is inside the clips of the 22CB-NG by the contacts (7). The auxiliary contacts (9) give the state of the earthing switch to the train monitoring system.

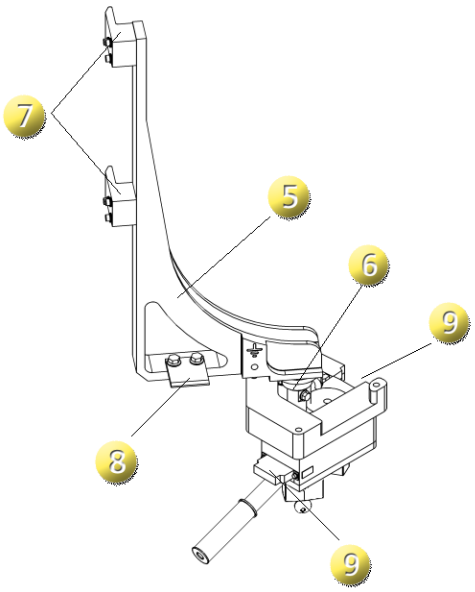


Fig.2.4 - Top view – outdoor part of the 38KS-M

In option, KABA key can be replaced by CISA version.

2.4 Variants and Accessories

Voltage	22CB-NG-E / 38KS M reference	Options
24 V	DTRP000197000	
	DTRP000197001	P
	DTRP000197002	F
	DTRP000197003	P + F
72 V	DTRP000242000	
	DTRP000242001	P
	DTRP000242002	F
	DTRP000242003	P + F
110 V	DTRP002432000	
	DTRP002432001	P
	DTRP002432002	F
	DTRP002432003	P + F

3. INTEGRATION / INTERFACES

3.1 Recommended roof opening

(see Fig.3.1)

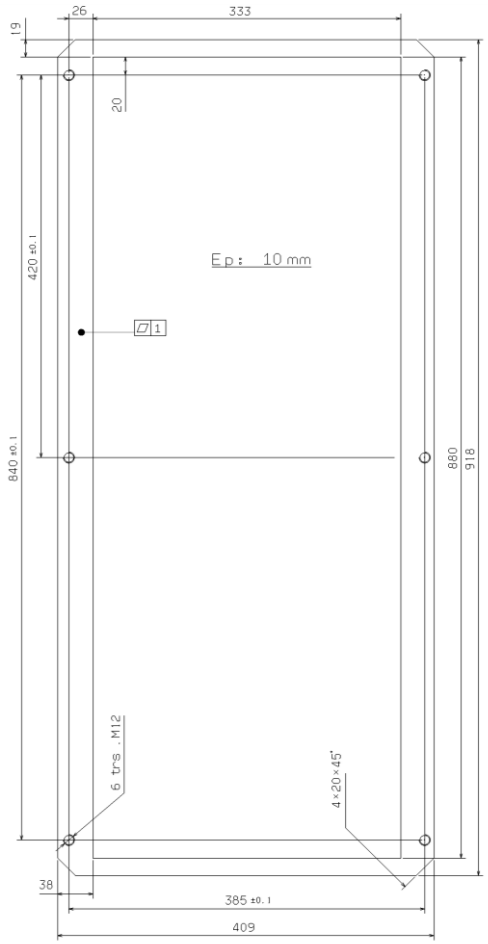


Fig.3.1 – Roof opening

3.1 Interfaces *(see Fig.3.2)*

The LV link is formed by two electric couplers (Connectors). The couplers ensure the link between the LV part of the 22CBNG-E / 38 KS-M and the traction system. Couplers type: VGE 28-21 PN and VGE 22-14 PN.

They accept a plug type : VGE1 D 22-14 SN ref DTR0000055631 with female pins DTR00251338KL (for VGE 22-14 PN) and VGE1 D 28-21 SN ref DTR 0000058684 with female pins DTR00251338KL (for VGE 28-21 PN).

The operating voltage depends on the control voltage Un of the multifunction roof unit.

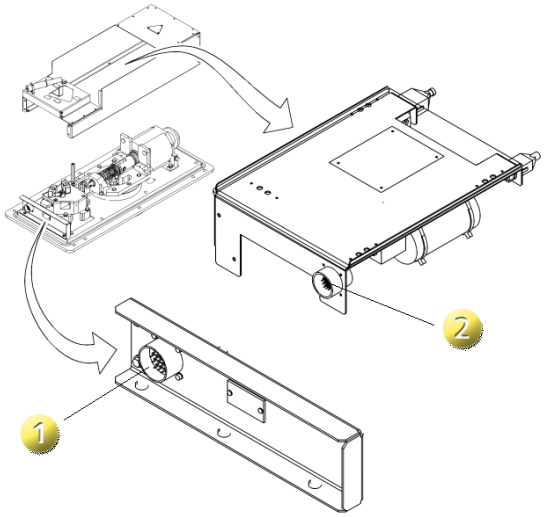


Fig.3.2 – Interfaces

Item	*Designation*	*type*
1	Coupler DTR 0000055631 (X2)	VGE 22-14 PN
2	Coupler DTR 0000058684 (X1)	VGE 28-21 PN
	Dry air blowing (§3.3.d)	Screwed coupling hose 8-10

3.3 Integration recommendation *(see Fig.3.3 and 3.4)*

a) Noise reduction

When opening, pneumatic VCB produces quite high sound level (see tab. 4.2). Structure borne sounds can also be generated due to rapid mechanical movement.

Therefore, in case of product implantation in passenger coach, specific attention has to be taken and corrective actions (sound insulation, mechanical uncoupling) has to be anticipated.

b) Vapour and thermal insulation

External parts of VCB (ceramic insulators and earthing switch arm) are directly subjected to climate variations.

Precautions have therefore to be taken when implementing product to reduce at the lowest level air circulation (from train inside) in order to minimize water condensation phenomena on its cold walls.

Thermal insulating panels, vapour tight, can efficiently be installed in front of VCB cover (thermal gradient limitation and low vapour removal).

c) Product accessibility

When implementing VCB, special attention has to be taken to permit accessibility of product for 38KS operating and easy maintenance (from the inside).

Outline drawing (see fig.5.3) reminds the minimum clear space which is required for proper access.

d) Blowing system

22CBng is equipped with a blowing system to avoid any condensation phenomena in the lower insulator of the VCB.

In continuous cold conditions and/or if temperature gradients (difference of temperate between the interior and the exterior or thermal chocks) may occur, this system must be activated :

The blowing connection needs to be supplied with compressed air regulated at 2,5 +/-0,2 bar with a quality 4.3.4 in accordance with the standard NF F 11-100 (whatever the utilisation, the dew point of the air provided to the blowing system must be lower than the minimum service temperature).

As blowing acts as a continuous leak (15Nl/min), in function of train configuration, a magnet valve should be added upstream on the air supply line to avoid to empty the circuit (when compressor is off).

A pressure switch should be added (downstream the magnet valve) on the supply line to check if the blowing is actually activated.

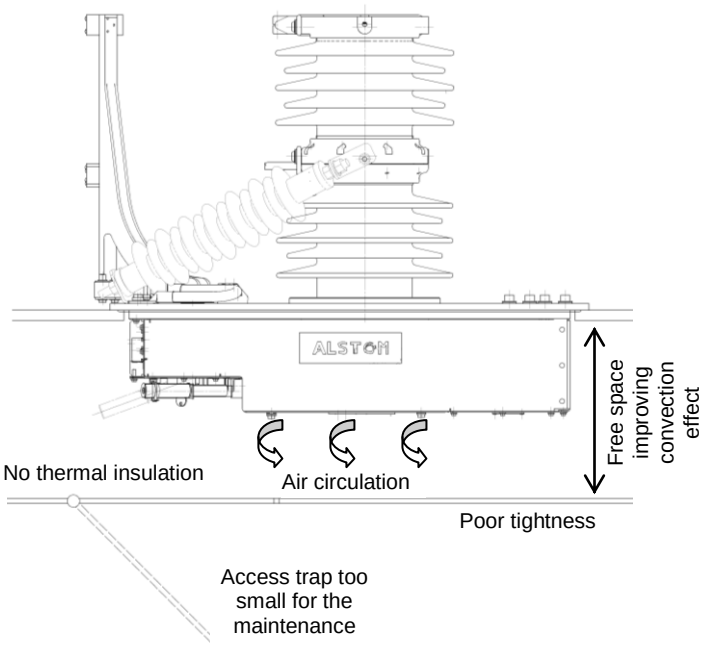


Fig.3.3 – Bad integration example

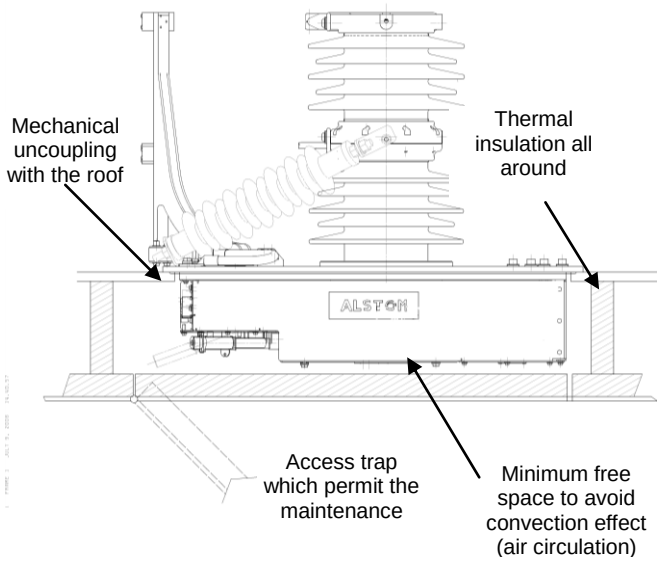


Fig.3.4 – Good integration example

4. CHARACTERISTICS

4.1 Standards

The multifunction roof unit is in accordance with:

- **IEC 60077-1-2-4**: Railway applications - Electric equipment for rolling stock
- **IEC 60060-1**: HV test technics.
- **IEC 62271-100**: High-voltage switchgear and controlgear - Alternating current disconnectors and earthing switches.
- **IEC 61373**: Railway applications - Rolling stock equipment - Shock and vibration tests.
- **IEC 60850**: Railway applications - Supply voltages of traction systems.
- **IEC 60694**: Common specifications for high-voltage switchgear and controlgear standards
- **IEC 68-2-30**: Environmental testing - test Db
- **NFF 16101***: Fire behaviour - Material choosing.
- **NFF 16102***: Fire behaviour - Material choosing and application for electric equipment.

.2 General features

Designations		Min	Max
Nominal Operating Temperature	Tu	-25°C	+70°C
Exceptional Operating Temperature	/	-40°C	+85°C
Storage Temperature	Ts	-40°C	+80°C
Height	Alt		1400m
Humidity	%		95% at 70°C
Mechanical endurance	200 000 Cycles (at 25°C)		
Weight	22CB-NG-E / 38KS-M : 165 kg Accessory surge arrester : 5 kg		
HV connections	2 holes M12 x 16 mm upstream 2 holes M12 x 16 mm downstream		
LV connections	All LV connections on Souriau connectors VGE type		
Sound level** generated when opening	90dB		
Sound level** generated when closing	81dB		

(**) Max. acoustic pressure measured at 1m (integrated on 125ms)

4.3 Power circuit

Designations	Typ.	Min	Max
U = 15 kV	15 kV 16Hz 2/3	-	17.5 kV 16Hz 2/3
U = 25 kV	25 kV 50Hz	-	27.5 kV 50Hz
Exceptional voltage (15 kV)	24 kV 16Hz 2/3 during 20 ms		
Exceptional voltage (25 kV)	38 kV 50Hz during 20 ms		
Line surges	In accordance with IEC 60 850		
Dielectric strength between poles	75 kV rms / 1mn / 50Hz (Wet & dry)		
Dielectric strength between Input and earth	75 kV rms / 1mn / 50Hz (Wet & dry)		
Shock wave of 1,2µs/50 Hz between poles	170 kV(contacts open with one of them connected to the earth)		
Shock wave of 1,2µs/50 Hz between input and earth	125 kV(closed contacts)		
Rated current	1000 A (at 25°C)		

4.4 Coil Voltage variants

Designations	Typ.	Min	Max
Coil voltage		0.7 Un	1.25 Un
Coil voltage variants	24 / 72 / 110 V DC		
Overvoltage protection device	Yes		
Insulation voltage between LV contacts and earth	2000 V		
Typical opening time	< 40 ms		
Typical closing time	< 115 ms		
Resistance (Holding coil)	330 Ω at 20°C (110V)		
	142 Ω at 20°C (72V)		
	15 Ω at 20°C (24V)		
Power consumption (Holding coil)	37W at 20°C (110V)		
	36W at 20°C (72V)		
	38W at 20°C (24V)		
L/R (Holding coil)	65 ms (110V)		
	273 ms (72V)		
	280 ms (24V)		

4.5 Withstand / Breaking features

	22CBNG-E
Short circuit withstand capacity	50kA peak at closing during 10ms and 20kA rms during 3s (50Hz) 55kA peak at closing during 35ms and 25kA rms during 3s (16Hz2/3)
Making capacity in sequence	59kA peak under 17,5kV / 16Hz2/3 40kA peak under 27,5kV / 50Hz
Breaking current in sequence	16kA rms under 27,5kV / 50Hz 25kA rms under 17,5kV / 16Hz2/3
Maximum breaking current	20kA rms under 27,5kV / 50Hz *(tested on 22CB-NG-P)*
Breaking current under 33kV	15kA rms under 33kV / 50Hz
	38KS-M
Short circuit withstand capacity	20kA during 2s 30kA during 500 ms 40 kA during 30 ms 55 kA during 10 ms

4.6 Control Panel

Designations			
Supply voltage (Un)	24V DC	72V DC	110V DC
Input supply voltage variation Ve	0.7 Un < Ve < 1.25 Un		
Supply voltage (95% of the life time)	1.15 Un		
Nominal input current	5.6 A	1.9 A	1.3 A
Peak inrush current	61 A	57 A	30 A
Rise time inrush	50 µs	20µs	20µs
Humidity *(in accordance with IEC 68-2-30)*	95% at 40°C		
Protection against reverse polarity at the input	Yes		
Maximum overvoltage at the input (power supply)	50 V / 3s	134 V / 3s	200 V / 3s
Control push button	Contactor input 4.7W L/R= 40ms		

4.7 Auxiliary contacts (*Schaltbau S826 type)*

Designations	Typ.	Min	Max
Voltage (AC or DC)		24 V	250 V
Current		1 mA (under 24V)	10A (I thermique)
Breaking current	350 000 cycles under 3A, 24V, L/R=5ms 200 000 cycles under 0,8A, 110V, L/R=5ms		
Mechanical endurance	10 000 000 Cycles		
Insulation voltage between auxiliary contacts and earth	1500 V		
Sequence (22CBNG-E)	▸ 3 NO + 3 NC Type a1 / b1 EN60077-2 ▸ 1NO (43-44) + 1NC (41-42) Type a0 / b0 * EN60077-2		
Sequence (38KS-M)	2 NO + 2 NC for input key 1 NO + 1 NC for output key		

* detect VCB closed in case of main contacts stuck

4.8 Surge arrester (optional)

Designations	.
Continuous operating voltage	33kVrms
Rated voltage	42kVrms
Nominal discharge current (8/20µs)	10kA peak
High current impulse (4/10µs)	100kA peak (2 times)
Long-duration current impulse (2000µs)	300A peak (18 times)
Maximum residual voltage (at 10kA)	120kV peak

5. DIMENSIONS

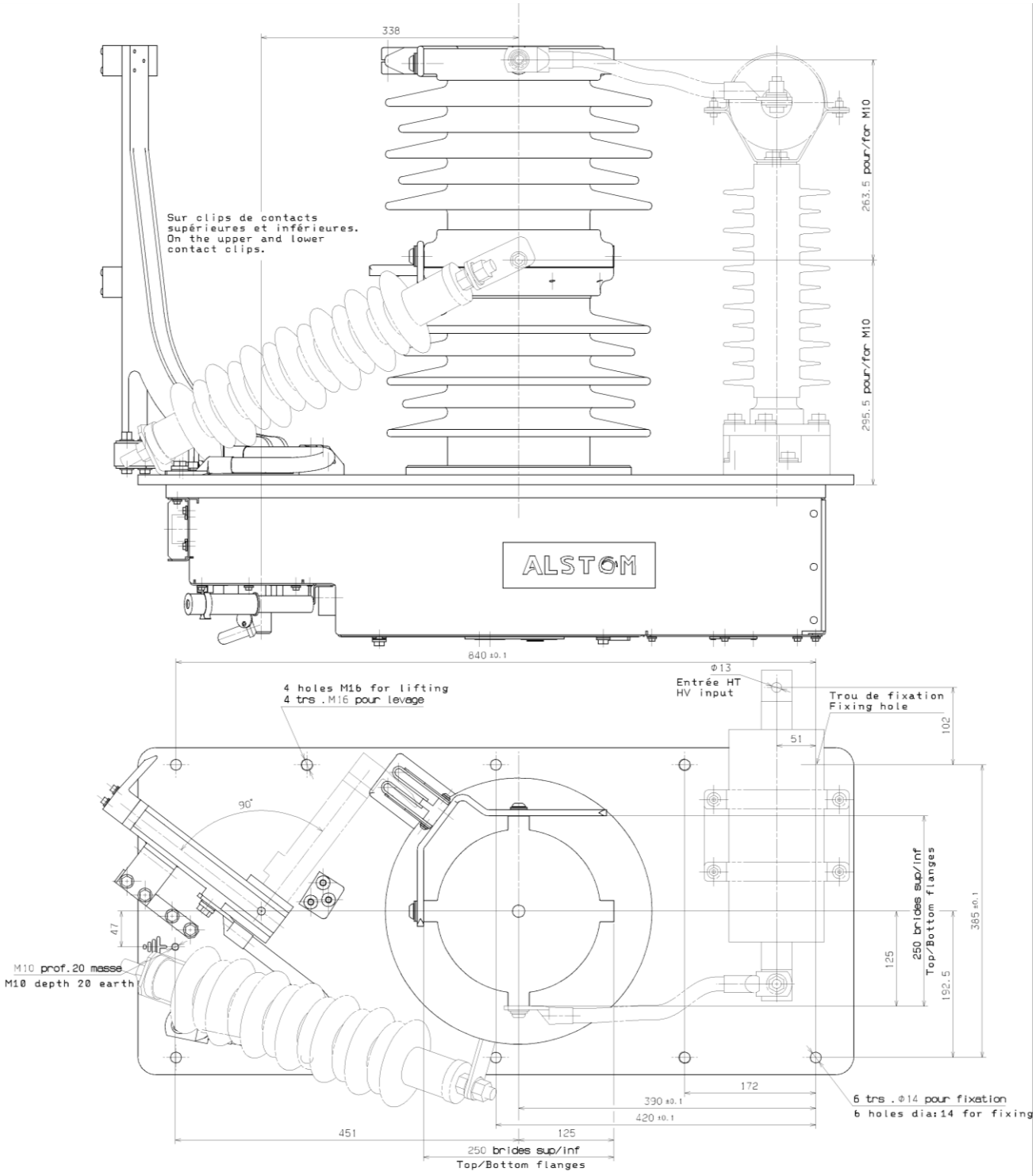


Fig.5.1 – Dimensions 01

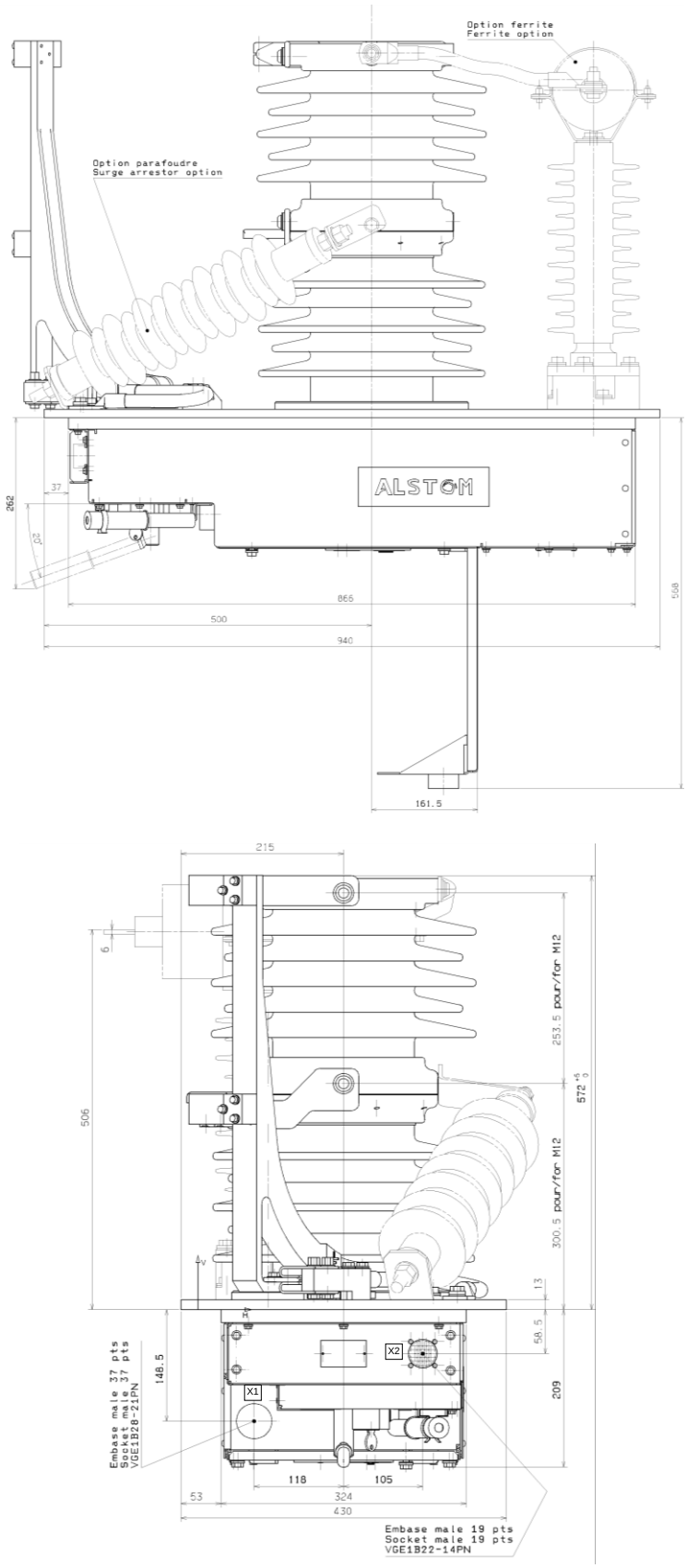
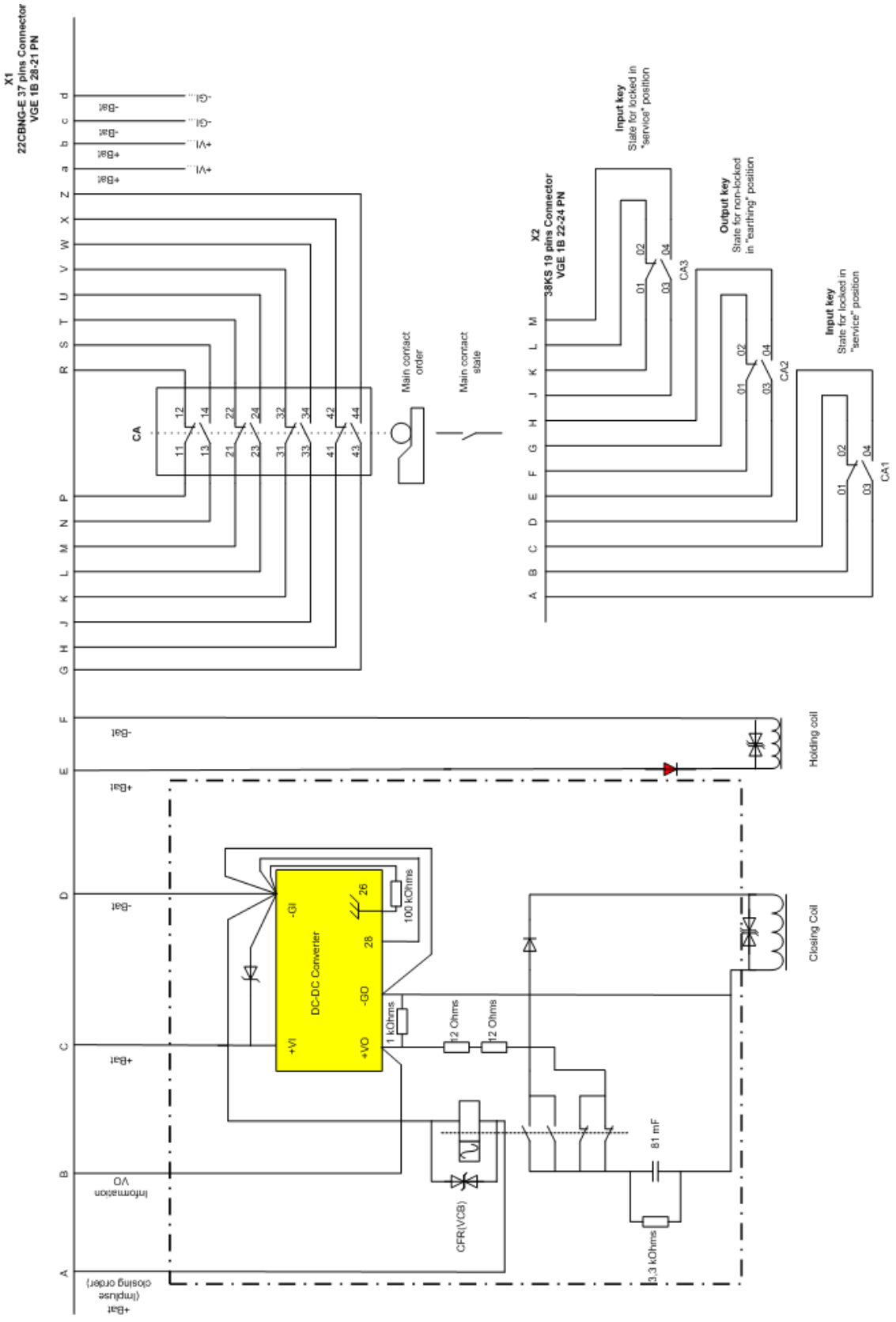


Fig.5.2 – Dimensions 02

ANNEXE 1:


X1
22CBNG-E 37 pins Connector
VGE 1B 28-21 PN
X2
38KS 19 pins Connector
VGE 1B 22-24 PN
Input key
State for locked in "service" position
Output key
State for non-locked in "earthing" position
Input key
State for locked in "service" position
CA
CA3
CA2
CA1
Main contact order
Main contact state
-Bat
+Bat
Holding coil
Closing Coil
DC-DC Converter
-GI
+VI
+VO
-GO
100 kOhms
1 kOhms
2 Ohms
2 Ohms
81 mF
3.3 kOhms
CFR(VCB)
Information VO
(Impluse closing order)