

AMV

Technical Overview

12 / 17.5 / 24 kV

Air-insulated metal-enclosed switchgear with mid-mount vacuum circuit-breaker

Edition 3.4/2014

RPS SWITCHGEAR

Reliability and safety you can trust

Edition 29/2013

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1 INTRODUCTION

1.1 AMV DESCRIPTION

- 3-phase AC withdrawable-pattern, air-insulated, metal-enclosed switchgear compliant to IEC 62271-200.
- Single and double-busbar configurations.
- Switchgear compartments designed in accordance with SANS 876 and suitable for 3-core / 1-core rear-entry power cable connections.
- Vacuum circuit-breakers (VCB's) and earthing switches compliant to IEC 62271-100 and IEC 62771-102.
- Vacuum contactor-fuse combination to IEC 60470 / IEC 62271-106.
- KEMA type test certification of complete type tests in accordance with IEC 62271-200.

Vacuum interrupter technology is used and the circuit-breakers have been tested for extended electrical endurance, ensuring long-life with minimal maintenance and trouble-free service. The operating mechanisms have been designed and tested for extended mechanical endurance. The withdrawable circuit breaker carriage arrangement greatly facilitates routine inspection. Special attention to both the design and testing of the switchgear has been given to ensure maximum practicable operator safety under normal and abnormal operating conditions.

2 SWITCHGEAR DESIGN

2.1 AMV PRODUCT RANGE TECHNICAL OVERVIEW

The AMV product range of air-insulated withdrawable indoor metal-enclosed switchgear is available in both single-busbar and double-busbar configurations depending on the user requirements. While single-busbar switchgear has proven to provide the most economical solution to users, double-busbar switchgear offers the user increased operational flexibility by allowing independent connection of the circuit-breaker main circuit between any one (or both) of the two busbars. Transfer of the load between the two busbar systems is possible without any interruption to the circuit. Each busbar system is fully enclosed in its own compartment and connected to the circuit-breaker's fixed isolating contacts by means of a busbar disconnector. While the busbar disconnectors are fully motorised, they can be operated manually and are fitted with the necessary safety electro-mechanical interlocks. An infrared camera and display screen is provided on each feeder/incomer panel to provide visual indication of the position of the disconnectors in addition to the mimic diagram signalling. As disconnectors are neither load-break nor fault-make switching devices, motorised operation of a disconnector is only permitted when the bus-coupler circuit-breaker is racked in and closed and the disconnector associated with the alternate busbar is closed.

Rated Voltage	12 kV / 17.5 kV	24 kV
Service Continuity	LSC2B	
Partition Class	PM (Metallic partitions and shutters)	
Internal Arc Classification (IAC)	AFLR 25 / 31.5 kA 1 sec	
Specific creepage	≥ 20 mm/kV	
Circuit-breaker Type	Mid-mount "cassette" type withdrawable circuit-breaker (motorised/manual)	
Circuit-breaker Insulation	Shrouded / embedded pole	Embedded pole
Circuit-breaker Class	S1, E2, M2, C2	
Circuit-breaker Interrupting Technology	Vacuum interrupter (AMF contacts)	
Circuit-breaker Mechanism	Stored energy operation	
Energy Storage Device	Spring	
Cable Earthing Devices	Integral earthing switch	
Busbar Earthing Device	Integral earthing switch / circuit-breaker	
Earthing Switch Class	E2, M0	E1, M0
Busbar Design	Single or double-busbar	Single busbar
Busbar Configuration	Vertical (single-busbar) and horizontal (double-busbar) with metal partitions between adjacent panels	Vertical with metal partitions between adjacent panels
Busbar Ratings	800 A / 1250 A / 2500 A	
MV Cable Entry	Bottom (rear) or top (rear)	
Corrosion Protection (enclosure)	Enclosure: AZ150 to SANS ISO 9364 ("Aluzinc®") (2 mm thick) Doors, side / rear covers: Powder coated steel (2 mm thick)	

2.2 DEFINED COMPARTMENTS

- Circuit-breaker / contactor / busbar VT / auxiliary transformer compartment
- Cable connection compartment housing current transformers, integral earthing switch and optional surge arresters
- Cable VT compartment housing – optional cable-side VT's
- Busbar compartment (single-busbar)
- Front and rear busbar compartments (double-busbar only)
- Busbar disconnector compartment (double-busbar only)
- Low-voltage (LV) compartment

2.3 CLEARANCES AND PHASE CENTRES

	12 kV / 17.5 kV	**24 kV**
Clearances (SANS 876)	**Distance [mm]**	
Phase to phase ('a') / phase to earth ('b') (Type 1 – Bare live conductors)	≥ 150 / 150	≥ 150 / 150
Phase to phase ('c') / phase to earth ('d') (Type 2 – Covered / shrouded live conductors)	≥ 55 / 50	> 110 / 100
Phase / pole centres	150 (650W panel) 210 (800W/900W panel) 275 (1000W/1100W panel)	210 (1250 A 800W panel) 275 (2500 A 1000W panel)
Note: The clearances 'a' and 'b' stated above are provided for information purposes. They are the shortest clearances applicable and apply to the cable connection tags. The AMV product range has been fully type tested based on the actual conductor geometry. The minimum clearances specified in SANS 876 are only applicable for non-type tested designs and assume a worst-case geometry (rod to plane).		

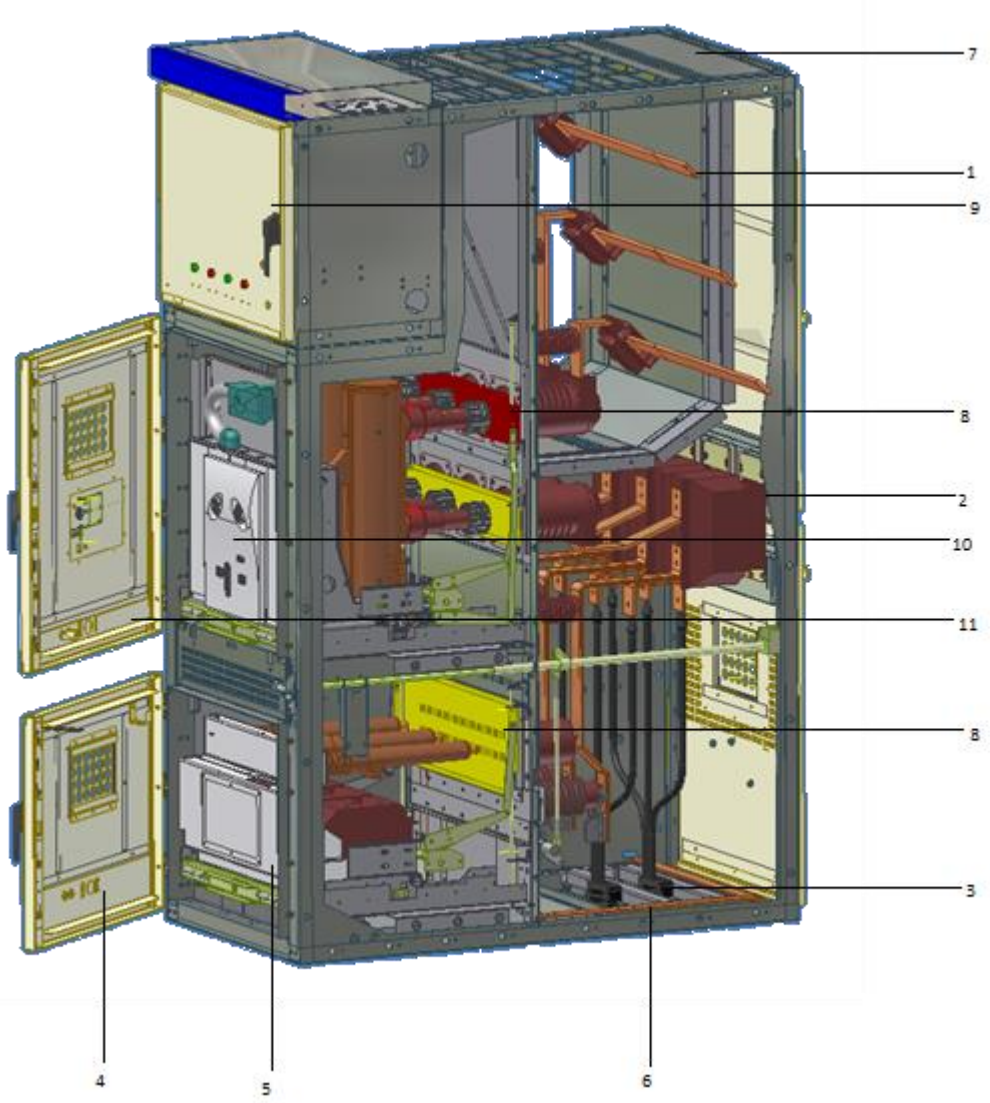
2.4 ACCESSIBILITY TO HIGH VOLTAGE COMPARTMENTS

Compartment	**Accessibility**
Circuit-breaker / busbar VT / auxiliary transformer	Interlock-controlled
Cable compartment	Interlock-controlled and tool-based
Cable-side VT compartment	Interlock-controlled
Busbar compartment/s	Procedure and tool-based
Busbar disconnector compartment (double-busbar)	Procedure and tool-based

2.5 EQUIPMENT OPTIONS AND PANEL GENERAL ARRANGEMENTS

2.5.1 EQUIPMENT OPTIONS

Panel Type	Standard and optional equipment
Incomer/feeder panel	• cable voltage detecting and indicating system (VDIS) (standard) • mimic diagram with LED status indication (standard) • CT's (DIN block type – to customer specification) (standard) • integral cable earthing switch (optional) • cable-side voltage transformer (optional) • cable-side surge arresters (optional) • motorised racking device (optional) • motorised busbar disconnectors for busbar selection (standard for double-busbar configuration) • camera and display for busbar disconnector position (standard for double-busbar configurations)
Bus-section panel	• left / right busbar voltage detecting and indicating system (VDIS) (optional) • mimic diagram with LED status indication (standard) • CT's (DIN block type – to customer specification) (optional) • integral busbar earthing switch (optional) • motorised racking device (optional) • available for front / rear busbar (double-busbar configuration) • adjacent riser panel[1] (standard required only for double-busbar configuration)
Bus-coupler panel (double-busbar configuration only)	• front & rear busbar voltage detecting and indicating system (VDIS) (optional) • mimic diagram with LED status indication (standard) • CT's (DIN block type – to customer specification) (optional) • motorised racking device (optional)
Busbar VT / control power auxiliary transformer (5 kVA CPAT)	• busbar voltage detecting and indicating system (VDIS) (standard) • mimic diagram with LED status indication (standard) • integral busbar earthing switch (optional) • motorised racking device (optional) • motorised busbar disconnector for busbar selection (optional for double-busbar configuration)
NOTE 1: For single-busbar configurations, no additional bus-riser panel is required for bus-sections as a rear housing extension is attached to the rear of the adjacent incomer/feeder panel.	



1	Busbars	7	Pressure relief vent
2	CT's	8	Shutters
3	Cable connections	9	LV compartment door
4	Cable-side VT compartment door	10	Vacuum circuit-breaker (VCB)
5	Cable-side VT	11	Circuit-breaker / contactor compartment door
6	Earthing circuit		

Figure 1 – AMV panel general arrangement (single-busbar)

2.5.2 AMV-VACUUM CONTACTOR-FUSE COMBINATION

Equipment Type	Ratings and features
Vacuum Contactor	• Rated voltage: 7.2 kV and 12 kV • Rated current (contactor): 400 A • Fuse-link type: IEC 60282-1 TYPE 1 (292 mm long) • Maximum fuse rating = 315 A (7.2 kV), 200 A (12 kV) • Electrical holding in closed position • Pole centre pitch = 150 mm • Stem pitch (upper to lower) = 275 mm • Designed for use in AMV 650 mm wide panel • Refer to 2.5.1 for standard and optional feeder panel equipment • Motorisation of contactor carriage (optional)

2.5.3 GENERAL ARRANGEMENTS

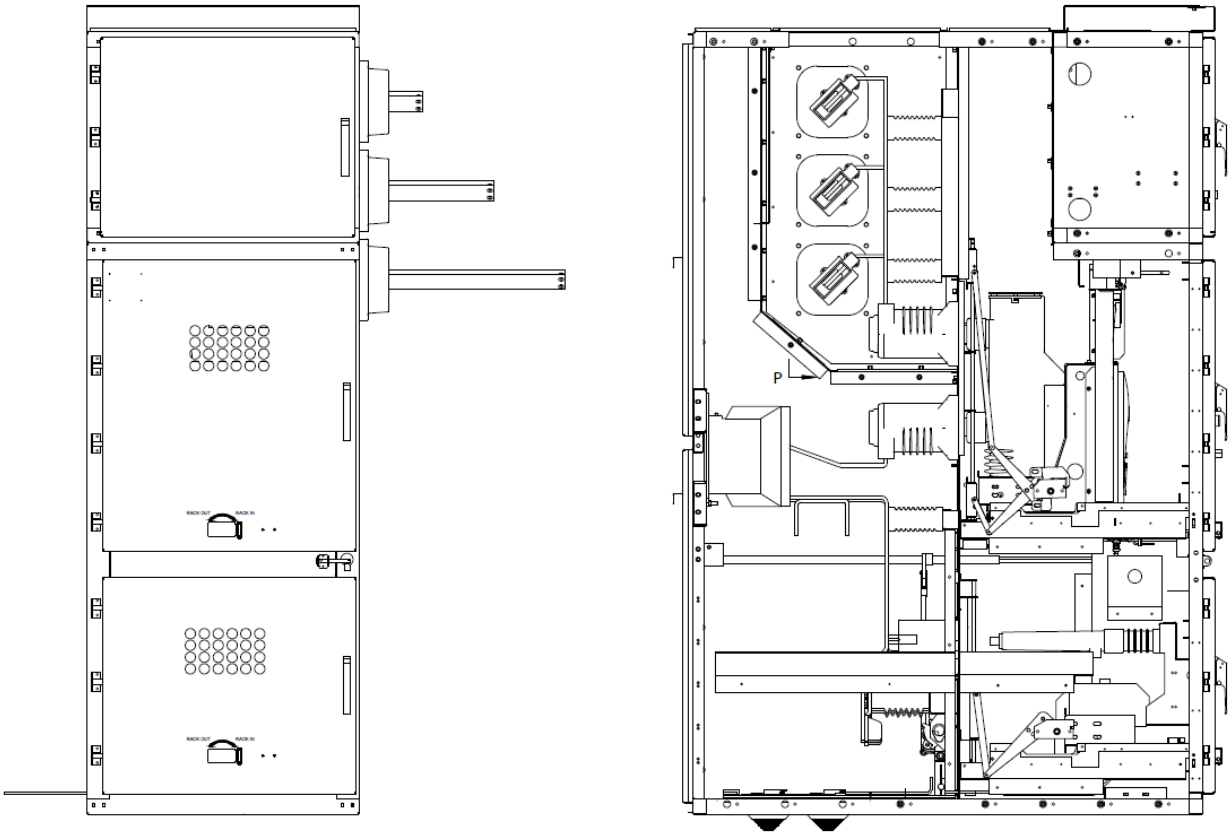


Figure 2 – AMV 1250 A, 31.5 kA incomer panel with cable-side VT general arrangement (single-busbar)

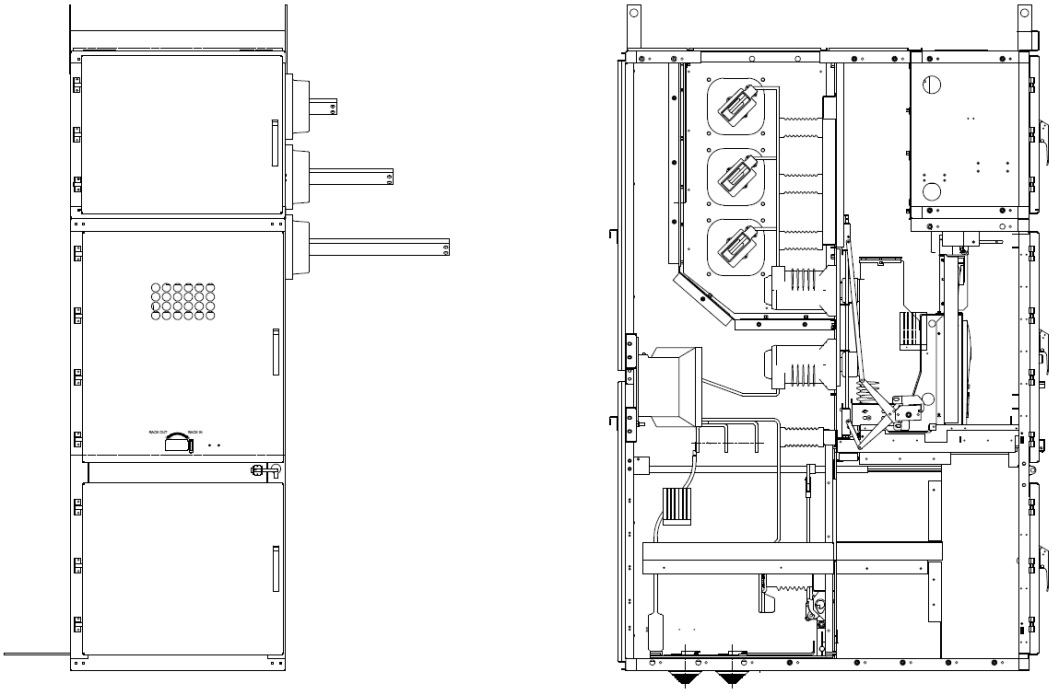


Figure 3 – AMV 1250 A, 31.5 kA feeder panel general arrangement (with surge arresters) (single-busbar)

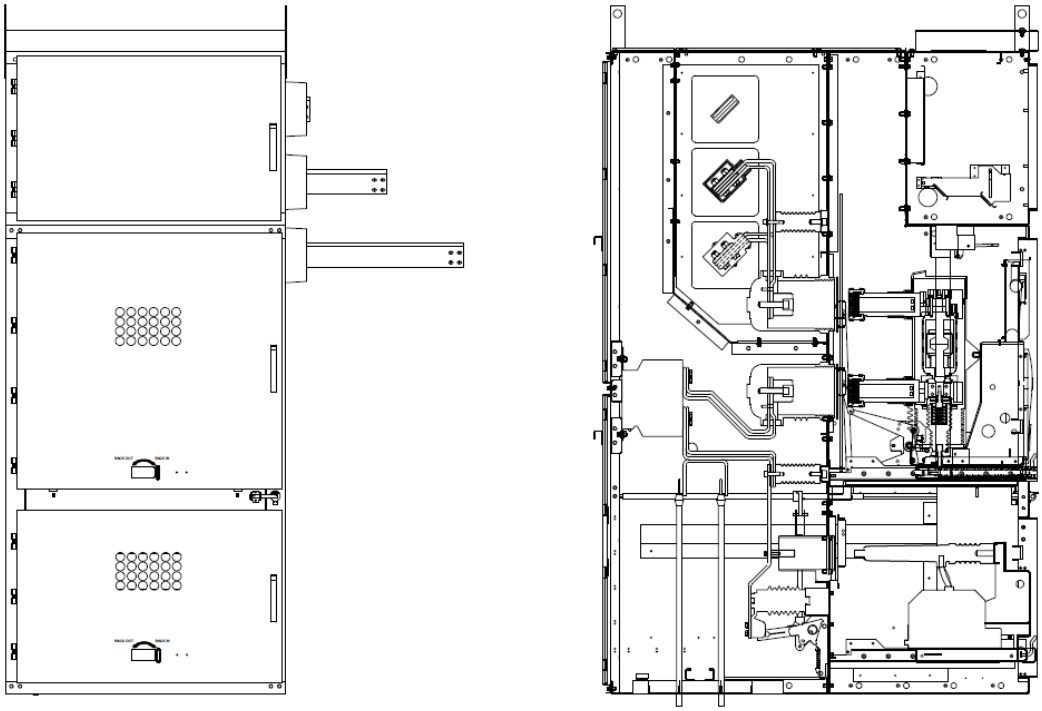


Figure 4 – AMV 2500 A, 31.5 kA incomer panel general arrangement (single-busbar)

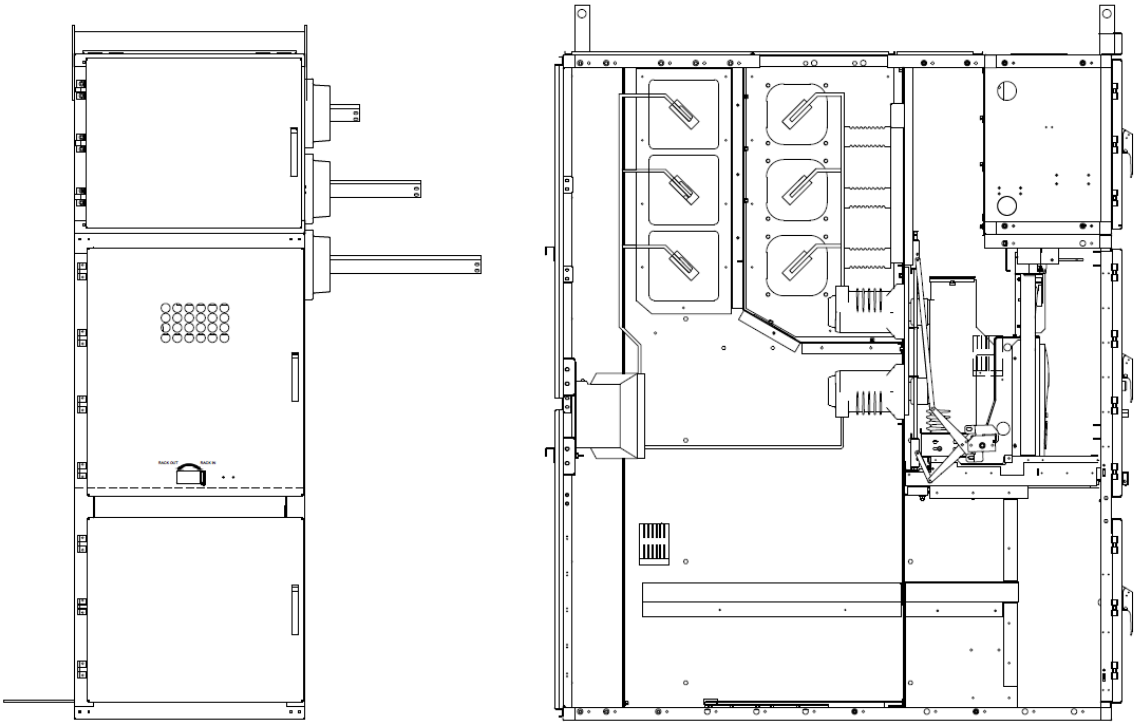


Figure 5 – AMV 1250 A, 31.5 kA bus-section panel general arrangement (single-busbar)
***only for 12 kV and 17.5 kV rated panels**

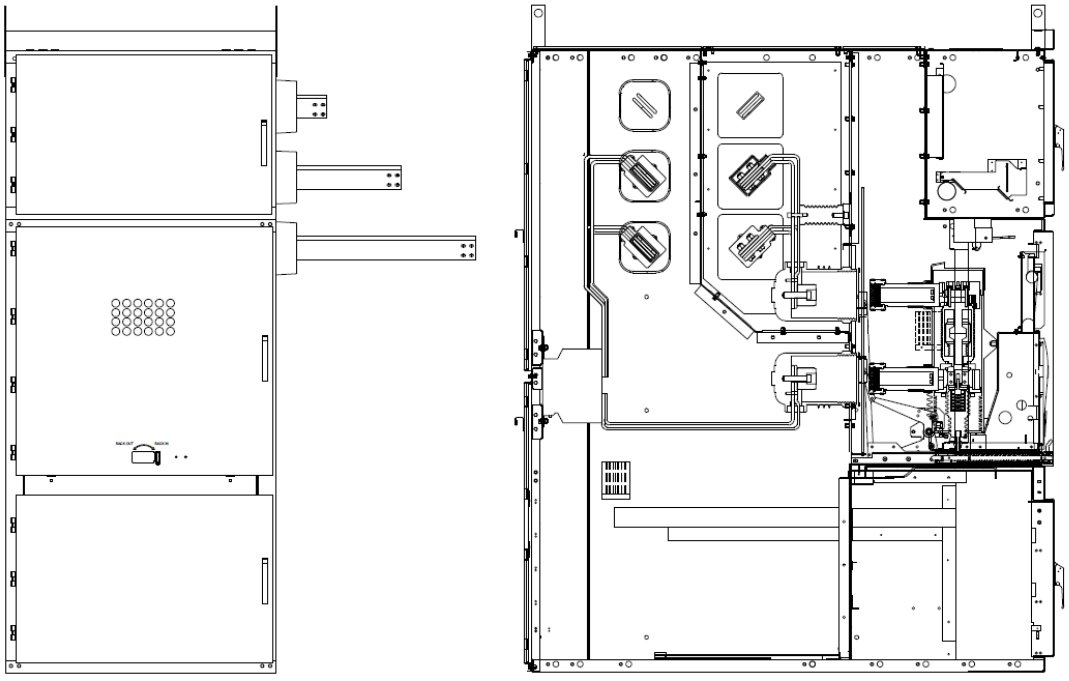


Figure 6 – AMV 2500 A, 31.5 kA bus-section panel general arrangement (single-busbar)
***only for 12 kV and 17.5 kV rated panels**

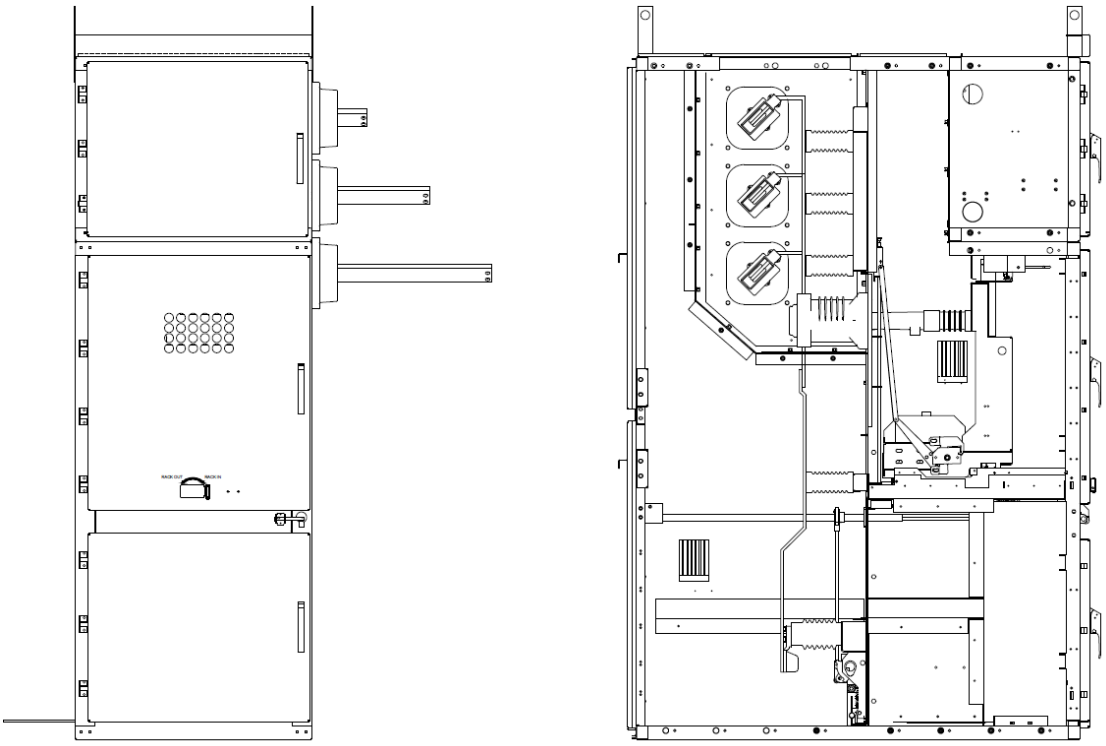


Figure 7 – AMV 31.5 kA busbar VT panel general arrangement (single-busbar)

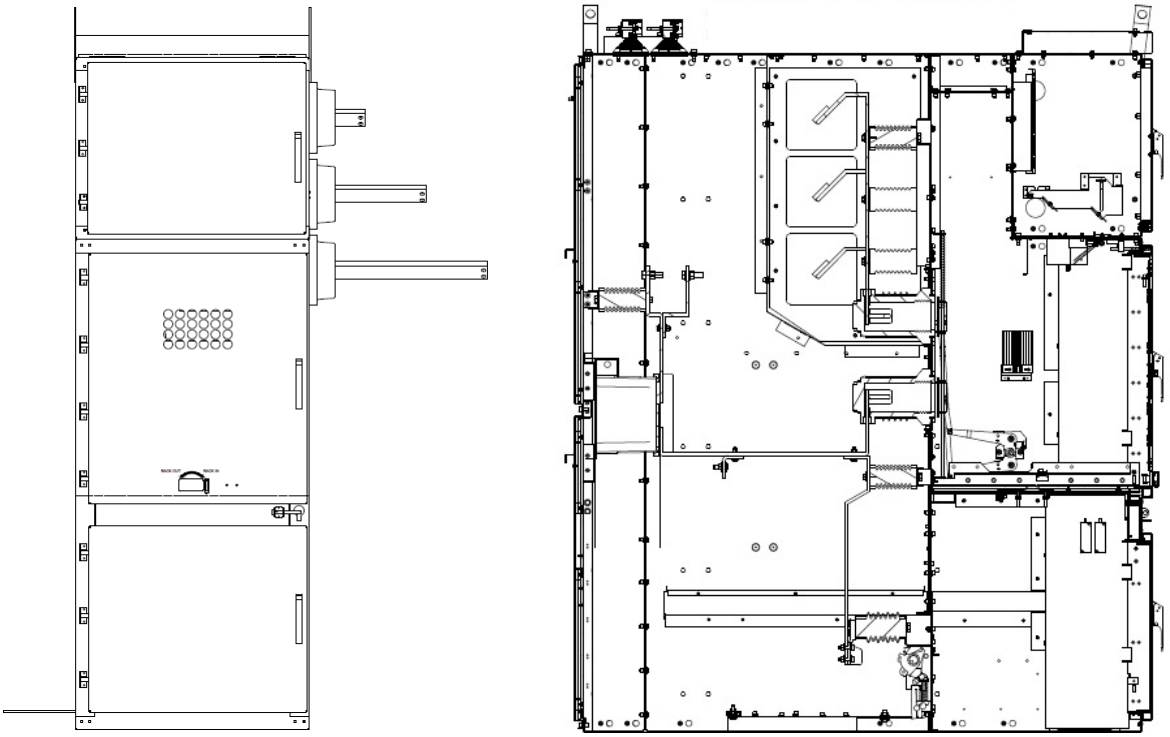


Figure 8 – AMV 1250 A, 31.5 kA top-entry feeder panel general arrangement (with surge arresters) (single-busbar)
*only for 12 kV and 17.5 kV rated panels

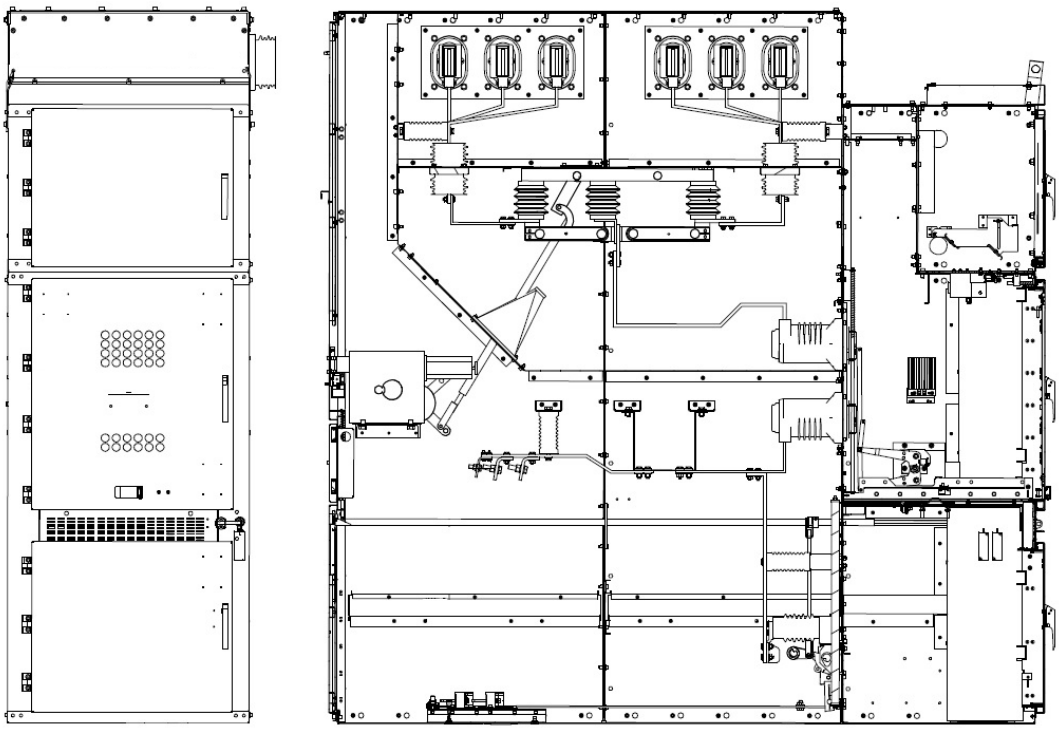


Figure 9 – AMV 1250 A, 31.5kA feeder panel general arrangement (double-busbar)
***only for 12 kV and 17.5 kV rated panels**

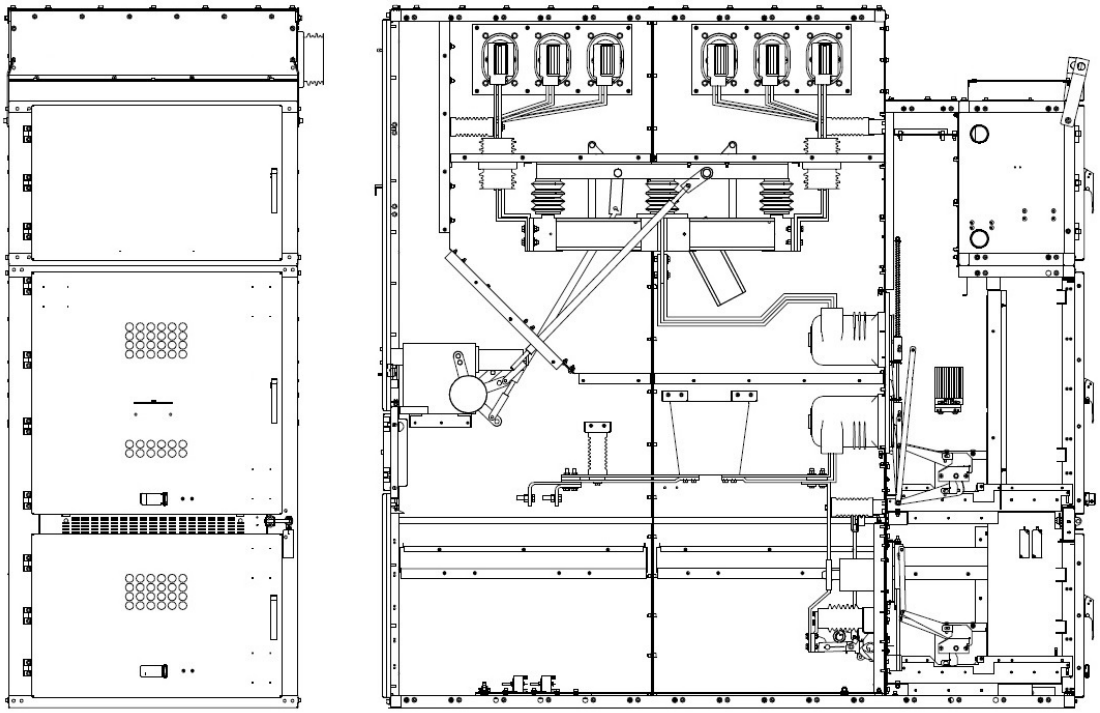


Figure 10 – AMV 2500 A, 31.5 kA incomer panel general arrangement (double-busbar)
***only for 12 kV and 17.5 kV rated panels**

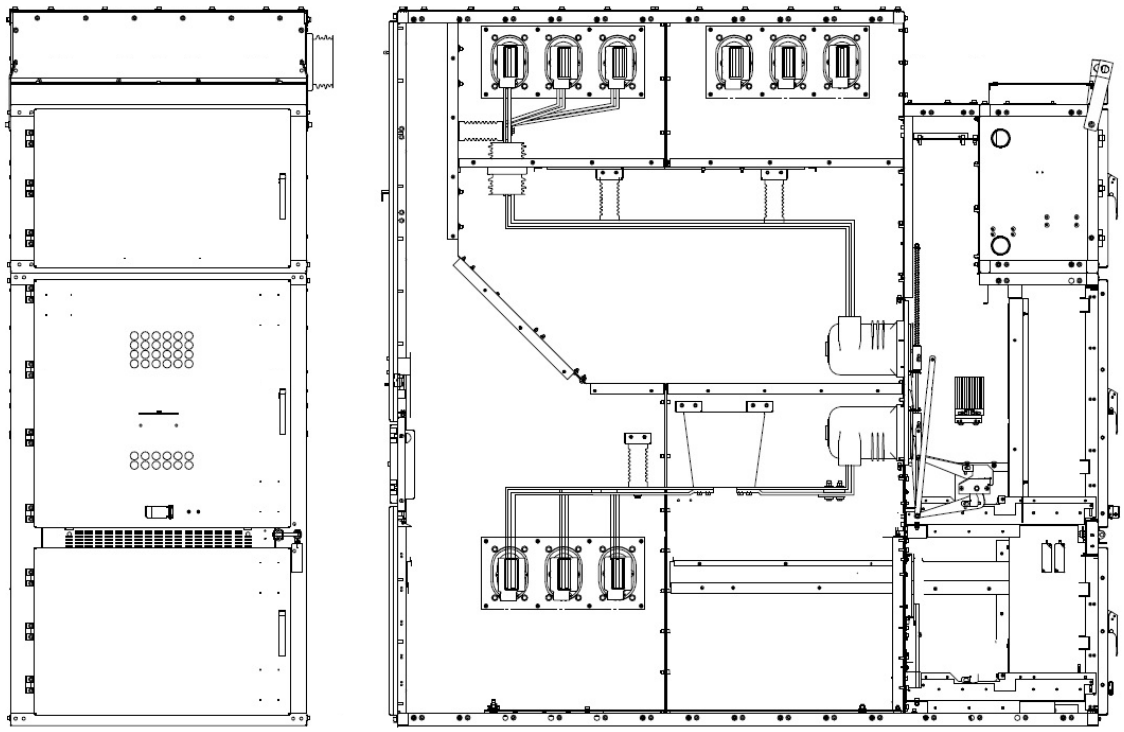


Figure 11 – AMV 31.5 kA bus-section (rear busbar) panel general arrangement (double-busbar)
***only for 12 kV and 17.5 kV rated panels**

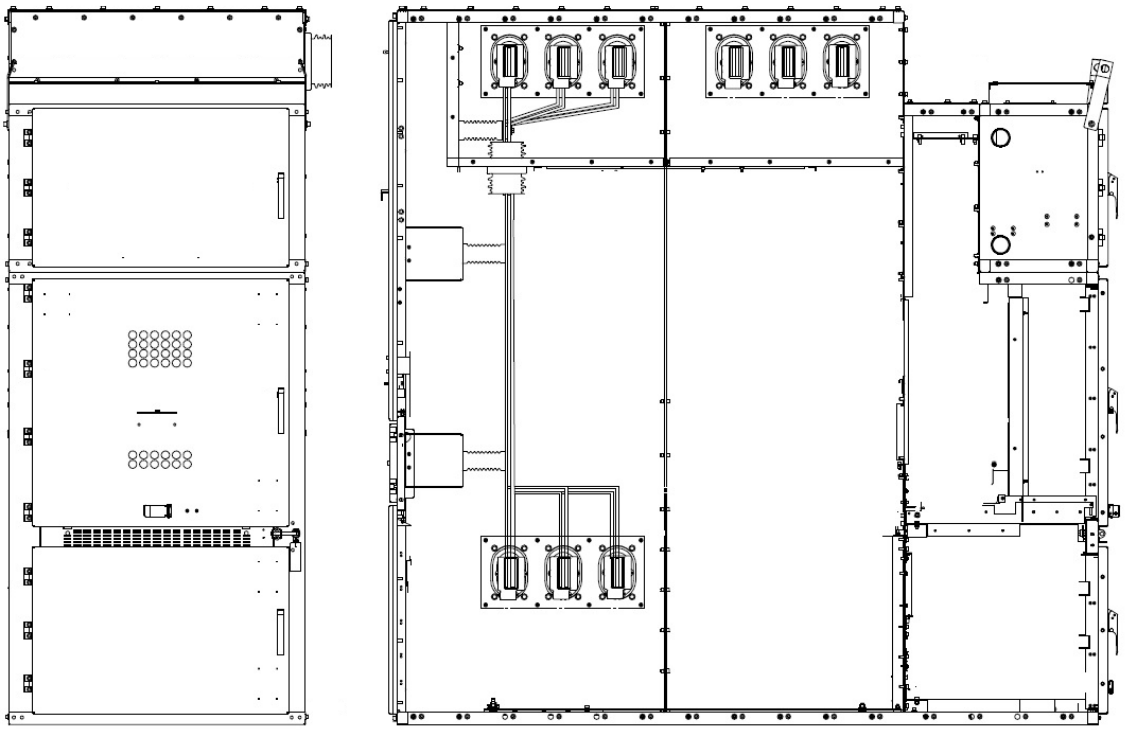


Figure 12 – AMV 31.5 kA bus-section (rear busbar) riser panel general arrangement (double-busbar)
***only for 12 kV and 17.5 kV rated panels**

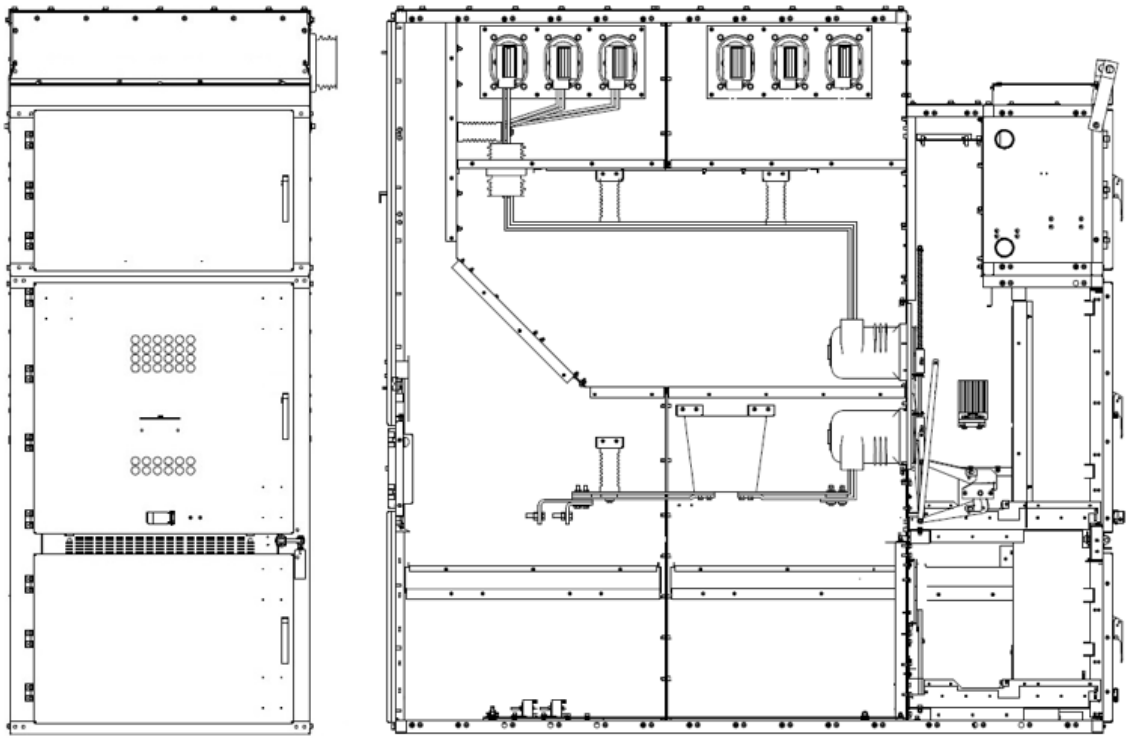


Figure 13 – AMV 31.5 kA cable-connected bus-section (rear busbar) panel general arrangement (double-busbar)
*only for 12 kV and 17.5 kV rated panels

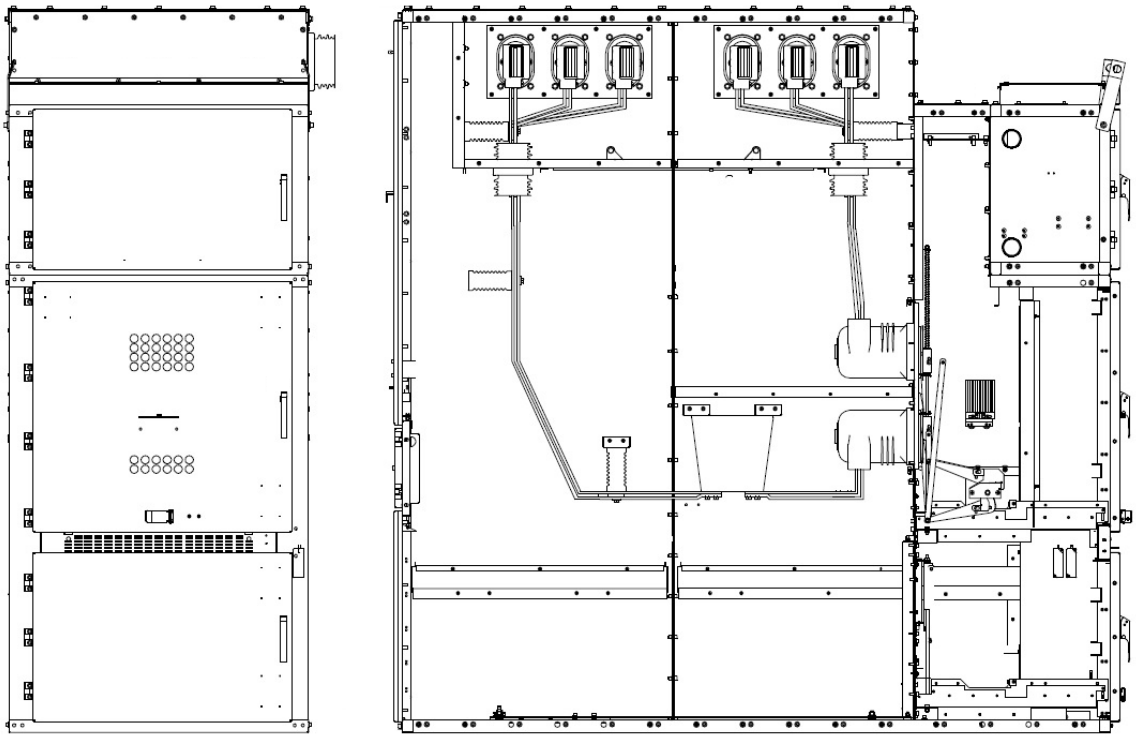


Figure 14 – AMV 31.5 kA bus-coupler panel general arrangement (double-busbar)
*only for 12 kV and 17.5 kV rated panels

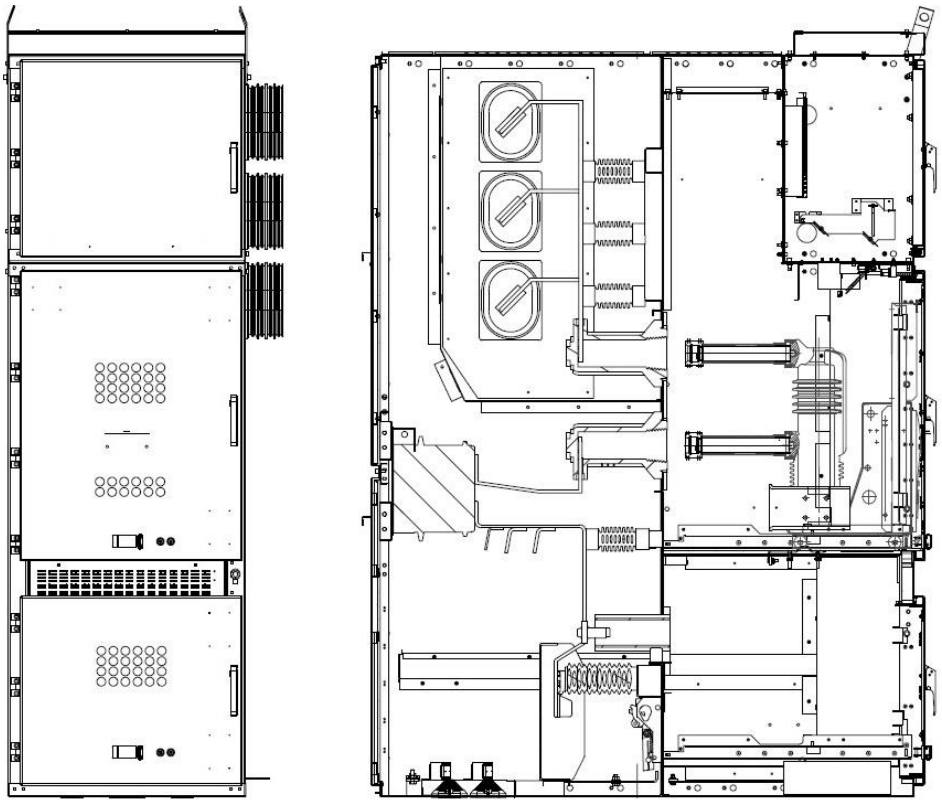


Figure 15 – AMV24 31.5 kA 1250 A incomer/feeder panel general arrangement (single-busbar)

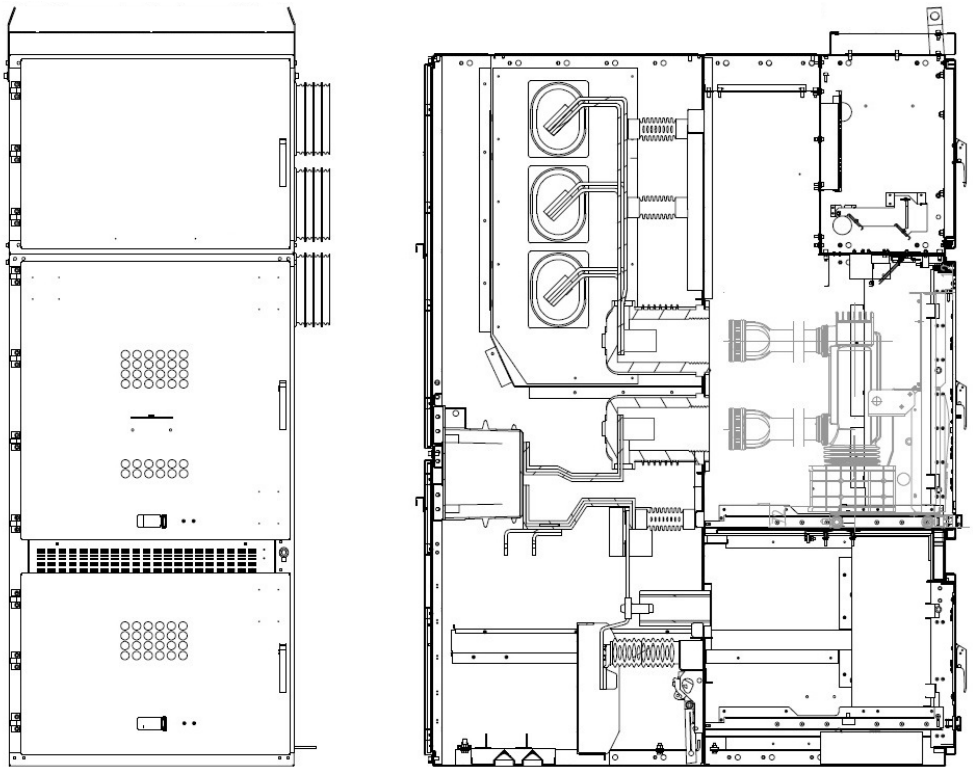


Figure 16 – AMV24 31.5 kA 2500 A incomer panel general arrangement (single-busbar)

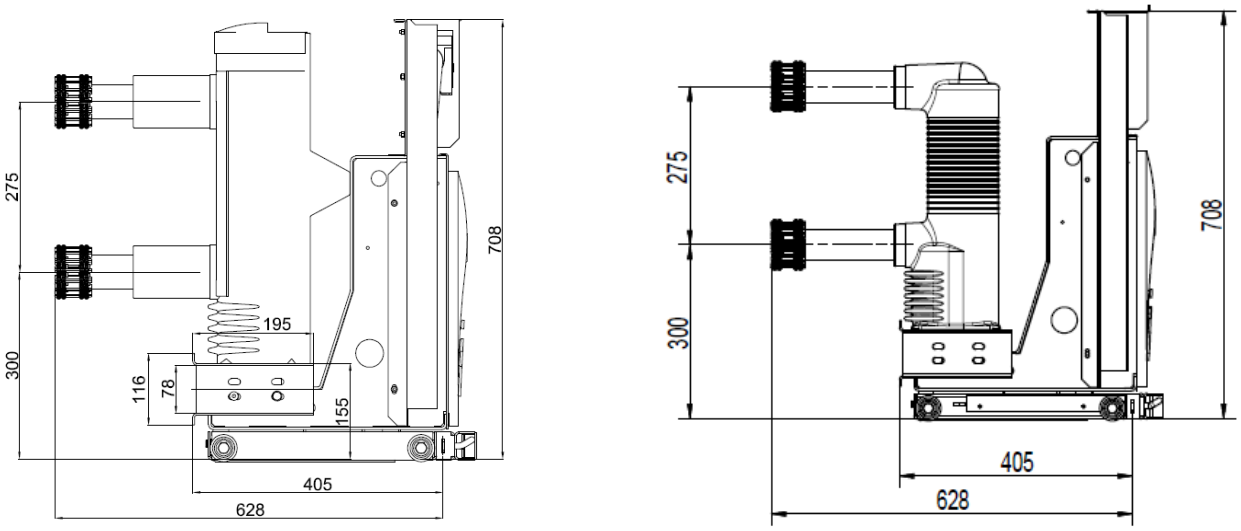


Figure 17 – AMV 12 kV & 17.5 kV, 31.5 kA, 800 A shrouded pole & 1250 A embedded pole circuit-breaker general arrangement

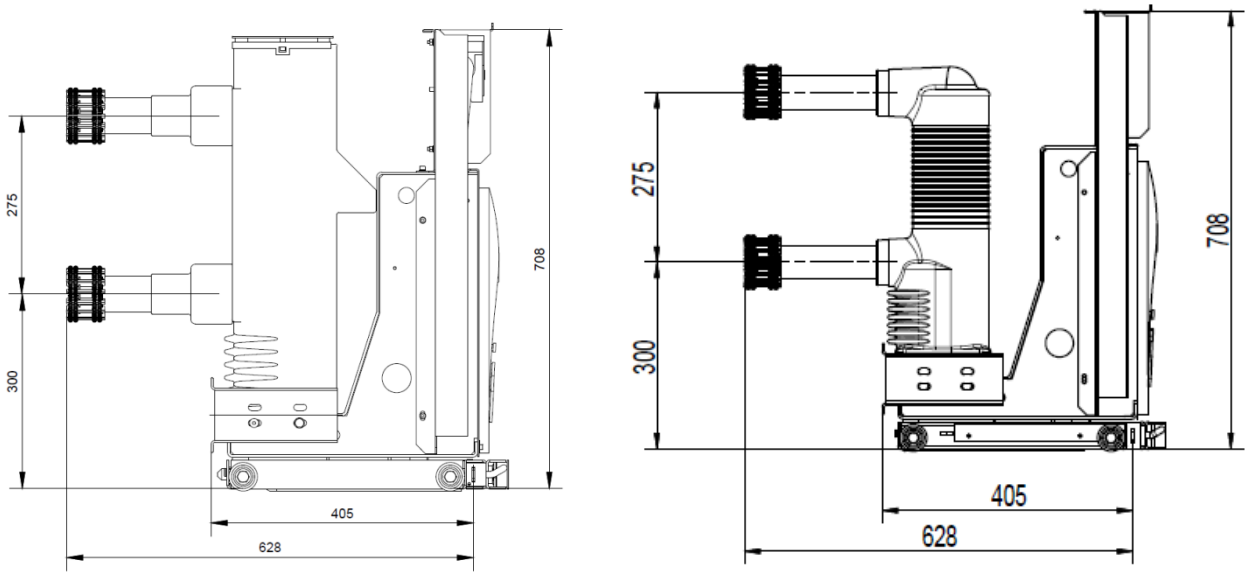


Figure 18 – AMV 12 kV & 17.5 kV, 31.5 kA, 1250 A shrouded & embedded pole circuit-breaker general arrangement

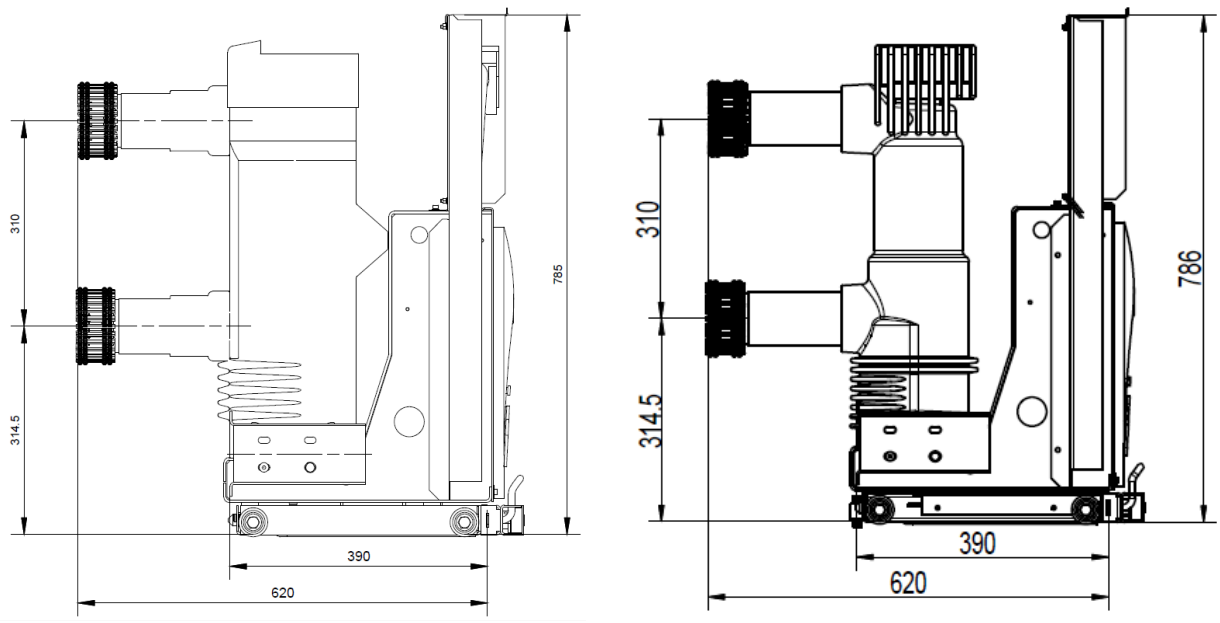


Figure 19 – AMV 12 kV & 17.5 kV, 31.5 kA, 2500 A shrouded & embedded pole circuit-breaker general arrangement

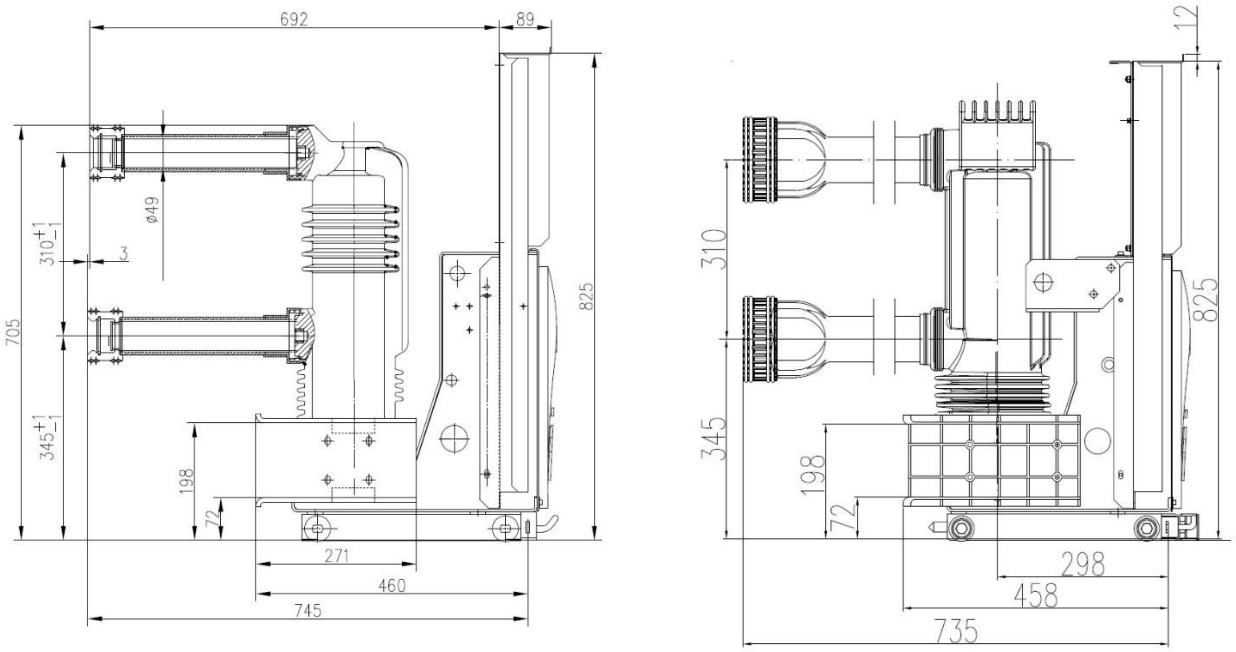


Figure 20 – AMV 24 kV, 31.5 kA, 1250 A & 2500 A embedded pole circuit-breaker general arrangement

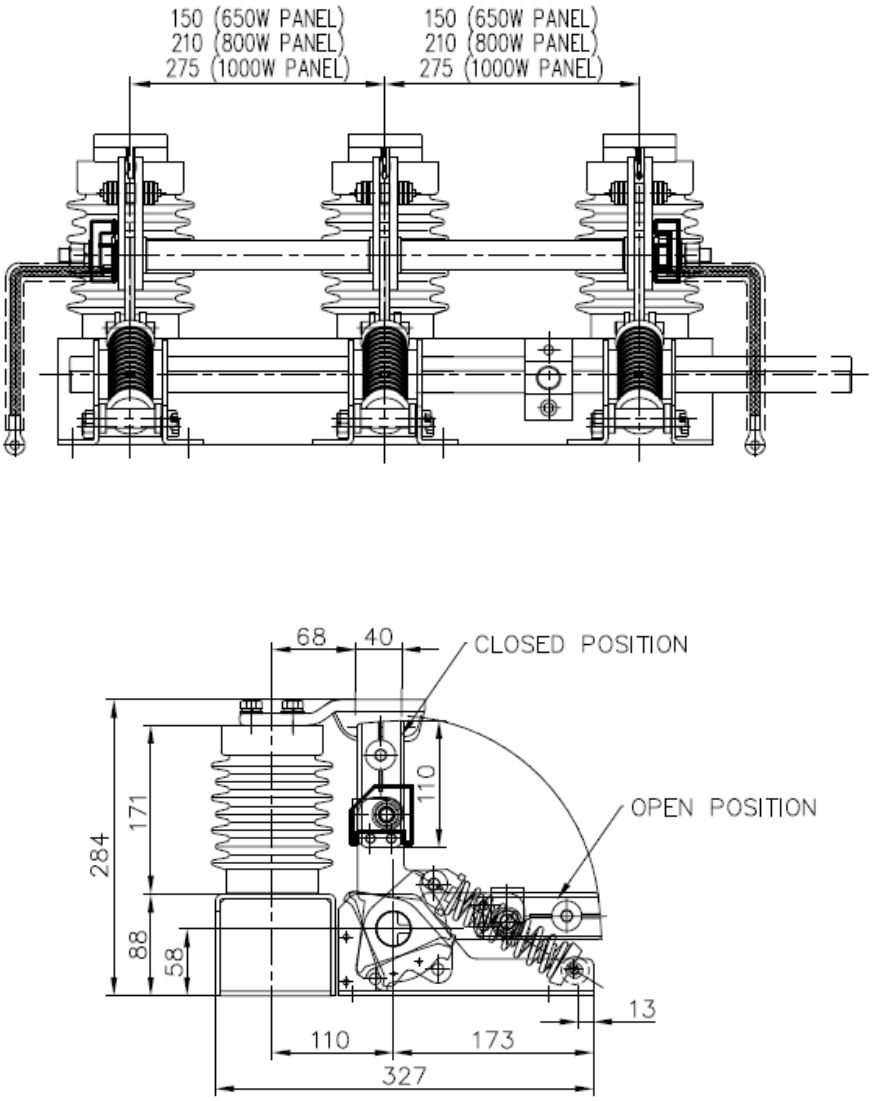


Figure 21 – AMV 17.5 kV, 31.5 kA earthing switch general arrangement (AMV17/31.5/ES)

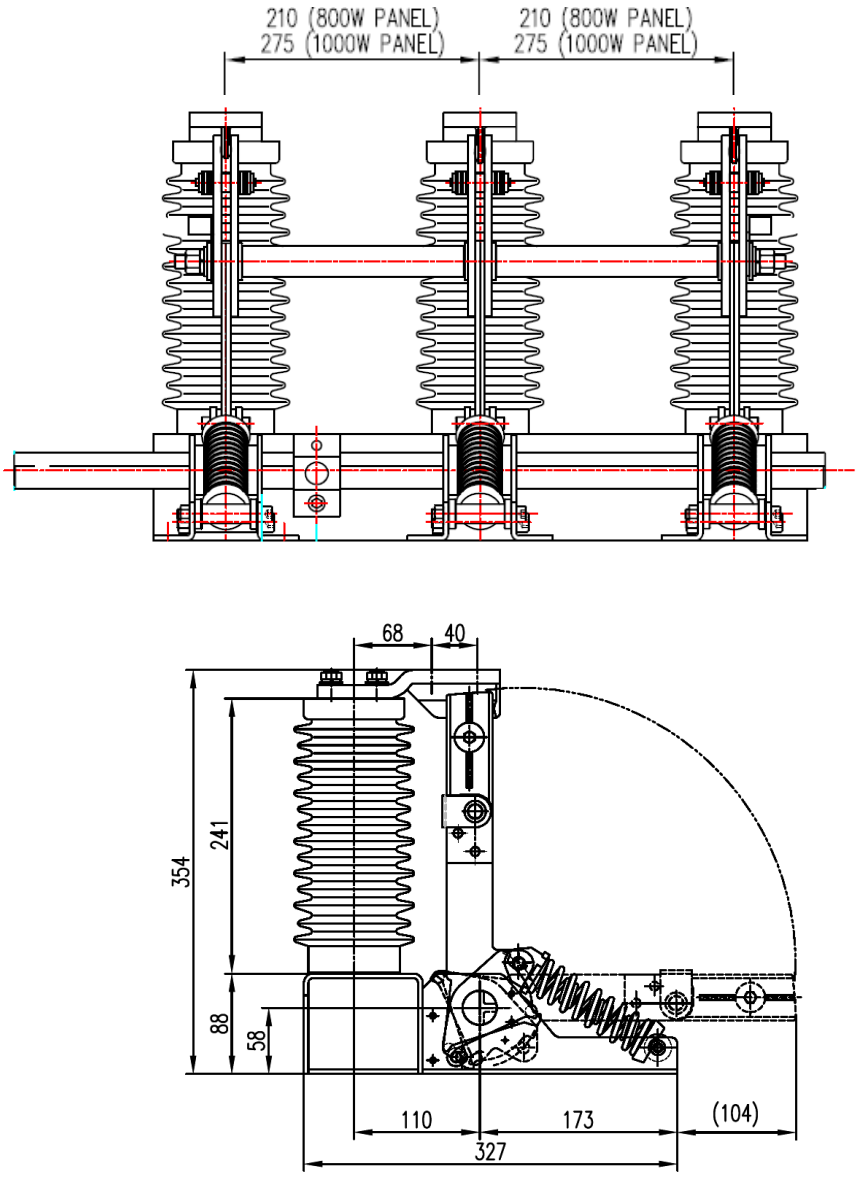


Figure 22 – AMV 24 kV, 31.5 kA earthing switch general arrangement (AMV24/31.5/ES)

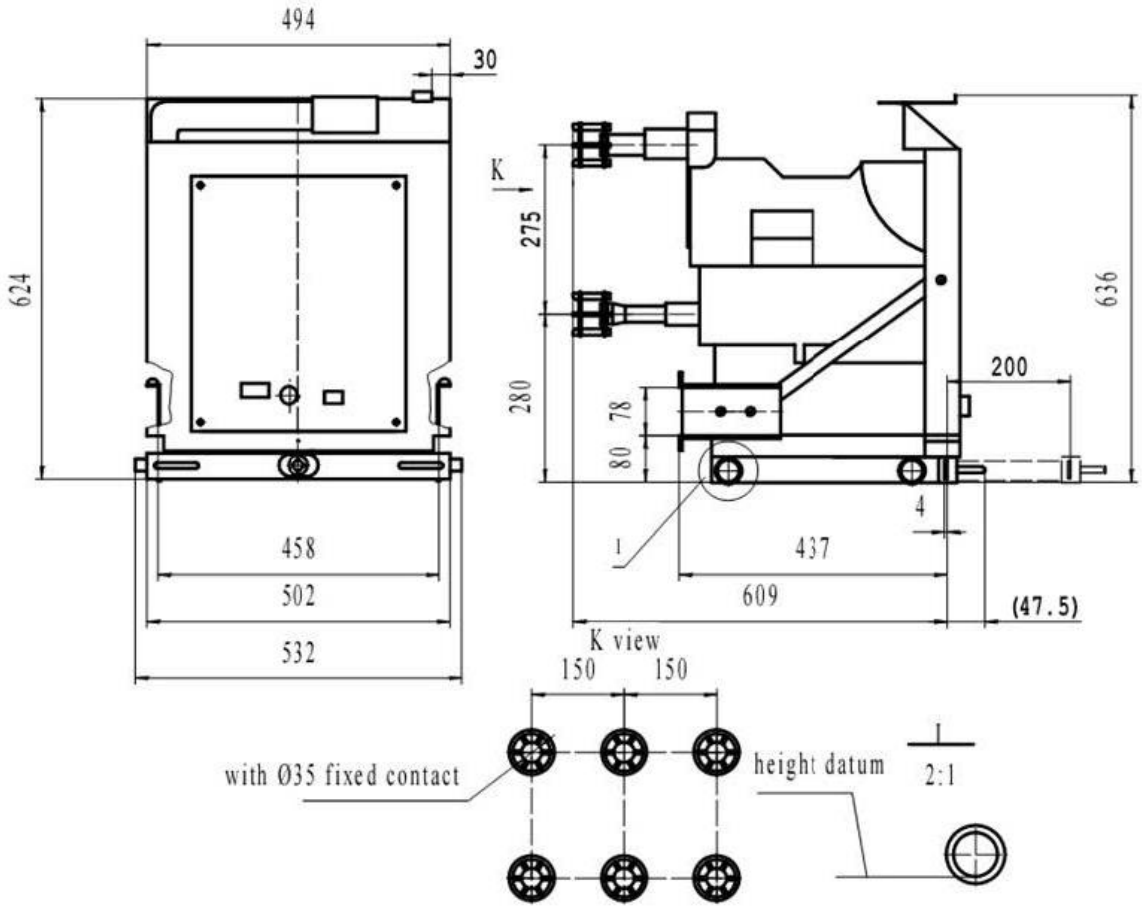


Figure 23 – AMV contactor-fuse combination general arrangement

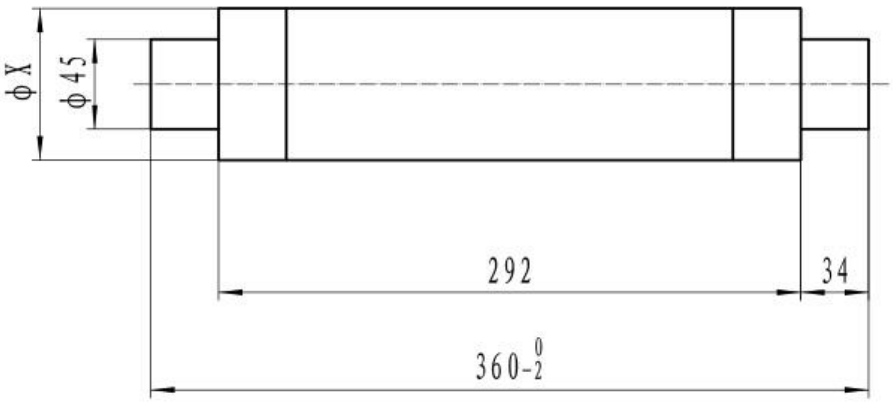


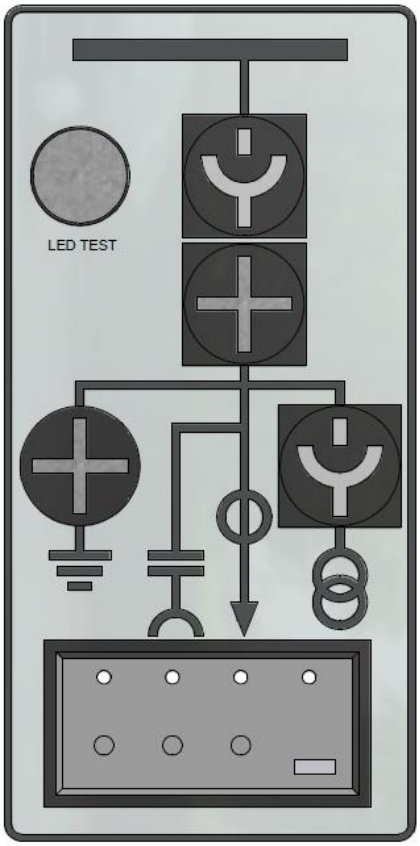
Figure 24 – AMV contactor fuse-link - overall dimensions (IEC 60282-1 TYPE 1)

2.6 POSITION INDICATION AND VOLTAGE DETECTING & INDICATING SYSTEM (VDIS)

2.6.1 AMV MIMIC DIAGRAM

The AMV panels are supplied with a main circuit single-line mimic diagram with integrated LED status and position indicators on the LV compartment door. The LED status and position indication system can be supplied with an optional self check facility (lamp test push-button).

The power consuption per LED status indicator is ≤ 1 W.





2.6.2 AMV VOLTAGE DETECTING AND INDICATING SYSTEM (VDIS)

IMPORTANT INFORMATION:
When VDIS units are not fitted, ensure that the capacitive voltage divider secondary output is suitably earthed.

It is possible to carry out power frequency voltage withstand tests on the primary circuit without having to earth the secondary terminals of the VDIS unit.

Standard features provided with the Voltage Detecting and Indicating System (VDIS):

- Cable/busbar live indication
- Test points
- 'Self-check' push-button facility
- 'Lock' facility and indication for the earthing switch blocking magnet
- Power consumption: ≤ 3 W

The VDIS system provided with the AMV panels is compliant to IEC 62271-213 as well as the previous voltage detection system (VDS) standard IEC 61243-5. The VDIS 'self-check' push-button facility can also be used to verify correct functionality of the blocking magnet use to 'lock' (i.e. prevent) operation of the associated earthing switch.

A VDIS portable testing device (DXN-C) is available that can be used to verify the phasing (phase comparison) and also as an additional backup to test for the presence of voltage (voltage indication) as follows:

- Indication: Insert the test device between the earth test point and any phase test point of the VDIS unit of the switchgear panel. If the test device light is on, the tested phase is alive.
- Phase comparison: Insert the test device between the test points of the same phase of two different switchgear panels. If the test device light is off, the tested phase in in-phase.



2.7 PANEL DIMENSIONS AND MASS

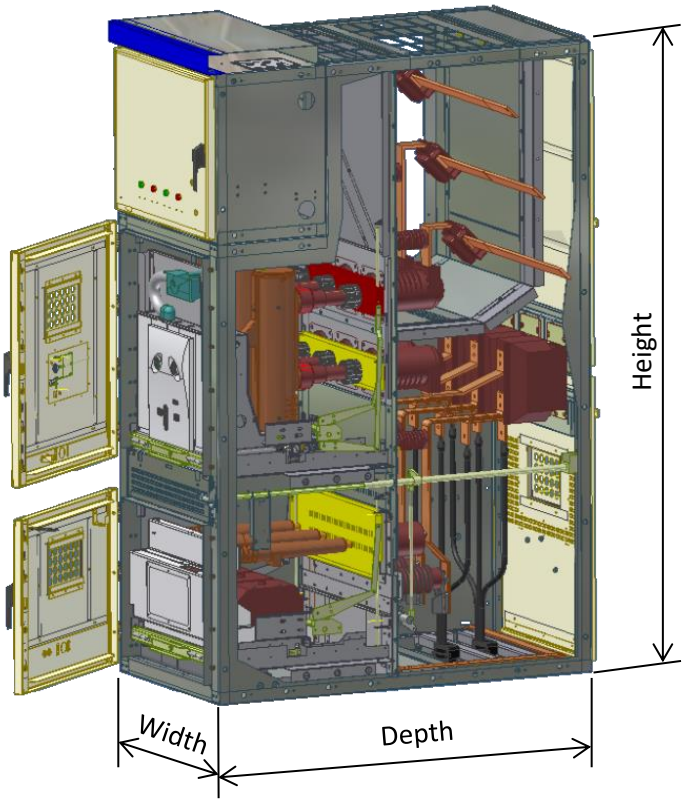


Figure 25 – AMV panel overall dimensions (single-busbar configuration)

2.7.1 SINGLE-BUSBAR CONFIGURATION – 12 kV & 17.5 kV

Dimensions & Mass	800/1250 A Incomer/ feeder	2500 A Incomer	800/1250 A Bus-section / riser / top-entry feeder	1250 A Bus-section / riser / top-entry feeder	2500 A Bus-section / riser / top-entry incomer	Busbar VT Panel
Width	650/800 mm	1000 mm	650 mm	800 mm	1000 mm	650/800 mm
Depth (incl. doors & rear covers, excl. handles)	1566 mm	1566 mm	1966 mm	1966 mm	1966 mm	1566 mm
Depth (base)	1500 mm	1500 mm	1900 mm	1900 mm	1900 mm	1500 mm
Height (to top of front facia)	2380 mm	2380 mm	2380 mm	2380 mm	2380 mm	2380 mm
Height (to pressure relief device - 25kA 1s)	2305 mm	2305 mm	2305 mm	2305 mm	2305 mm	2305 mm
Height (with 31.5 kA arc coolers)	2461 mm	2461 mm	2461 mm	2461 mm	2461 mm	2461 mm
Height (with 31.5 kA arc deflectors)	2755 mm	2755 mm	2755 mm	2755 mm	2755 mm	2755 mm
Height (with 31.5 kA arc ducting)	2825 mm	2825 mm	2825 mm	2825 mm	2825 mm	2825 mm

Dimensions & Mass	800/1250 A Incomer/ feeder	2500 A Incomer	800/1250 A Bus-section / riser / top-entry feeder	1250 A Bus-section / riser / top-entry feeder	2500 A Bus-section / riser / top-entry incomer	Busbar VT Panel
Mass (panel with CTs, excl. main busbars, CB & VT carriage)*	700/750 kg	1000 kg	800/900/900 kg	850/950/950 kg	1100/1250/ 1250 kg	600 kg
Mass (circuit-breaker)*	105/125 kg	200 kg	105 kg	125 kg	200 kg	N/A
Mass (VT carriage with VTs)*	60/95 kg	105 kg	60 kg	85 kg	105 kg	95 kg
Mass (CTs & VTs)*	CT: 30 kg (x3) VT: 23 kg (x3)	CT: 45 kg (x3) VT: 23 kg (x3)	CT: 30 kg (x3) VT: 35 kg (x1)	CT: 30 kg (x3) VT: 23 kg (x3)	CT: 45 kg (x3) VT: 23 kg (x3)	VT: 23 kg (x3)

* NOTE: Masses of equipment provided are approximate.

2.7.2 SINGLE-BUSBAR CONFIGURATION – 24 kV

Dimensions & Mass	800/1250 A Incomer/ feeder	2500 A Incomer	1250 A Bus-section / riser	2500 A Bus-section / riser	Busbar VT Panel
Width	800 mm	1000 mm	800 mm	1000 mm	800 mm
Depth (incl. doors & rear covers, excl. handles)	1866 mm	1866 mm	2266 mm	2266 mm	1866 mm
Depth (base)	1800 mm	1800 mm	2200 mm	2200 mm	1800 mm
Height (to top of front facia)	2580 mm	2580 mm	2580 mm	2580 mm	2580 mm
Height (to pressure relief device - 25kA 1s)	2500 mm	2500 mm	2500 mm	2500 mm	2500 mm
Height (with 31.5 kA arc coolers)	2660 mm	2660 mm	2660 mm	2660 mm	2660 mm
Height (with 31.5 kA arc ducting)	3025 mm	3025 mm	3025 mm	3025 mm	3025 mm
Mass (panel with CTs, excl. main busbars, CB & VT carriage)*	750 kg	1000 kg	850/950 kg	1100/1250 kg	600 kg
Mass (circuit-breaker)*	125 kg	200 kg	125 kg	200 kg	N/A
Mass (VT carriage with VTs)*	95 kg	105 kg	85 kg	105 kg	95 kg
Mass (CTs & VTs)*	CT: 30 kg (x3) VT: 23 kg (x3)	CT: 45 kg (x3) VT: 23 kg (x3)	CT: 30 kg (x3) VT: 23 kg (x3)	CT: 45 kg (x3) VT: 23 kg (x3)	VT: 23 kg (x3)

* NOTE: Masses of equipment provided are approximate.

2.7.3 DOUBLE-BUSBAR CONFIGURATION (12 kV and 17.5 kV only)

Dimensions & Mass	1250 A Feeder	2500 A Incomer	2500 A Bus-section / riser / bus-coupler	Busbar VT Panel
Width	900 mm	1100 mm	1100 mm	900 mm
Depth (incl. doors & rear covers, excl. handles)	2666 mm	2666 mm	2666 mm	2666 mm
Depth (base)	2600 mm	2600 mm	2600 mm	2600 mm
Height (to top of panel)	2650 mm	2650 mm	2650 mm	2650 mm
Height (with 31.5 kA arc coolers)	2806 mm	2806 mm	2806 mm	2806 mm
Mass (panel with CTs, excl. main busbars, CB & VT carriage)*	1600 kg	2200 kg	1850 / 1000 / 2000 kg	600 kg
Mass (circuit-breaker)*	125 kg	200 kg	200 kg	N/A
Mass (VT carriage with VTs)*	95 kg	105 kg	105 kg	95 kg
Mass (CTs & VTs)*	CT: 30 kg (x3) VT: 23 kg (x3)	CT: 45 kg (x3) VT: 23 kg (x3)	CT: 45 kg (x3) VT: 23 kg (x3)	VT: 23 kg (x3)

* NOTE: Masses of equipment provided are approximate.

2.8 SUBSTATION DESIGN CONSIDERATIONS

	Minimum clearances around switchgear			Minimum ceiling height*
	Side of panel to wall	Rear of panel to wall	Front of panel to wall	(above floor)
12 / 17 kV	100 mm	800 mm	2000 mm	3000 mm (IAC 25 kA 1 s) 3000 mm (IAC 31.5 kA 1 s) – with arc ducting 3000 mm (IAC 31.5 kA 1 s) – with arc coolers 3200 mm (IAC 31.5 kA 1 s) – with arc deflectors
24 kV	100 mm	800 mm	2000 mm	3200 mm (IAC 25 kA 1 s) 3200 mm (IAC 31.5 kA 1 s) – with arc ducting 3200 mm (IAC 31.5 kA 1 s) – with arc coolers

* NOTE: Additional 300 mm ceiling height required for double-busbar configuration for 12 kV and 17.5 kV options.

2.9 AMV CARRIAGES

2.9.1 CIRCUIT-BREAKER CARRIAGES

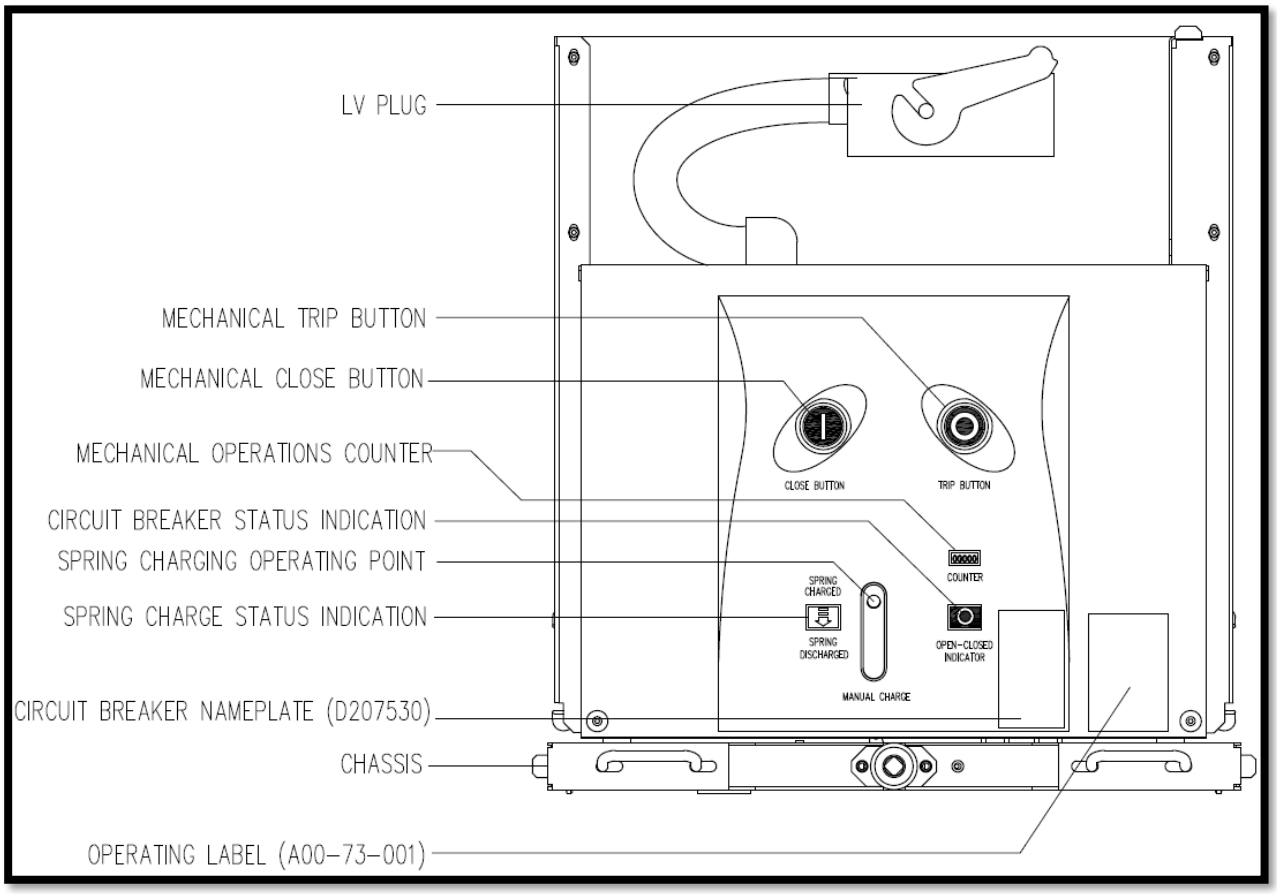


Figure 26 – Circuit-breaker operating interfaces

2.9.2 BUSBAR VT CARRIAGES

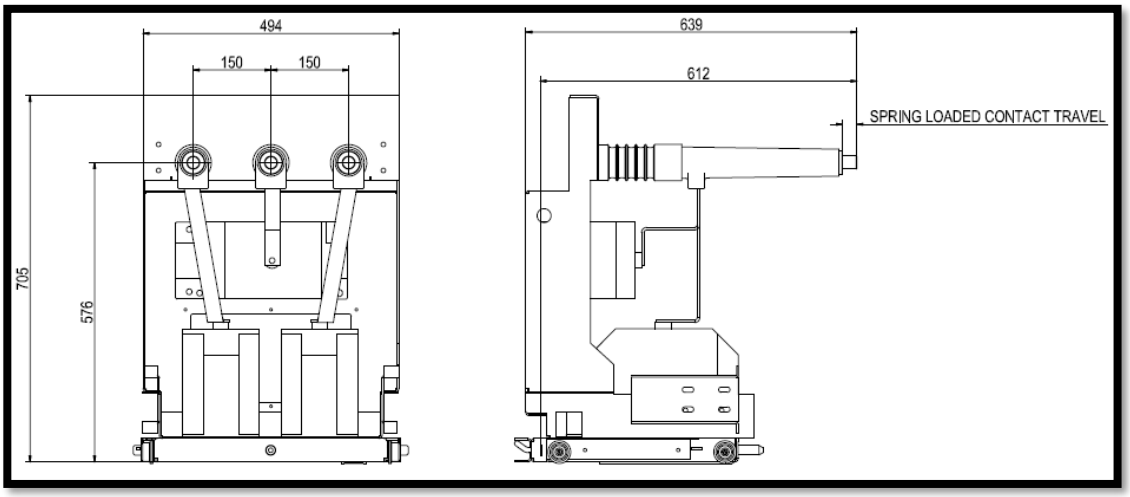


Figure 27 – Busbar VT carriage (650 mm wide panel)

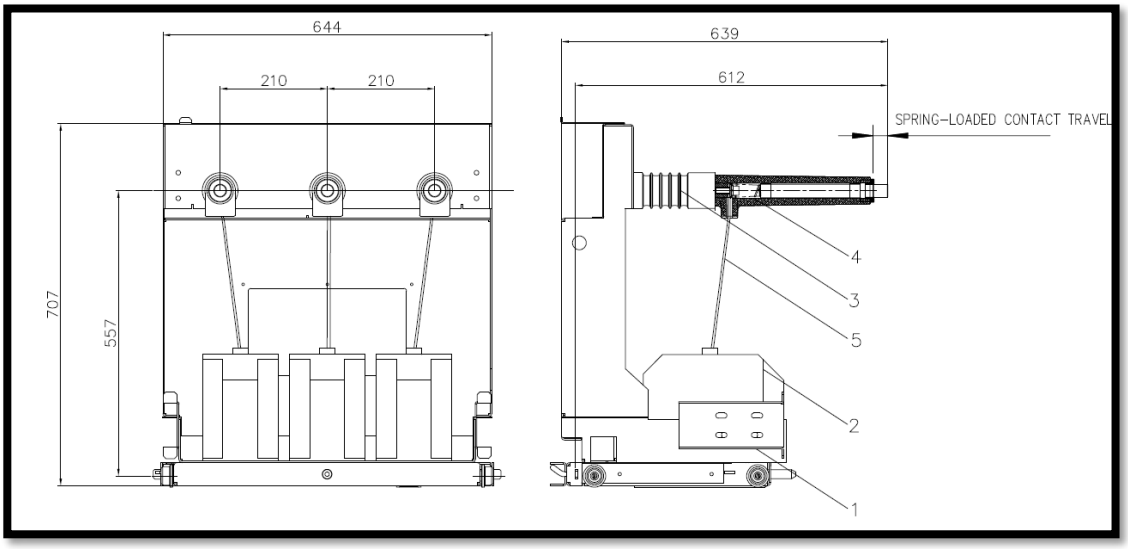


Figure 28 – Busbar VT carriage (800 mm wide panel)

No.	**Description**
1	VT carriage chassis
2	VT (3-phase VT for 650 mm wide panel, 1-phase VTs for 800 mm wide panel)
3	Insulator
4	VT primary fuse-holder shroud
5	VT primary connection

2.9.3 CABLE-SIDE VT CARRIAGES

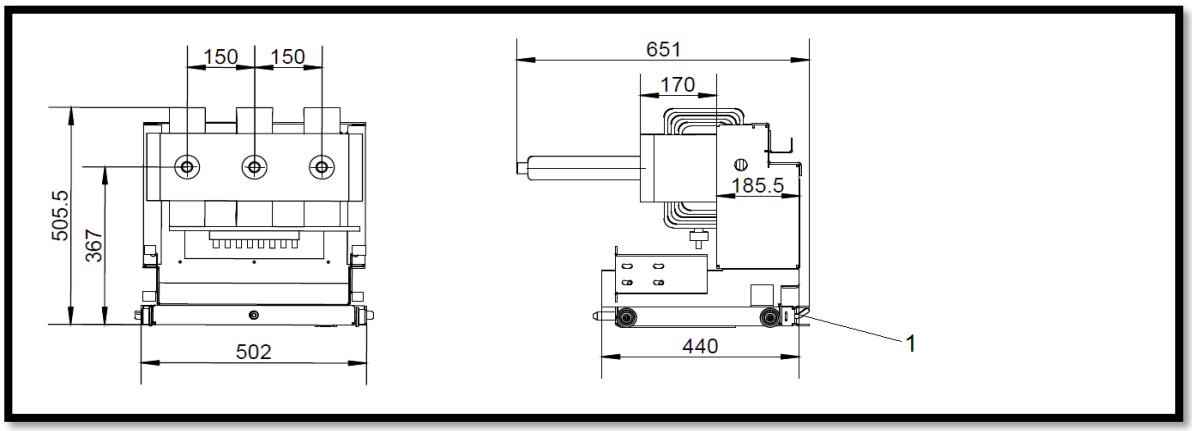


Figure 29 – 800/1250 A panel cable-side VT carriage (3-phase VT for 650 mm wide panel)

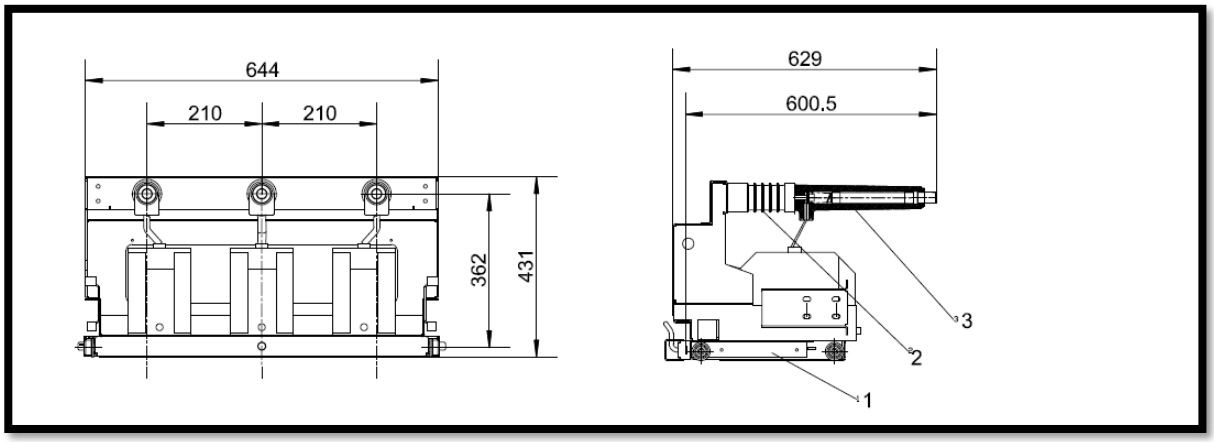


Figure 30 – 1250 A panel cable-side VT carriage (1-phase VTs for 800 mm wide panel)

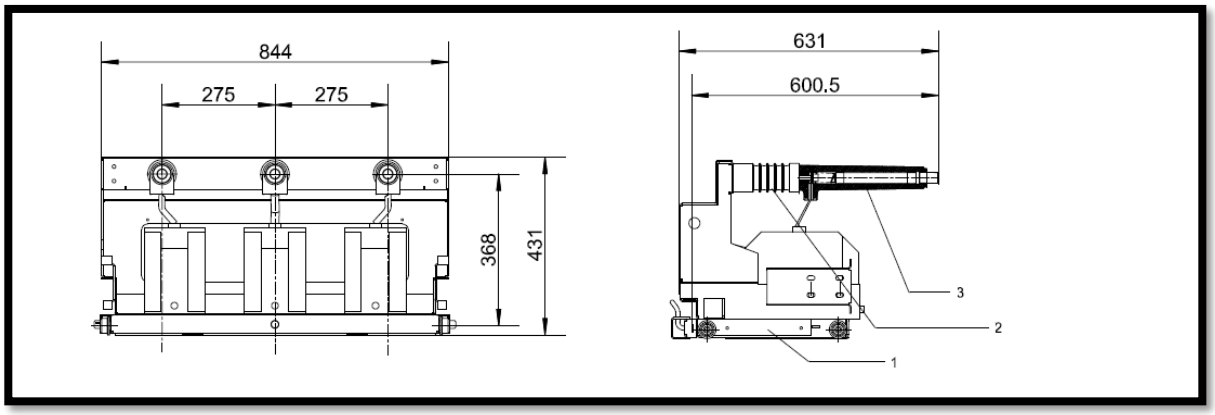


Figure 31 – 2500 A wide panel cable-side VT carriage (1-phase VTs for 1000 mm wide panel)

No.	**Description**
1	VT carriage chassis
2	Insulator
3	VT primary fuse-holder shroud

2.10 PADLOCKING FACILITIES

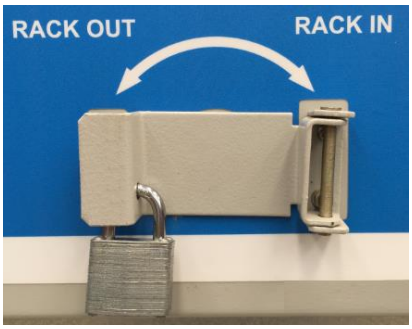
The following standard padlocking facilities are provided in the AMV switchgear:

- panel housing compartment door handles;
- circuit-breaker compartment door TRIP/CLOSE orifice shutter;
- circuit-breaker / VT compartment door racking handle orifice shutter;
- earthing switch operating handle orifice shutter; and
- busbar and cable orifice shutters (in the closed position).

The holes provided are suitable for padlocks having a shackle diameter ≤ 6 mm.

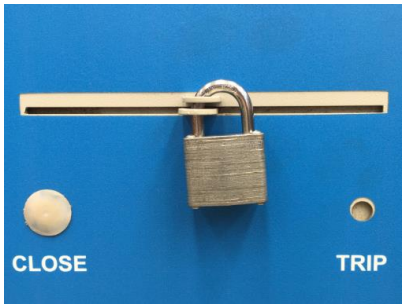
IMPORTANT INFORMATION:
When a circuit-breaker or VT carriage is removed from the panel housing, it is recommended that the corresponding compartment door is closed and padlocked. This will prevent unauthorised tampering with the equipment and shutters in the compartment.


Compartment door handles



Racking handle orifice shutter


Cable-side orifice shutters



TRIP/CLOSE orifice shutter


Earthing switch orifice shutter


Busbar-side orifice shutters

Figure 32 – Padlocking facilities

2.11 MOTORISED RACKING

Each AMV circuit-breaker and/or VT carriage can be supplied with a motorised chassis for remote operation. The standard supply for the racking motor is either 110 V DC or 220 V DC. Each racking motor is controlled by a racking motor controller which ensures that racking only takes place when the necessary interlock and safety conditions (e.g. door closed, etc.) are met.

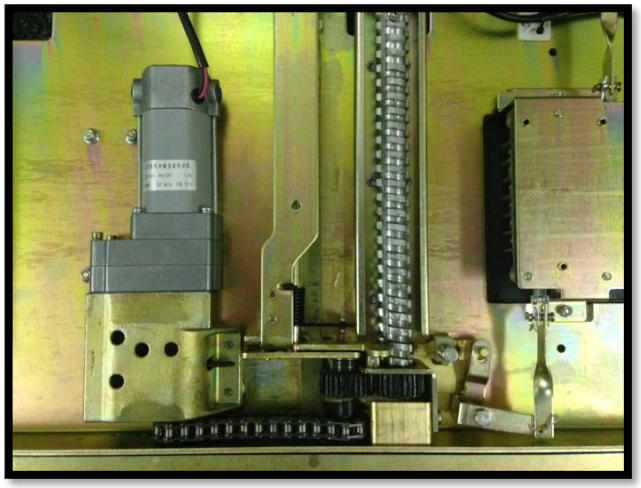


Figure 33 – Motorised circuit-breaker chassis



Figure 34 – Racking motor controller

2.12 UNDERVOLTAGE TRIPPING

Each AMV circuit-breaker can be supplied with undervoltage tripping equipment. The standard voltage for the undervoltage tripping equipment is either 110 V DC or 220 V AC/DC. The undervoltage equipment consists of:

- an undervoltage trip coil;
- an undervoltage circuit-board fitted with a rectifier and capacitor providing the stored energy to trip the circuit-breaker in the event of an undervoltage condition;
- a voltage sensing relay (i.e. blocking magnet) with auxiliary contacts (i.e. microswitch) used to a) energise the undervoltage trip coil and b) prevent both electrical and mechanical closing of the circuit-breaker when the relay is de-energised (i.e. during an undervoltage condition); and
- a 110 V d.c. undervoltage trip coil is used for both 110 V and 220 V a.c. (d.c. trip voltage supplied from capacitor charged to 110 V x √2).

3 AMV SWITCHGEAR RATINGS AND TECHNICAL INFORMATION

3.1 800 A AND 1250 A VACUUM CIRCUIT-BREAKER PANELS

Parameter	Unit of Measure	Rated value		
Rated voltage (U_r)	kV	12	17.5	24
Number of phases		3		
Rated short-duration power-frequency withstand voltage (U_d)	kV	28	38	50
Rated peak lightning impulse withstand voltage (U_p)	kV	95	95	125
Rated frequency (f_r)	Hz	50		
Rated normal current (I_r) – busbars (single-busbar)	A	800 / 1250 / 2500	800 / 1250 / 2500	800 / 1250 / 2500
Rated normal current (I_r) – busbars (double-busbar)	A	1250 / 2500		-
Rated normal current (I_r) – circuit-breaker (single-busbar)	A	800[1]/1250[2] (650W) / 1250 (800W)	800[1]/1250[2] (650W) / 1250 (800W)	800 (800W) / 1250 (800W)
Rated normal current (I_r) – circuit-breaker (double-busbar)	A	1250 (900W)		-
Rated short-time withstand current (I_k and I_{ke})	kA	31.5		
Rated duration of short circuit (t_k) – main circuit and earthing switch	s	3		
Rated duration of phase-to-earth short circuit (t_{ke}) – 1-phase earthing circuit	s	1		
Rated peak withstand current (I_p and I_{pe}) and short-circuit making current of circuit-breaker and earthing switch	kA	78.75 (79)		
Internal arc classification	IAC	AFLR		
IAC test current value	kA	25 / 31.5		
IAC test current duration	s	1		
Loss of service continuity category	LSC	LSC2B		
Partition class	PM/PI	PM		
Degree of protection	IP	4X (enclosure)		
Earthing switch electrical endurance class	E1/E2	E2 (short-circuit making x 5)		E1
Earthing switch mechanical endurance class	M0/M1/M2	M0 (1000 operations)		
Double-busbar disconnector mechanical endurance class	M0/M1/M2	M0 (1000 operations)		
Rated supply voltage of closing and opening devices and of auxiliary and control circuits (U_a)	V	110 / 220 / 30 (d.c.) 110 / 220 (a.c.)		
Rated a.c. supply voltage of heaters and other a.c. auxiliary circuits (U_a)	V	230		
Rated supply frequency of closing and opening devices and of auxiliary and control circuits	Hz	d.c. (d.c.) 50 (a.c.)		
Rated supply frequency of heaters and other a.c. auxiliary circuits	Hz	50		
Rated short-circuit breaking current (I_{SC}) of circuit-breaker	kA	31.5		
DC time constant of rated short-circuit current	ms	45		
DC component	%	53		>36

Parameter	Unit of Measure	Rated value		
Rated voltage (U_r)	kV	12	17.5	24
Circuit-breaker class	S1/S2	S1		S2
Circuit-breaker electrical endurance class	E1/E2	E2 – with auto-reclose		
Rated operating sequence for circuit-breaker		O–0,3s–CO–3min–CO		
First-pole-to-clear factor (k_{pp}) for circuit-breaker		1.5 & 1.3		
Standard values of TRV related to the rated short-circuit breaking current (IEC 62271-100)		IEC 62271-100 Table 1		
System neutral earthing		Effective & non-effective		
Minimum resting time following rated operating sequence	min	3 min		
Classification of circuit-breaker according to its restrike performance (line-charging breaking current)	C1/C2	C2		
Rated capacitive switching currents for circuit-breaker – line-charging breaking current	A	10		
Classification of circuit-breaker according to its restrike performance (cable-charging breaking current)	C1/C2	C2		
Rated capacitive switching currents for circuit-breaker – cable-charging breaking current	A	25		31.5
Classification of circuit-breaker according to its restrike performance (capacitor bank breaking current)	C1/C2	C2		
Rated capacitive switching currents for circuit-breaker – single capacitor bank breaking current	A	400		
Circuit-breaker mechanical endurance class	M1/M2	M2 (10 000 operations)		
Rated opening time for circuit-breaker	ms	< 40	< 50	
Rated break-time for circuit-breaker	ms	< 50	< 60	
Rated closing time for circuit-breaker	ms	< 60		
Vacuum interrupter type		TD14-12/1250-31.5BQ		TD-24/1250-31.5Q
Vacuum interrupter contact stroke	mm	11 ±1		13 ±1
Circuit-breaker mechanism over-travel	mm	3 ±0.5		3.5 ±0.5
Vacuum interrupter contact erosion limit	mm	2		2.5
Average opening speed	m/s	1.3 ±0.3		1.6 ±0.3
Average closing speed	m/s	0.8 ±0.3		0.8 ±0.3
Contact bounce duration for closing operation	ms	≤ 2		
Contact re-bound amplitude for opening operation	mm	≤ 2		
Three-phase pole discrepancy	ms	< 1		
Vacuum interrupter contact resistance	μΩ	≤ 20		
Circuit-breaker resistance (excluding cluster contacts)	μΩ	≤ 40		
Spring charging motor – rated continuous power	W	70		
Spring charging motor – peak current	A	1.4 / 0.7 / 5.4 (@ 110 / 220 / 30 V d.c.)		
Spring charging motor – charging time	s	< 10 (@17 r/min)		
Closing and opening coil – power consumption	W	302.5 / 302.5 / 500 (@ 110 / 220 / 30 V d.c.)		
Closing and opening coil – current	A	2.75 / 1.38 / 16.7 (@ 110 / 220 / 30 V d.c.)		
Closing and opening coil – resistance (@ 20°C)	Ω	40 / 160 / 1.8 (110/220/30 V)		
Racking motor – rated continuous power	W	180		

Parameter	Unit of Measure	Rated value		
Rated voltage (U_r)	**kV**	**12**	**17.5**	**24**
Racking motor – peak power	W	**720**		
Racking motor – racking time	s	**< 30**		
Double-busbar disconnector motor – rated continuous power	W	**360**		**-**
Double-busbar disconnector motor – peak power	W	**594**		**-**
Double-busbar disconnector motor – operating time	s	**3.4**		**-**
Main circuit resistance (excl. busbars) – no CTs (L1/L2/L3)	μΩ	**≤ 95 / 90 / 85**		
Main circuit resistance (excl. busbars) – with CTs (L1/L2/L3)	μΩ	**≤ 115 / 110 / 105**		

NOTE 1: The 650 mm wide panel with shrouded pole VCB is rated 800 A.

NOTE 2: The 650 mm wide panel with embedded pole VCB is rated 1250 A.

3.2 2500 A VACUUM CIRCUIT-BREAKER PANELS

Parameter	Unit of Measure	Rated value		
Rated voltage (U_r)	**kV**	**12**	**17.5**	**24**
Number of phases		**3**		
Rated short-duration power-frequency withstand voltage (U_d)	kV	**28**	**38**	**50**
Rated peak lightning impulse withstand voltage (U_p)	kV	**95**	**95**	**125**
Rated frequency (f_r)	Hz	**50**		
Rated normal current (I_r) – busbars	A	**2500**		
Rated normal current (I_r) – circuit-breaker (single-busbar)	A	**2500 (1000W)**		
Rated normal current (I_r) – circuit-breaker (double-busbar)	A	**2500 (1100W)**		**-**
Rated short-time withstand current (I_k and I_{ke})	kA	**31.5**		
Rated duration of short circuit (t_k) – main circuit and earthing switch	s	**3**		
Rated duration of phase-to-earth short circuit (t_{ke}) – 1-phase earthing circuit	s	**1**		
Rated peak withstand current (I_p and I_{pe}) and short-circuit making current of circuit-breaker and earthing switch	kA	**78.75 (79)**		
Internal arc classification	IAC	**AFLR**		
IAC test current value	kA	**25 / 31.5**		
IAC test current duration	s	**1**		
Loss of service continuity category	LSC	**LSC2B**		
Partition class	PM/PI	**PM**		
Degree of protection	IP	**4X (enclosure)**		
Earthing switch electrical endurance class	E1/E2	**E2 (short-circuit making x 5)**		**E1**
Earthing switch mechanical endurance class	M0/M1/M2	**M0 (1000 operations)**		
Double-busbar disconnector mechanical endurance class	M0/M1/M2	**M0 (1000 operations)**		

Parameter	Unit of Measure	Rated value		
Rated voltage (U_r)	kV	12	17.5	24
Rated supply voltage of closing and opening devices and of auxiliary and control circuits (U_a)	V	110 / 220 / 30 (d.c.) 110 / 220 (a.c.)		
Rated a.c. supply voltage of heaters and other a.c. auxiliary circuits (U_a)	V	230		
Rated supply frequency of closing and opening devices and of auxiliary and control circuits	Hz	d.c. (d.c.) 50 (a.c.)		
Rated supply frequency of heaters and other a.c. auxiliary circuits	Hz	50		
Rated short-circuit breaking current (I_{SC}) of circuit-breaker	kA	31.5		
DC time constant of rated short-circuit current	ms	45		
DC component	%	53		>36
Circuit-breaker class (S2 only applicable from 15 kV to 100 kV)	S1/S2	S1		
Circuit-breaker electrical endurance class	E1/E2	E2		
Rated operating sequence for circuit-breaker		O–0,3s–CO–3min–CO		
First-pole-to-clear factor (k_{pp}) for circuit-breaker		1.5 & 1.3		
Standard values of TRV related to the rated short-circuit breaking current (IEC 62271-100)		IEC 62271-100 Table 1		
System neutral earthing		Effective & non-effective		
Minimum resting time following rated operating sequence	min	3 min		
Classification of circuit-breaker according to its restrike performance (line-charging breaking current)	C1/C2	C2		C2
Rated capacitive switching currents for circuit-breaker – line-charging breaking current	A	10		
Classification of circuit-breaker according to its restrike performance (cable-charging breaking current)	C1/C2	C2		C2
Rated capacitive switching currents for circuit-breaker – cable-charging breaking current	A	25		31.5
Circuit-breaker mechanical endurance class	M1/M2	M2 (10 000 operations)		
Rated opening time for circuit-breaker	ms	< 40	< 50	
Rated break-time for circuit-breaker	ms	< 50	< 60	
Rated closing time for circuit-breaker	ms	< 60		
Vacuum interrupter type		TD14-12/2500-31.5AQ		TD-24/2500-31.5Q
Vacuum interrupter contact stroke	mm	11 ±1		13 ±1
Circuit-breaker mechanism over-travel	mm	4 ±0.5		4 ±0.5
Vacuum interrupter contact erosion limit	mm	3		3
Average opening speed	m/s	1.3 ±0.3		1.6 ±0.3
Average closing speed	m/s	0.8 ±0.3		0.8 ±0.3
Contact bounce duration for closing operation	ms	≤ 3		
Contact re-bound amplitude for opening operation	mm	≤ 2		
Three-phase pole discrepancy	ms	< 1		
Vacuum interrupter contact resistance	μΩ	≤ 12		
Circuit-breaker resistance (excluding cluster contacts)	μΩ	≤ 20		
Spring charging motor – rated continuous power	W	120		

Parameter	Unit of Measure	Rated value		
Rated voltage (U_r)	kV	12	17.5	24
Spring charging motor – peak current	A	2.4 / 1.2 / 8.8 (@ 110 / 220 / 30 V d.c.)		
Spring charging motor – charging time	s	< 10 (@17 r/min)		
Closing and opening coil – power consumption	W	302.5 / 302.5 / 500 (@ 110 / 220 / 30 V d.c.)		
Closing and opening coil – current	A	2.75 / 1.38 / 16.7 (@ 110 / 220 / 30 V d.c.)		
Closing and opening coil – resistance (@ 20°C)	Ω	40 / 160 / 1.8 (110/220/30 V)		
Racking motor – rated continuous power	W	180		
Racking motor – peak power	W	720		
Racking motor – racking time	s	< 30		
Double-busbar disconnector motor – rated continuous power	W	720		-
Double-busbar disconnector motor – peak power	W	1144		-
Double-busbar disconnector motor – operating time	s	3.4		-
Main circuit resistance (excl. busbars) – no CTs (L1/L2/L3)	μΩ	≤ 40 / 37 / 34		
Main circuit resistance (excl. busbars) – with CTs (L1/L2/L3)	μΩ	≤ 50 / 47 / 44		

3.3 VACUUM CONTACTOR-FUSE COMBINATION PANELS

Characteristic		Unit	Value	
Rated voltage (U_r)		kV	7.2	12
Rated current (*contactor*))		A	400 A	
Rated operational current (I_e) (due to fuse)		A	≤315	≤200
Fuse-link type			IEC 60282-1 TYPE 1 (292 mm long)	
Rated frequency (f_r)		Hz	50~60	
Rated making capacity		A	10 x Ie	
Rated breaking capacity		A	8 x Ie	
Rated short time withstand current (I_k)		kA	6.3	
Rated peak withstand current (I_p)		kA	40	
Rated short circuit duration (t_k)		s	4	
Rated prospective short circuit breaking current (due to fuse)		kA	≤ 40	
Rated short circuit making current		kA	100	
Take-over current		A	3150	
Rated short-duration power-frequency withstand voltage (U_d)	Between phases, phase to earth	kV	32	42
	Vacuum interrupter gap	kV	32	42
Rated peak lightning impulse withstand voltage[1] (U_p)		kV	60	75
Control circuit:				
Rated control voltage[2] (U_a)		V	AC or DC 110/220	
Rated power (Ps)	Electrical holding	VA	≤1000/100 (absorbing/holding)	
	Mechanical holding	VA	≤900/350 (closing/opening)	
Auxiliary contacts			6a+6b	
Contact rated values			AC 220V/5A	
Control circuit, auxiliary circuit to earth power frequency withstand voltage		kV	2	
Rated operating cycle duties				
Long-term		cycles/h	300	
Short-term		cycles/h	600	
Mechanical endurance (no-load)		operations	300 000	
Electrical endurance (on-load)		operations	100 000 (AC-3)	
Mechanical characteristics				
Closing time		ms	≤150	
*O*pening time		ms	≤150 (electrical holding) ≤60 (electrical holding)	
3-phase synchronism		ms	≤3	
Closing tripping		ms	≤6	

NOTE 1: 12kV panels rated 95 kV are supplied with surge arresters.
NOTE 2: Rated control voltage can be customised.