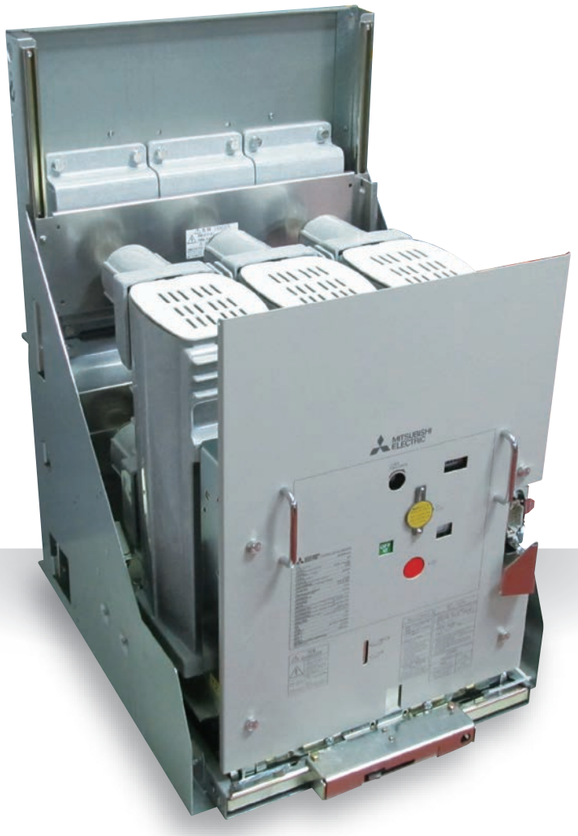
for a greener tomorrow

MITSUBISHI ELECTRIC
Changes for the Better

FACTORY AUTOMATION

VPR Series
Vacuum Circuit Breakers



Safety & Quality

⚠ Safety Warning

To ensure proper use of the products listed in this catalog,
please be sure to read the instruction manual prior to use.

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GLOBAL IMPACT OF MITSUBISHI ELECTRIC

Through Mitsubishi Electric's vision, "Changes for the Better" are possible for a brighter future.

Changes for the Better

We bring together the best minds to create the best technologies. At Mitsubishi Electric, we understand that technology is the driving force of change in our lives. By bringing greater comfort to daily life, maximizing the efficiency of businesses and keeping things running across society, we integrate technology and innovation to bring changes for the better.

Mitsubishi Electric is involved in many areas including the following

Energy and Electric Systems
A wide range of power and electrical products from generators to large-scale displays.

Electronic Devices
A wide portfolio of cutting-edge semiconductor devices for systems and products.

Home Appliance
Dependable consumer products like air conditioners and home entertainment systems.

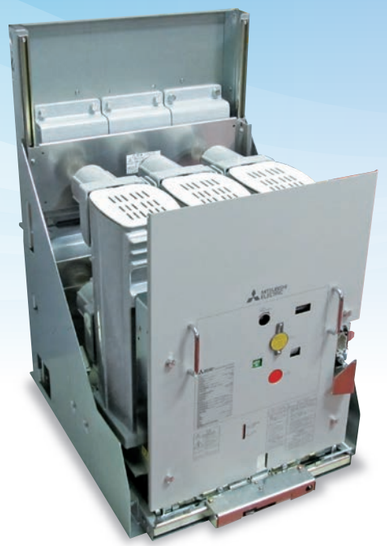
Information and Communication Systems
Commercial and consumer-centric equipment, products and systems.

Industrial Automation Systems
Maximizing productivity and efficiency with cutting-edge automation technology.

OVERVIEW

VPR series

High Levels of Reliability and Safety Achieved Through Use of the Latest Technologies Vacuum Circuit Breakers Designed for the Future with Enhanced Environmental Measures and Maintenance Features.



10-VPR-D Series

Outstanding Reliability

- Incorporates Mitsubishi Electric vacuum interrupter technology, realizing a more compact vacuum interrupter (VI) 16% smaller than in the previous type* and high reliability (class E2).
- Self-cooling vacuum circuit breakers (VCBs) that do not require a fan to be mounted on the panel. Available in a wide range, from rated current of 600 to 3,150A.
- Compliant with IEC 62271-100-2012 and has passed type tests for classes M2, E2 and C2, which represent the highest levels of quality.

*The VI in 10-VPR-32D (1,250A)

High-level Safety

- Exposure of live parts in the main circuit has been minimized even in VCBs with a 3,150A rating. This enhances safety through prevention of potential hazards such as short circuits caused by intrusion of small animals.

Simple Maintenance

- The mechanical parts are coated with a long-life grease that contributes to the prevention of oxidation degradation and oilless bearings has been adopted for the bearing section of latch, thus extending the lubrication cycle to mechanical parts from three to six years and reducing the time required for maintenance.
- Includes a new withdrawable with door closed* (in addition to the conventional lever-based insert/draw-out mechanism) with cam-slide mechanism that reduces operating effort, saves time and enhances VCB safety.

*Mechanism used to insert/draw-out the circuit breaker from the external panel based on IEC 62271-200 switchgear standards.

- Enhanced options including additional auxiliary switch and earthing switch.
- VCB with the rated normal current up to 3,150A is transported together with a panel by shipping clamps.
- Compatibility with mounting frame of previous 10-VPR-C Series (positions of mounting holes, terminals and partitions are the same).

Pursuit of Environmental Design

- No use of the six hazardous substances (mercury, cadmium, lead, hexavalent chromium, PBB and PBDE), a measure that exceeds the requirements of RoHS standards. One example is use of a rust-proofing treatment for small parts such as pins and screws that is free of hexavalent chromium, a substance known to contaminate soil.
- Marking of main resin materials to facilitate recycling.

3/6-VPR-D Series

Simple Maintenance

- The mechanical parts are coated with a long-life grease that contributes to the prevention of oxidation degradation and oilless bearings has been adopted for the bearing section of latch, thus extending the lubrication cycle to mechanical parts from three to six years and reducing the time required for maintenance.

Pursuit of Environmental Design

- No use of the six hazardous substances (mercury, cadmium, lead, hexavalent chromium, PBB and PBDE), a measure that exceeds the requirements of RoHS standards. One example is use of a rust-proofing treatment for small parts such as pins and screws that is free of hexavalent chromium, a substance known to contaminate soil.
- Marking of main resin materials to facilitate recycling.

10-VPR-50C(D) 4000A

Outstanding Reliability

- Enabling a self-cooling mechanism with 4000A rated normal current without cooling fans.

20-VPR-D Series

Pursuit of Quality to the Limit

- Vacuum Interrupter
  - Pursuit of high breaking performance and high electric strength performance by applying efficient contact material.
  - Pursuit of the optimum structural design by application of the most advanced arc control technology and insulation design technology.
  - Pursuit of improvement in magnetic drive efficiency by spiral contact.
- Operation mechanism
  - The conventional BH-1H type operation mechanism is further advanced, and operation stability is pursued by simple operation principle confirmed by motion analysis technology and stress analysis technology, etc.
  - Pursuit of maintenance cost reduction by extending the operation mechanism inspection interval from 3 years of the type VPR-C to 6 years by adopting long life grease.
  - Pursuit of convenience by attempting to use the same motor for charging the closing spring for both AC and DC power sources.
- Main circuit
  - Pursuit of heat generation reduction of the main circuit by application of electric resistance welding on the shunt part and reducing the contact resistance.
  - Pursuit of contact stability by adopting 2-point contact structure by forging the primary junction.

Pursuit of Safety and Reliability

- Pursuit of safety by applying withdrawable with door closed operation mechanism, metal shutter and earthing switch.
- Pursuit of safety and environment by adopting excellent molding material in tracking.
- Pursuit of minimization of live outcrop which makes good use of bulk mold compound molding technique, and was proven by heat analysis technology.

Pursuit of Environmental Design

- No use of the six hazardous substances (mercury, cadmium, lead, hexavalent chromium, PBB and PBDE), a measure that exceeds the requirements of RoHS standards.※ One example is use of a rust-proofing treatment for small parts such as pins and screws that is free of hexavalent chromium, a substance known to contaminate soil.

※Except 2500A and fixed (type L)

- Marking of main resin materials to facilitate recycling.

Cutting-edge Technologies Using 3D CAD and CAE to Ensure the Utmost Levels of Reliability and Safety

1. VCB Structure (10-VPR-D)

- Through use of thermal fluid analysis, we have realized efficient release of heat to the cylinder-shaped insulation frame covering the VCB main circuit part, enabling a self-cooling mechanism up to a rated current of 3150A.
- Compound insulation of insulated parts and air has been optimized through analysis and testing, resulting in a basic impulse level (BIL) up to 95kV, yet at a size equivalent to the previous 10-VPR-C Series.
- Materials with superior tracking resistance have been adopted and a cylindrical shape realized through stress analysis of the insulation frame and cutting-edge molding technology.
- Improved safety through insulation of live parts to prevent short circuits caused by intrusion of small animals.

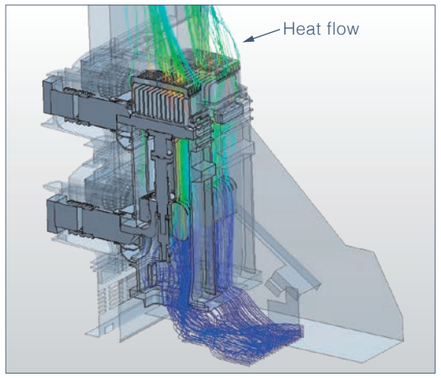


Fig.1 Example of thermal fluid analysis.

2. Vacuum Interrupter (VI)

- VIs with even higher reliability through utilization of computer-aided engineering (CAE) technology and backed by record of manufacturing 4.6 million※1 VIs in over 50 years of manufacturing experience that has seen us capture the top share of the market in Japan.
- In addition to adopting spiral contacts, improvements in contact materials, and tests utilizing electromagnetic analysis and arc behavior observations have realized a 16% size reduction compared to the VI in the previous 10-VPR-32D type.

※1 As of 2018

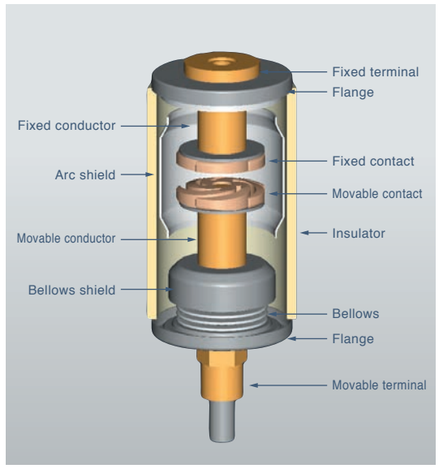


Fig. 2 Three-dimensional model of a VI.

Optical Observation for Arc Behavior

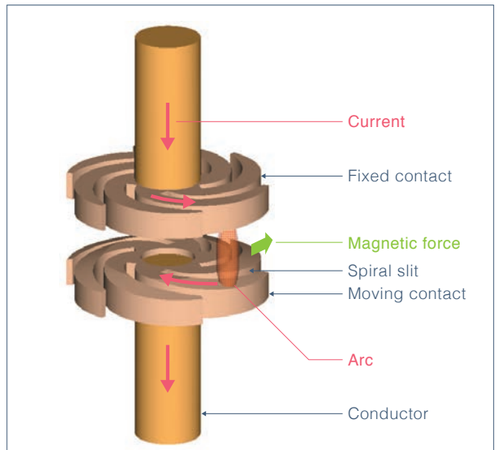


Fig. 3 Current flow at the time of breaking.

Arc behavior was observed via a high-speed camera at the time of interruption between the fixed and moving contacts (see Fig. 4).

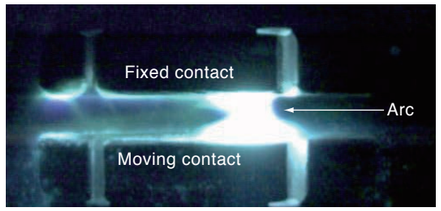
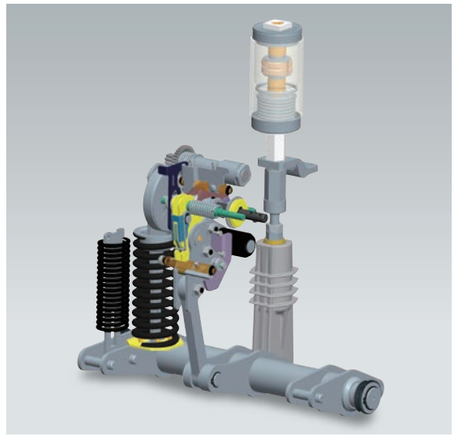


Fig. 4 Observation of arc behavior in an internal VI.

Current flows along the spiral electrode causing a radial magnetic field which generates an electromagnetic force circumferentially towards the contacts. This results in arcs that rotate circumferentially on the contact surface.

3. Operating Mechanism (10-VPR-D)

- Greater performance reliability and extension of the lubrication cycle from three to six years through measures for the operating mechanism such as minimizing the number of parts, reducing the number of moving parts, adopting oilless bearings and use of a long-life grease.
- More reliable distribution of operating friction (which, due to the addition of a spring load, is difficult to verify/evaluate) has been achieved thanks to utilization of a three-dimensional mechanical simulation used to switch operation from the operating mechanism to a VI contact.



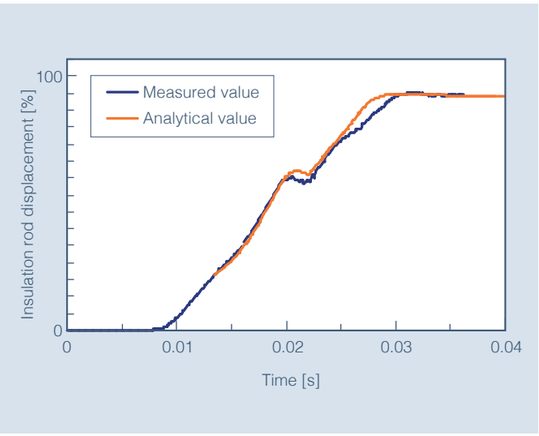


Fig. 5 Example of the three-dimensional mechanism simulation.

3 Type Selection

3/6-VPR-D

Rated voltage	Type	Rated short-circuit breaking current	Series name	Classification (Class E1)	Standards	Mounting configuration
3	VPR	20	D	–	I	C

3	3.6kV	20	20kA	–	Standard
6	7.2kV	25	25kA	G	Low surge ※4

I	IEC62271-100

Type	Description		High-voltage switchgear standards (IEC62271-200)
C	Withdrawable type	Withdrawable with door open and mounting frame (class CW)	LSC1
D		Withdrawable with door open and mounting frame (class PW)	LSC2B-PI
L	Fixed type	Fixed (with wheels)	LSC1

10-VPR-D

Rated voltage	Type	Rated short-circuit breaking current	Series name	Classification※1	Standards※2	Mounting configuration※3
10	VPR	25	D	1	J	M

10	12kV	25	25kA	1	Class E1
15	15kV	32	31.5kA	2	Class E2
		40	40kA	3	Class E1, BIL95 k V (12 k V)
				4	Class E2, BIL95 k V (12 k V)

J	JEC2300
I	IEC62271-100

Type	Description		High-voltage switchgear standards (IEC62271-200)
M	Withdrawable type	Withdrawable with door closed and mounting frame (class MW)	LSC2B-PM
C		Withdrawable with door open and mounting frame (class CW)	LSC1
D		Withdrawable with door open and mounting frame (class PW)	LSC2B-PI
G		Withdrawable with door open and mounting frame (class MW)	LSC2B-PM
L	Fixed type	Fixed (with wheels)	LSC1

10-VPR-25D (M)

Rated voltage	Type	Rated short-circuit breaking current	Series name	Classification (Class E1)	Standards	Mounting configuration
10	VPR	25	D	M	I	C

10	12kV	25	25kA	M	Class E1

I	IEC62271-100
J	JEC2300

Type	Description		High-voltage switchgear standards (IEC62271-200)
C	Withdrawable type	Withdrawable with door open and mounting frame (class CW)	LSC1
D		Withdrawable with door open and mounting frame (class PW)	LSC2B-PI
G		Withdrawable with door open and mounting frame (class MW)	LSC2B-PM

10-VPR-50C (D)

Rated voltage	Type	Rated short-circuit breaking current	Series name	Classification (Class E1)	Standards	Mounting configuration
10	VPR	50	C(D)	–	J	C

10	12kV	50	50kA	–	Standard

J	JEC2300
I	IEC62271-100

Type	Description		High-voltage switchgear standards (IEC62271-200)
C	Withdrawable type	Withdrawable with door open and mounting frame (class CW)	LSC1
D		Withdrawable with door open and mounting frame (class PW)	LSC2B-PI
G		Withdrawable with door open and mounting frame (class MW)	LSC2B-PM

20-VPR-D

Rated voltage	Type	Rated short-circuit breaking current	Series name	Classification	Standards	Mounting configuration
20	VPR	16	D	1	I	M

20	24kV	16	16kA	1	Class E1
		25	25kA		

I	IEC62271-100

Type	Description		High-voltage switchgear standards (IEC62271-200)
M	Withdrawable type	Withdrawable with door closed and mounting frame (class MW)	LSC2B-PM
C		Withdrawable with door open and mounting frame (class CW)	LSC1
D		Withdrawable with door open and mounting frame (class PW)	LSC2B-PI
G		Withdrawable with door open and mounting frame (class MW)	LSC2B-PM

20-VPR-D (Fixed type L)

Rated voltage	Type	Rated short-circuit breaking current	Series name	Classification (Class E1)	Standards	Mounting configuration※3
20	VPR	16	D	–	J	L

20	24kV	16	16kA	J	JEC2300
		25	25kA	I	IEC62271-100

Type	Description		High-voltage switchgear standards (IEC62271-200)
L	Fixed type	Fixed (with wheels)	LSC1

20-VPR-D 2500A

Rated voltage	Type	Rated short-circuit breaking current	Series name	Classification (Class E1)	Standards	Mounting configuration
20	VPR	25	D	–	J	C

20	24kV	25	25kA	J	JEC2300
				I	IEC62271-100

Type	Description		High-voltage switchgear standards (IEC62271-200)
C	Withdrawable type	Withdrawable with door open and mounting frame (class CW)	LSC1
D		Withdrawable with door open and mounting frame (class PW)	LSC2B-PI

※1 Rated short-circuit breaking current of 40kA with E2 class cannot be manufactured.
And basic impulse level (BIL) with rated voltage 12kV has BIL 75kV (classification 1 or 2) and BIL 95kV (classification 3 or 4).
※2 When selecting JEC 2300-2010 for standard, select class E1 for classification.
※3 Fixed (type-L) with rated current of 2500A and 3000/3150A cannot be manufactured.
In additon, fixed (type-L) with the rated voltage 15kV BIL 95kV cannot be manufactured.
※4 Low surge types are only available for 630/1250A of 3/6-VPR VCBs.
※5 Fixed (type-L) with rated current of 2000A cannot be manufactured.

LSC1 : No partition
LSC2B-PI : Partitions in all compartments
LSC2B-PM : Partitions in all compartments

3 TYPE SELECTION

■ List of Ratings (JEC/IEC Standards)

Table 1 List of Ratings

Type		3-VPR-20D	3-VPR-25D	6-VPR-20D	6-VPR-25D	10-VPR-25D (M) ※4	10-VPR-25D	10-VPR-32D	10-VPR-40D	10-VPR-50C(D)	15-VPR-25D	15-VPR-32D	15-VPR-40D	20-VPR-16D	20-VPR-25D	
		3-VPR-D				10-VPR-25D(M)	10-VPRD			10-VPR-50C(D)	15-VPR-D			20-VPR-D	20-VPR-D	
Low surge		○	○	○	○	–	–	–	–	–	–	–	–	–	–	–
Closing operating mechanism		Motorspring charged mechanism		Motorspring charged mechanism		Motorspring charged mechanism	Motorspring charged mechanism				Motorspring charged mechanism			Motorspring charged mechanism		
Standards ※1		– IEC 62271-100 (2008)		– IEC 62271-100 (2008)		JEC 2300 IEC 62271-100 (2012)	JEC 2300 IEC 62271-100 (2012)			JEC 2300 IEC 62271-100 (2003)	– IEC 62271-100 (2012)			– IEC 62271-100※6	JEC 2300 IEC 62271-100 (2003)	
Rated voltage (kV)		3.6		7.2		12	12				15			24		
Rated normal current (A)		630 1250		630 1250		600/630 1200/1250	1600 2000 2500 3000/3150	600/630 1200/1250 1600 2000 2500 3000/3150		4000	630 1250 1600 2000			630 1250 2000※7	2500	
Rated frequency (Hz)		50/60		50/60		50/60	50/60				50/60			50/60		
Rated short-circuit breaking current (kA)		20	25	20	25	25	25	31.5	40	50	25	31.5	40	16	25	
Rated making current (kA)	JEC	–	–	–	–	63	63	80	100	125	–	–	–	–	–	65
	IEC	52	65	52	65	65	65	81.9	104	130	65	81.9	104	41.6	65	
Rated short-time withstand current (kA-s)	JEC	–	–	–	–	25-2	25-2	31.5-2	40-2	50-2	–	–	–	–	–	25-2
	IEC	20-3	25-3	20-3	25-3	25-3	25-3	31.5-3	40-3	50-3	25-3	31.5-3	40-3	16-3	25-3	
Rated opening time (s)		0.03		0.03		0.03	0.03				0.03			0.03		
Rated breaking time (cycles)		3		3		3	3				3			3		
Rated withstand voltage (kV) (JEC/IEC)	Power frequency	-/10		-/20		28/28	28/28			28/28	-/36			50	50/50	
	Lighting impuse	-/40		-/60		75/75	75/75, 95			75/75	-/95			-/125	125/125	
Type test class※2	Mechanical	M1		M1		M2	M2				M2			M2		
	Electrical	E1		E1		E1	E1, E2		E1	E1	E1, E2		E1	E1		
	Small capacitive current switching	C2		C2		C2	C2			C1	C2			C2		
Rated operating sequence	JEC	–		–		O-1min-CO-3min-CO (A) CO-15s-CO (B) O-0.3s-CO-1min-CO (R)	O-1min-CO-3min-CO (A) CO-15s-CO (B) O-0.3s-CO-1min-CO (R)				–			–	O-1min-CO-3min-CO(A) CO-15s-CO(B) O-0.3s-CO-1min-CO(R)	
	IEC	O-1min-CO-3min-CO CO-15s-CO O-0.3s-CO-1min-CO		O-1min-CO-3min-CO CO-15s-CO O-0.3s-CO-1min-CO		O-3min-CO-3min-CO CO-15s-CO O-0.3s-CO-1min-CO	O-3min-CO-3min-CO CO-15s-CO O-0.3s-CO-1min-CO			O-1min-CO-3min-CO CO-15s-CO O-0.3s-CO-1min-CO	O-3min-CO-3min-CO CO-15s-CO O-0.3s-CO-1min-CO			O-3min-CO-3min-CO CO-15s-CO O-0.3s-CO-1min-CO	O-1min-CO-3min-CO O-0.3s-CO-3min-CO	
No-load closing time (s)		0.1		0.1		0.1	0.1				0.1			0.1		
Closeing operating/ control current (A)	Motor	0.8 (motor charging time 8s) (DC100V)		0.8 (motor charging time 8s) (DC100V)		1 (motor charging time 8s) (DC110V)	1.2 (motor charging time 6s) (DC110V)			1.5 (motor charging time 10s) (DC100V)	1.2 (motor charging time 6s) (DC110V)			1 (motor charging time 8s) (DC100V)	1.2 (motor charging time 6s) (DC100V)	
	Control current (Closing coil)	3.5 (DC100V)		3.5 (DC110V)		4 (DC110V)	3.5 (DC110V)			3.2 (DC100V)	3.5 (DC110V)			4(DC100V)	4.5 (DC100V)	
Tripping device		Shunt tripping coil (STC)		Shunt tripping coil (STC)		Shunt tripping coil (STC)	Shunt tripping coil (STC)				Shunt tripping coil (STC)			Shunt tripping coil (STC)		
Operating control current (A) (STC)		3.5		3.5		3.4	4			3.2	4			3.4	4	
Auxiliary switch※3		5a5b		5a5b		5a5b	5a5b (can be add)			10a10b	5a5b (can be add)			5a5b		
Opening conter (mechanical)		Standard equipment		Standard equipment		Standard equipment	Standard equipment				Standard equipment			Standard equipment		
Mounting configuration		Fixed (type L) Withdrawable (types C, D)		Fixed (type L) Withdrawable (types C, D)		Withdrawable (types C, D, G)	Fixed (type L) ※4,5 Withdrawable (types M, C, D, G)			Withdrawable (types C, D, G)	Withdrawable (types M, C, D, G)			Fixed(type L) ※8,9 Withdrawable (types M, C, D, G)	Withdrawable (types C, D)	
Mass of VCB (kg)	600A/630A	51(Low surge : 55)		51(Low surge : 55)		100	M：124 C, D, G, L：112			–	M：124 C, D, G：112			C, D, G：102 M：110 L：90	C, D, G：103 M：111 L：91	–
	1200A/1250A	55(Low surge : 59)		55(Low surge : 59)		105	M：124 C, D, G, L：112			–	M：124 C, D, G：112			C, D, G：115 M：123 L：91	C, D, G：118 M：126 L：94	–
	1600A/2000A	–		–		–	M：152 C, D, G, L：140			–	M：152 C, D, G：140			C, D, G：126 M：134		–
	2500A ～ 3150A	–		–		–	M：200 C, D, G：188			–	–			–		330
	4000A	–		–		–	–			440	–			–		–
Mass of mounting frame (kg)	600A/630A	C, D：34		C, D：34		C：59 D, G：65	C：59 D, G：64			–	C：59 D, G：64			60		–
	1200A/1250A	C, D：42		C, D：42		C：59 D, G：65	C：59 D, G：64			–	C：59 D, G：64			60		–
	1600A/2000A	–		–		–	C：65 D, G：70			–	C：65 D, G：70			70		–
	2500A ～ 3150A	–		–		–	C：87 D, G：92			–	C：87 D, G：92			–		C：156 D：160
	4000A	–		–		–	–			C：235 D, G：240	–			–		–
External dimensions reference page		P11～P14		P11～P14		P15～P16	P17～P24				P17～P20			P25～P30	P31～P32	

※1 JEC:Japanese standard, JEC 2300, IEC:International standards, IEC62271-100
※2 Type test class described in IEC62271-100
※3 Auxiliary switches are available up to 10a10b by adding 5a5b.
In additon, when selecting additional shunt tripping coil from optional accessories, the switches are 3a3b and will be 8a8b by adding 5a5b.
※4 Fixed (type L) with the rated voltage 15kV BIL95kV cannot be manufactured.
※5 Fixed (type L) for the rated current of 2500A and 3000/3150A cannot be manufactured.
※6 Rated currents of 630A and 1250A are IEC62271-100 (2012). Rated current of 2000A is IEC62271-100 (2017).
※7 Rated short-circuit breaking current of 16kA cannot be manufactured.
※8 Fixed (type L) is IEC62271-100 (2006)
※9 Fixed (type L) for the rated current of 2000A cannot be manufactured.

5 External Dimensions (1)

■ 3/6-VPR-20D, 3/6-VPR-25D 630A Rating External Dimensions (Circuit Breaker)

Fixed (type-L)

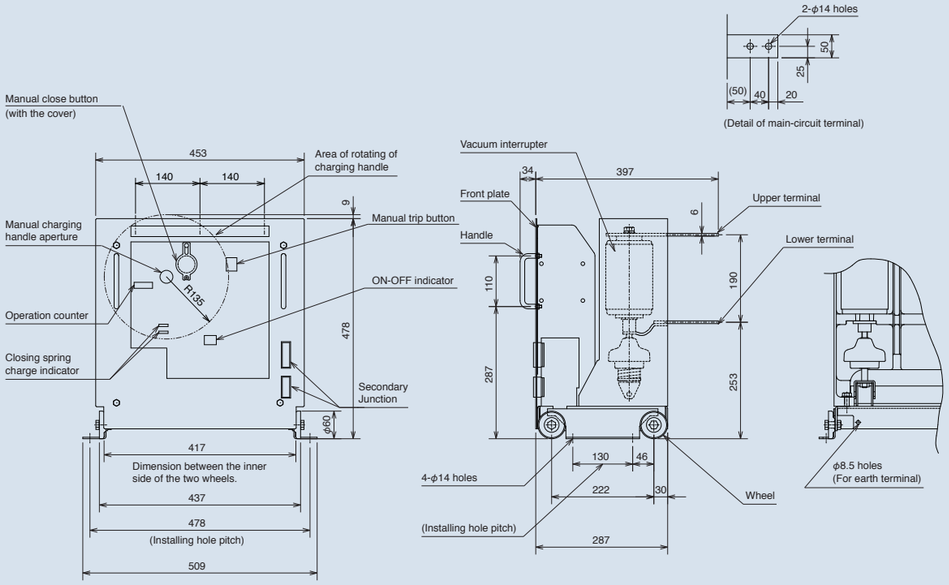


Fig.6

Withdrawable with door open (types-C and D)

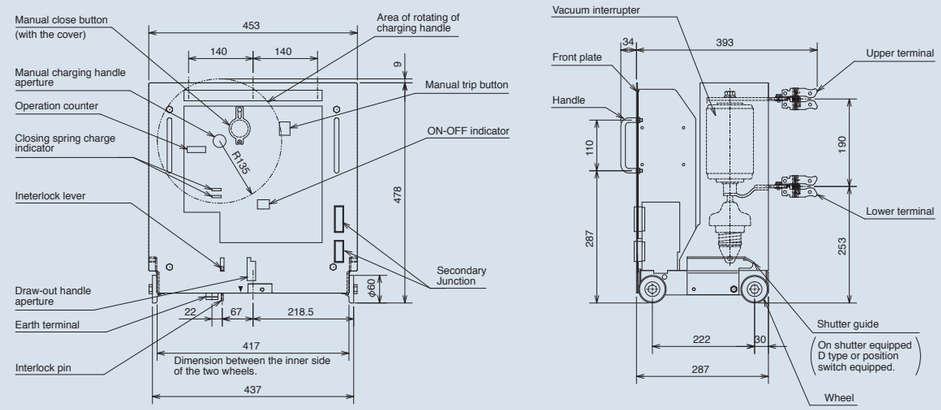


Fig.7

■ 3/6-VPR-20D, 3/6-VPR-25D 630A Rating External Dimensions (Mounting Frame)

Class CW (type-C)

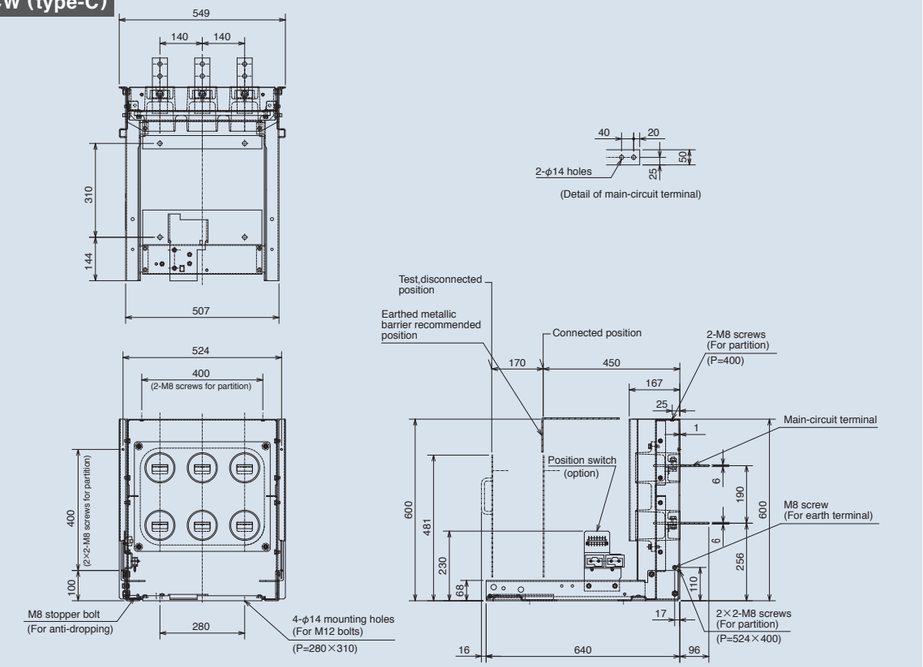


Fig.8

Class PW (type-D)

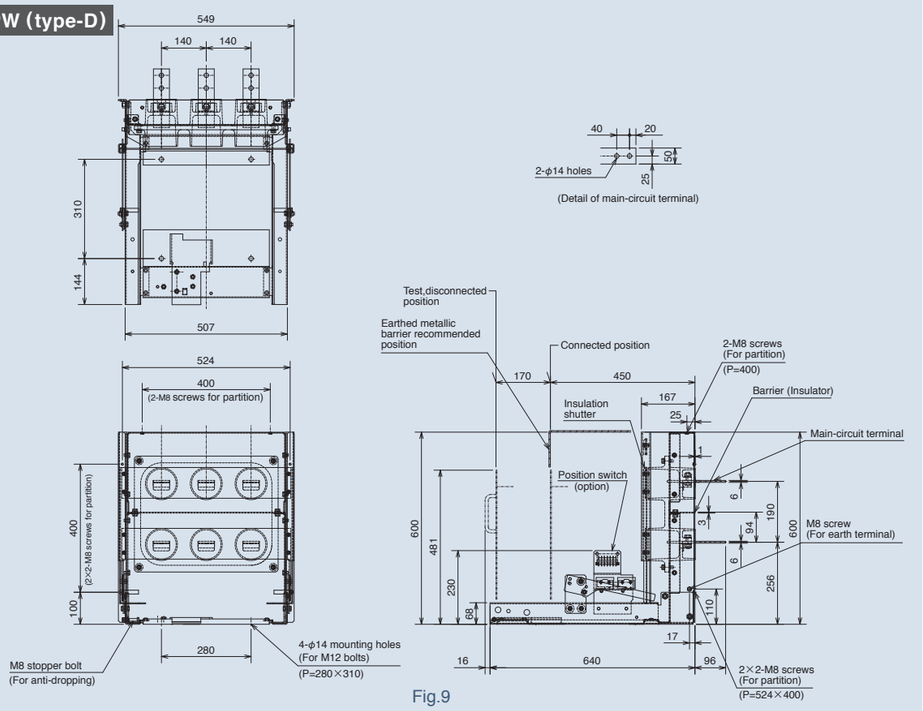


Fig.9

■ 3/6-VPR-20D, 3/6-VPR-25D 1250A Rating External Dimensions (Circuit Breaker)

Fixed (type-L)

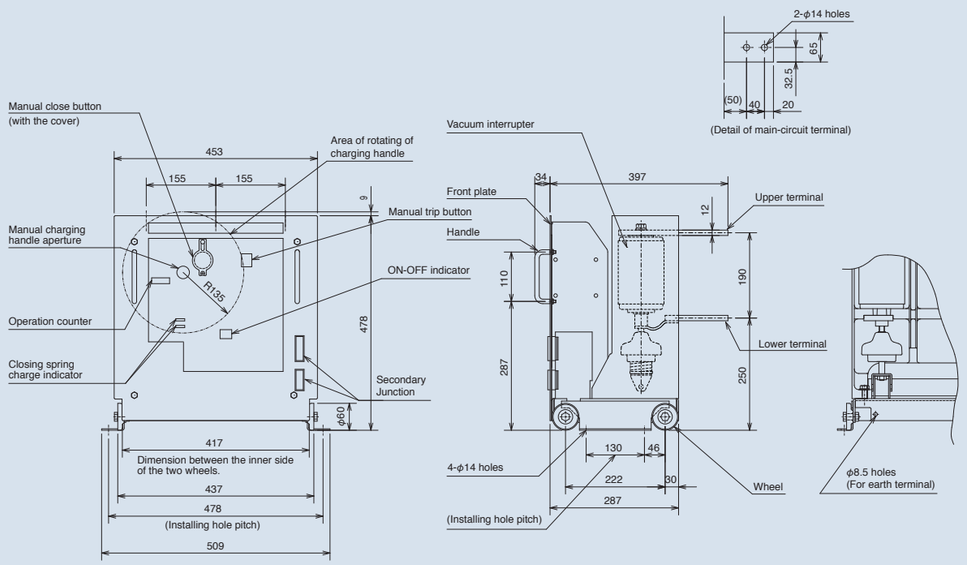


Fig.10

Withdrawable with door open (types-C and D)

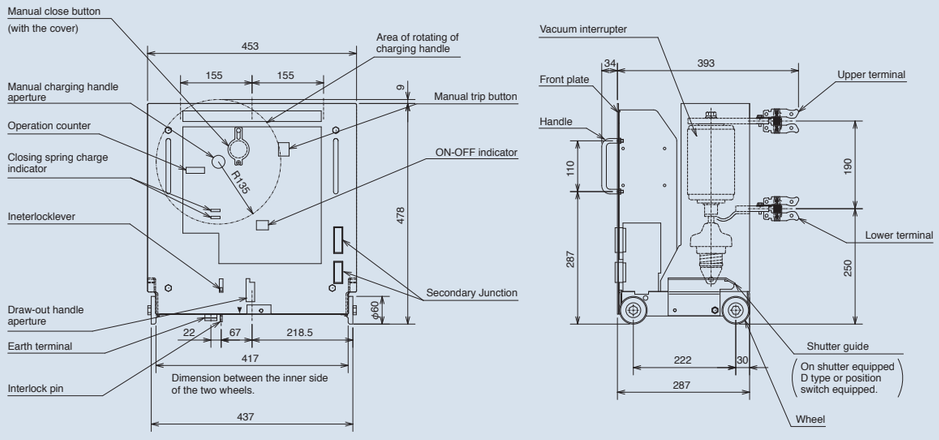


Fig.11

■ 3/6-VPR-20D, 3/6-VPR-25D 630A Rating External Dimensions (Mounting Frame)

Class CW (type-C)

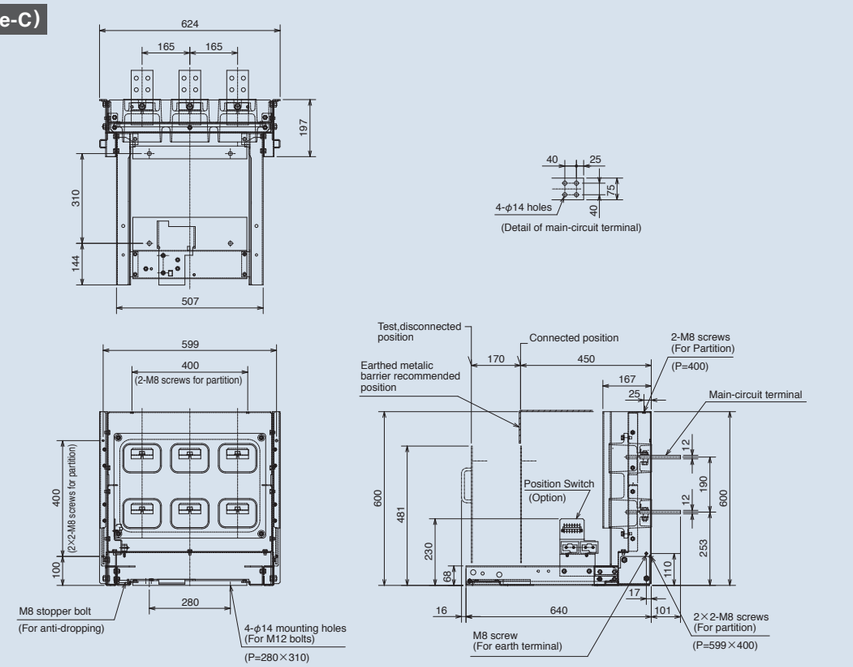


Fig.12

Class PW (type-D)

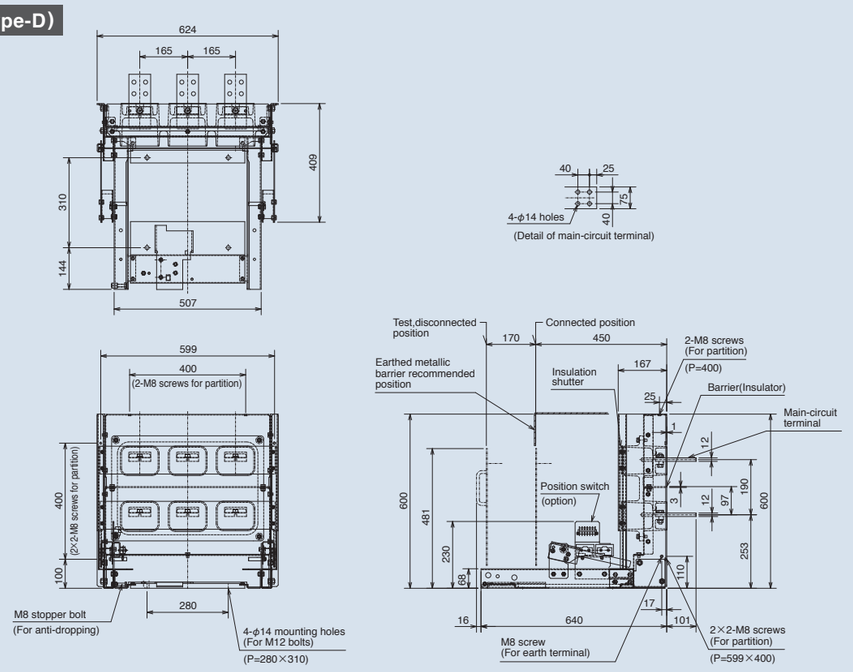


Fig.13

■ 10-VPR-25D (M) 600A/630A, 1200A/1250A Rating External Dimensions (Circuit Breaker)

Withdrawable with door open (types-C,D and G)

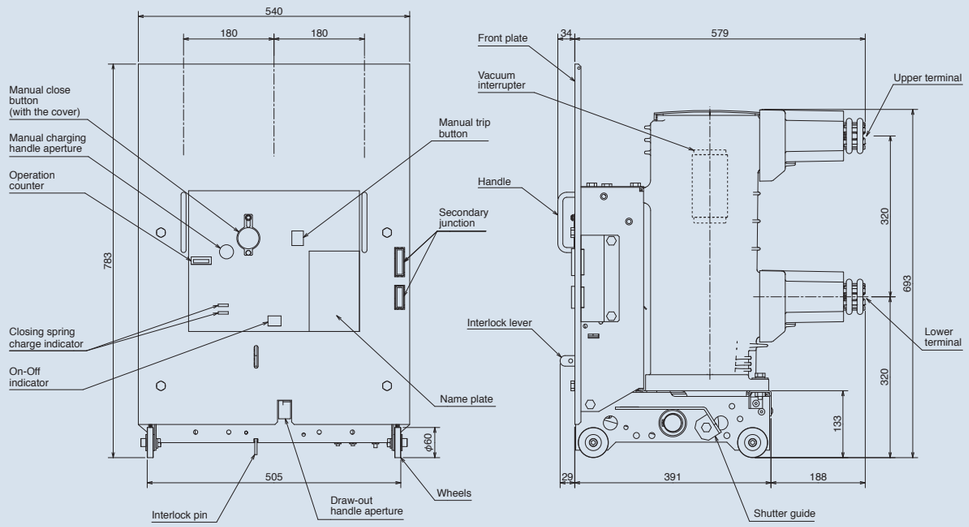
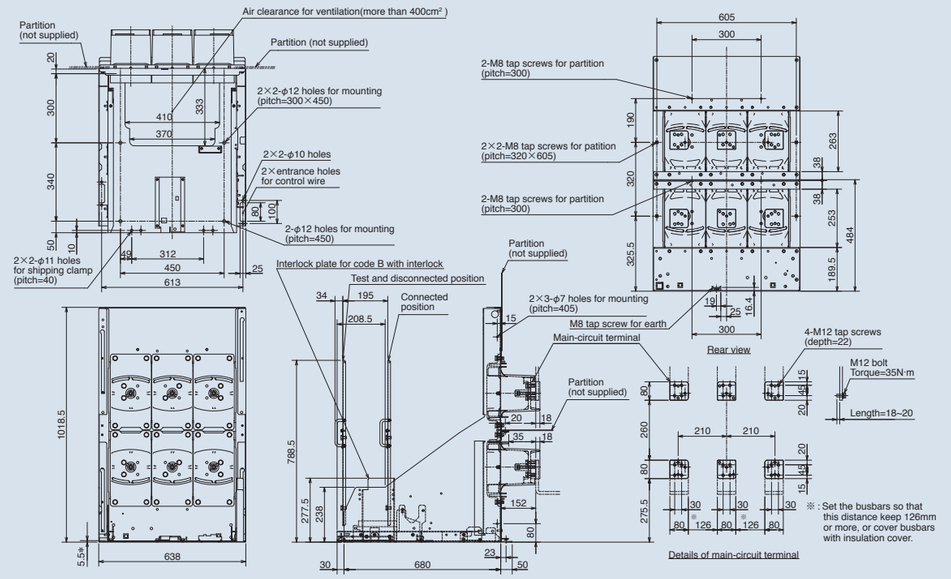


Fig.14

■ 10-VPR-25D (M) 600A/630A, 1200A/1250A Rating External Dimensions (Mounting Frame)

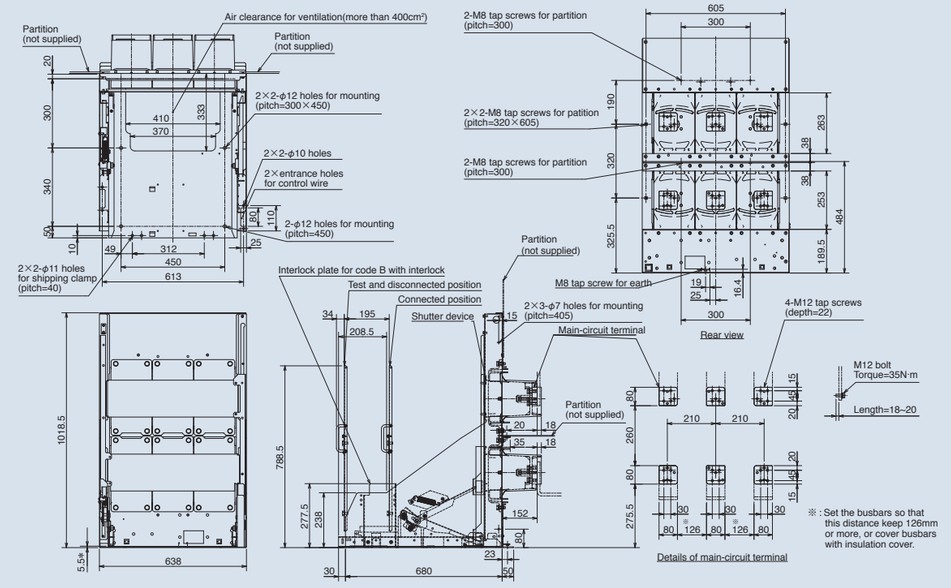
Class CW (type-C)



*Step between the botton of the fixed frame and the VCB insertion surface.

Fig.15

Classes PW and MW (types-D and G)



*Step between the botton of the fixed frame and the VCB insertion surface.

Fig.16

■ 10-VPR-D 600A/630A, 1200A/1250A Rating : External Dimensions (Circuit Breaker)

Fixed (type-L)

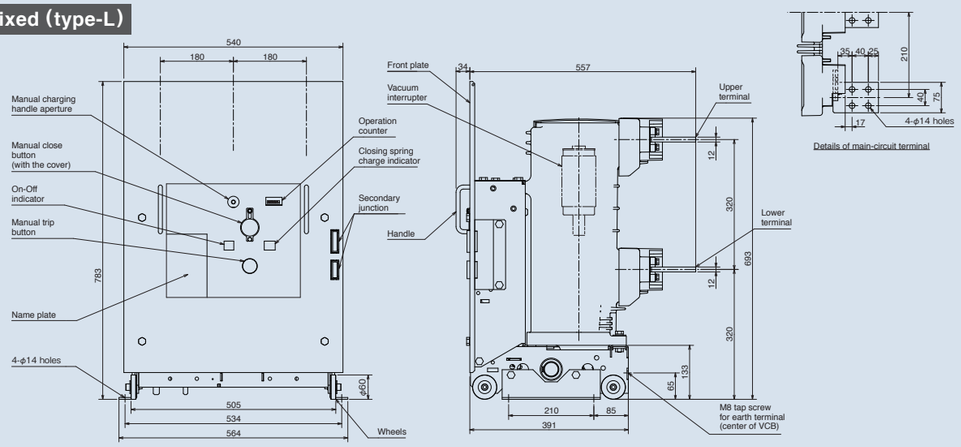
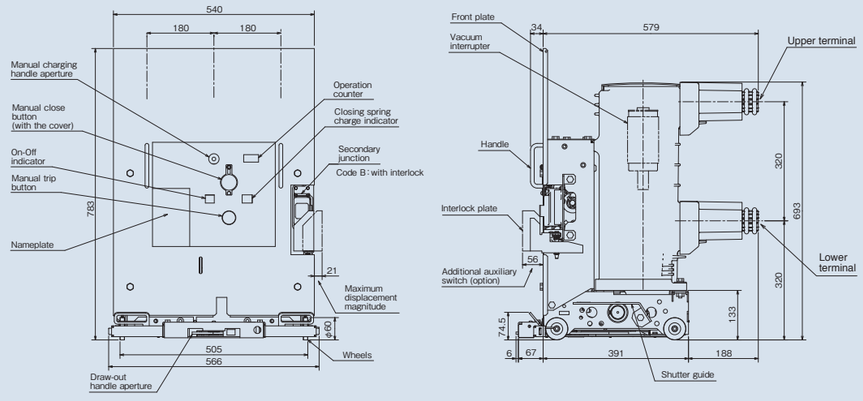


Fig. 17

■ 10/15-VPR-D 600A/630A, 1200A/1250A Rating : External Dimensions (Circuit Breaker)

Withdrawable with door closed (type-M)



Withdrawable with door open (types C, D and G)

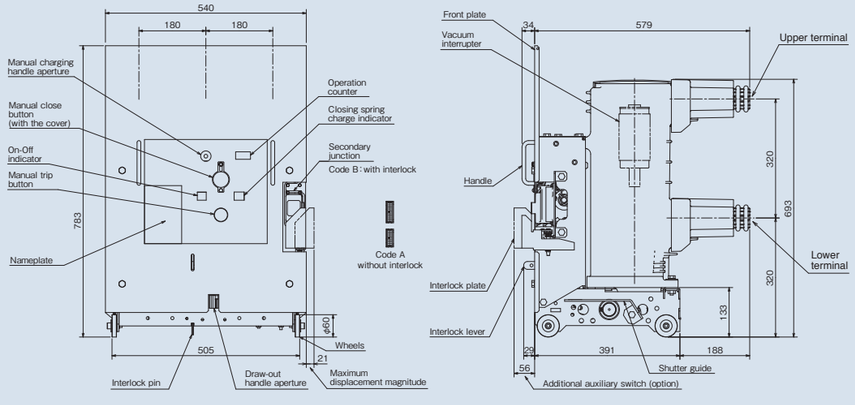


Fig. 18

■ 10/15-VPR-D 600A/630A, 1200A/1250A Rating : External Dimensions (Mounting Frame)

Class CW (type-C)

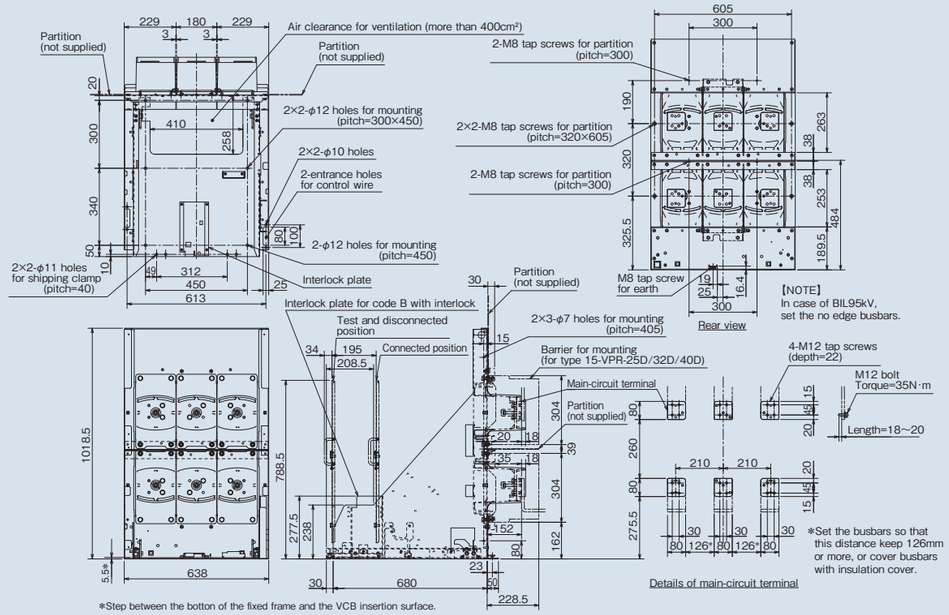


Fig. 19

Classes PW and MW (types M, D and G)

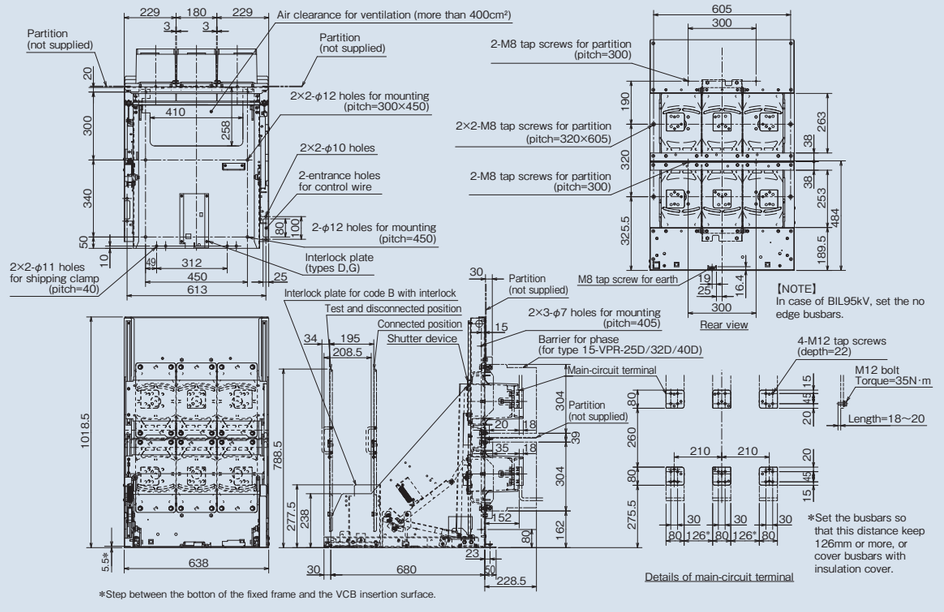


Fig. 20

■ 10-VPR-D 1600A, 2000A Rating : External Dimensions (Circuit Breaker)

Fixed (type-L)

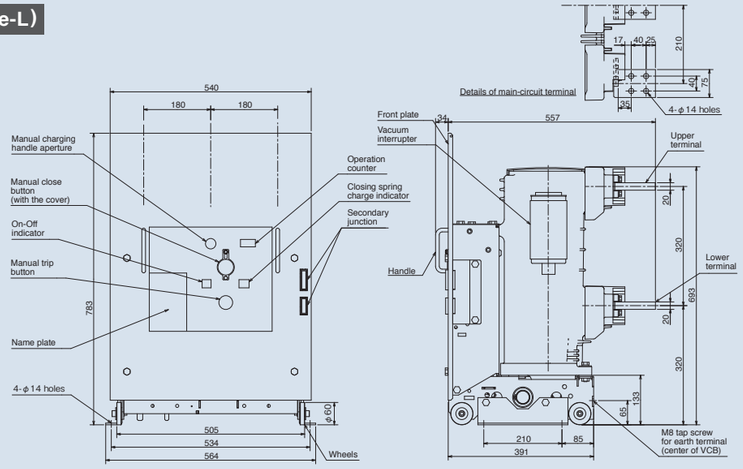
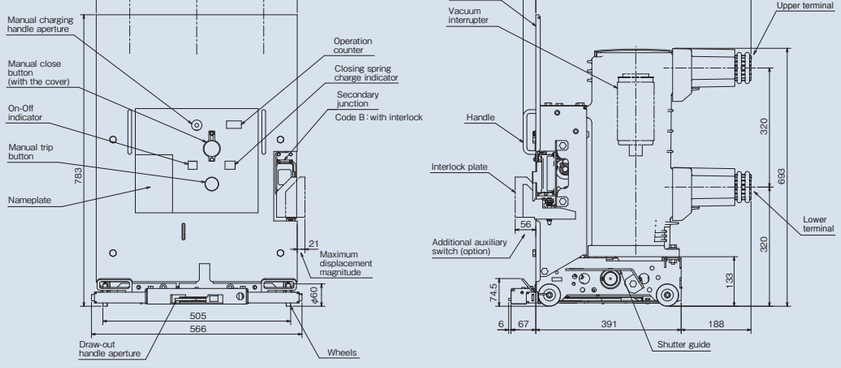


Fig. 21

■ 10/15-VPR-D 1600A, 2000A Rating : External Dimensions (Circuit Breaker)

Withdrawable with door closed (type-M)



Withdrawable with door open (types C, D and G)

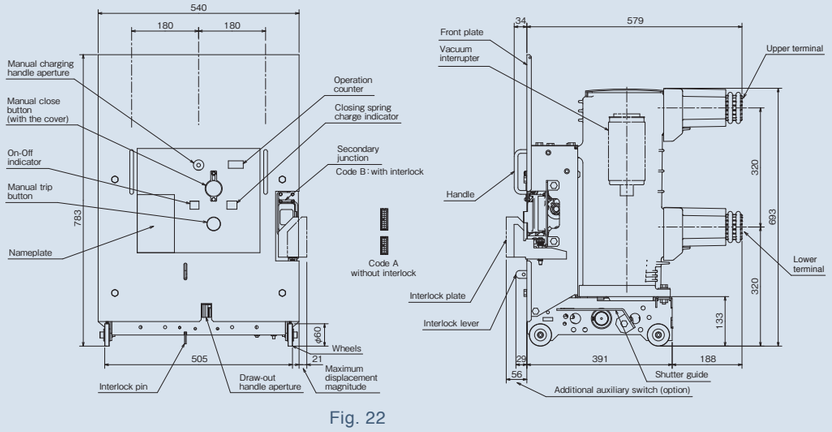


Fig. 22

■ 10/15-VPR-D 1600A, 2000A Rating : External Dimensions (Mounting Frame)

Class CW (type-C)

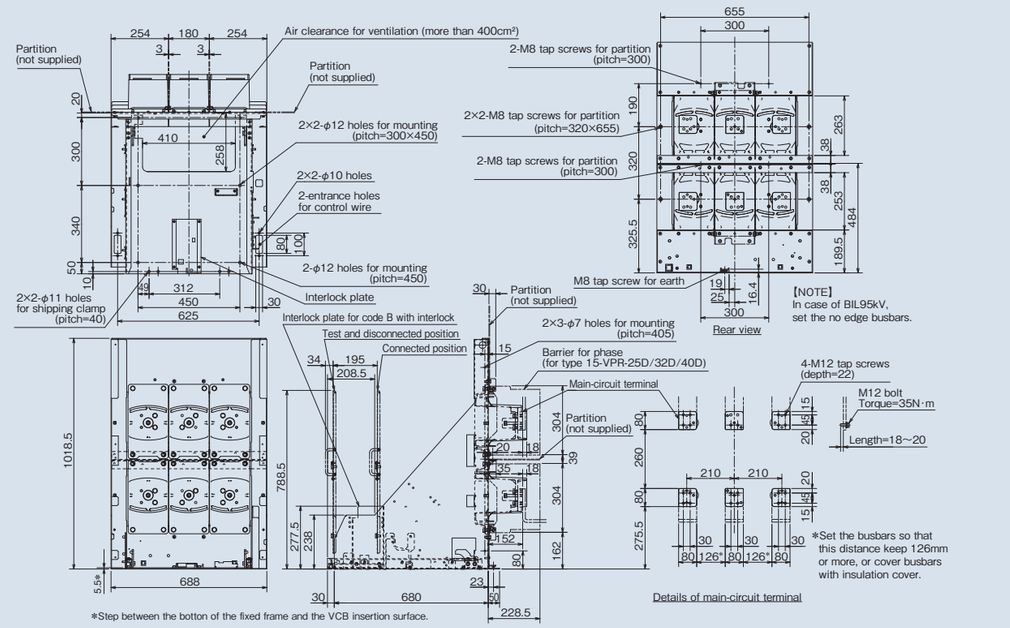


Fig. 23

Classes PW and MW (types M, D and G)

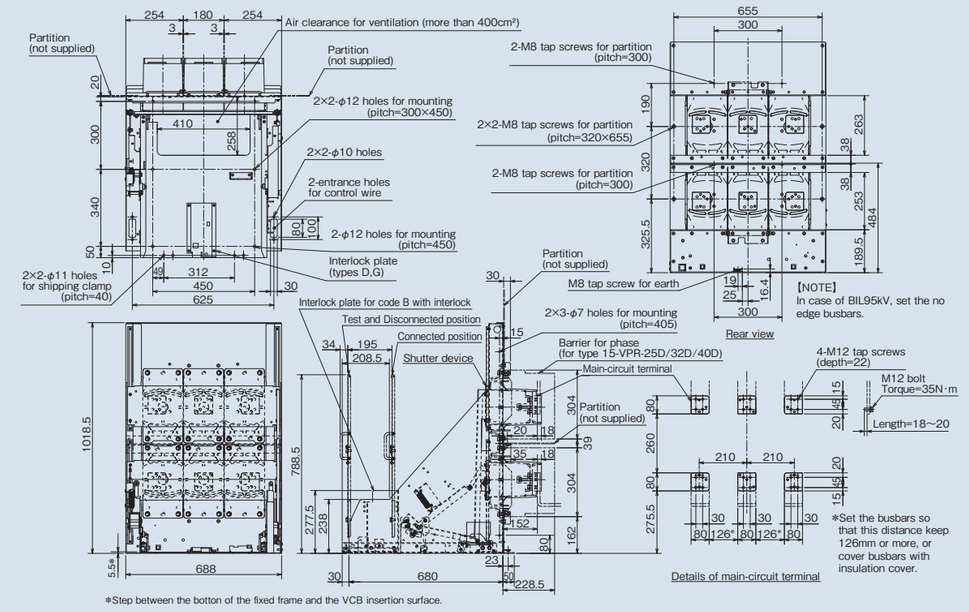
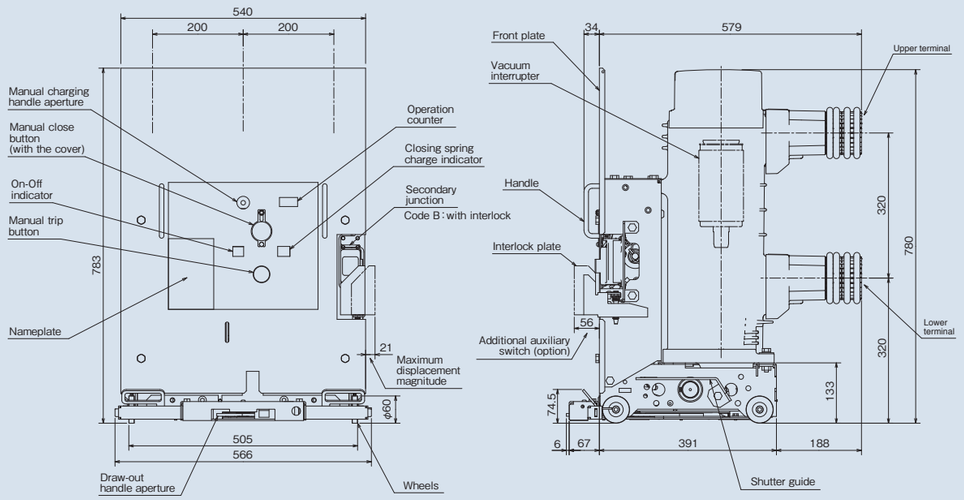


Fig. 24

■ 10-VPR-D 2500A, 3000A/3150A Rating : External Dimensions (Circuit Breaker)

Withdrawable with door closed (type-M)



Withdrawable with door open (types C, D and G)

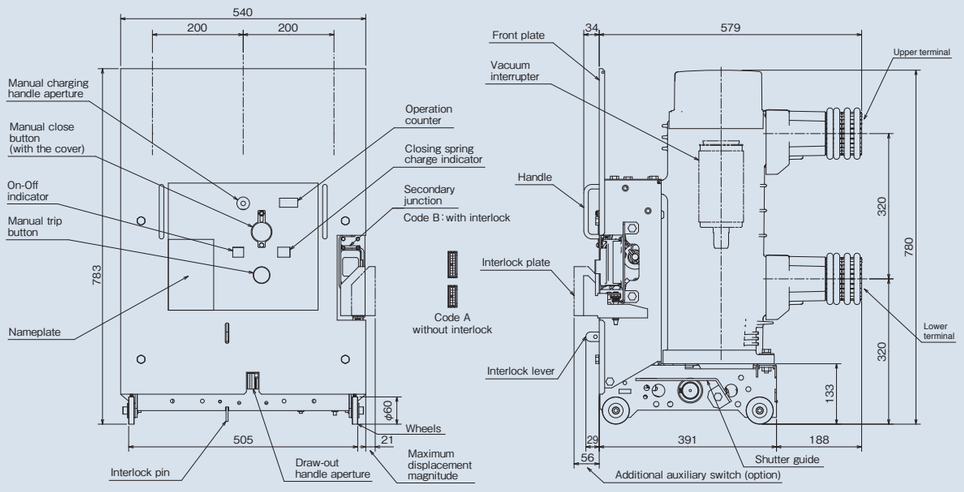
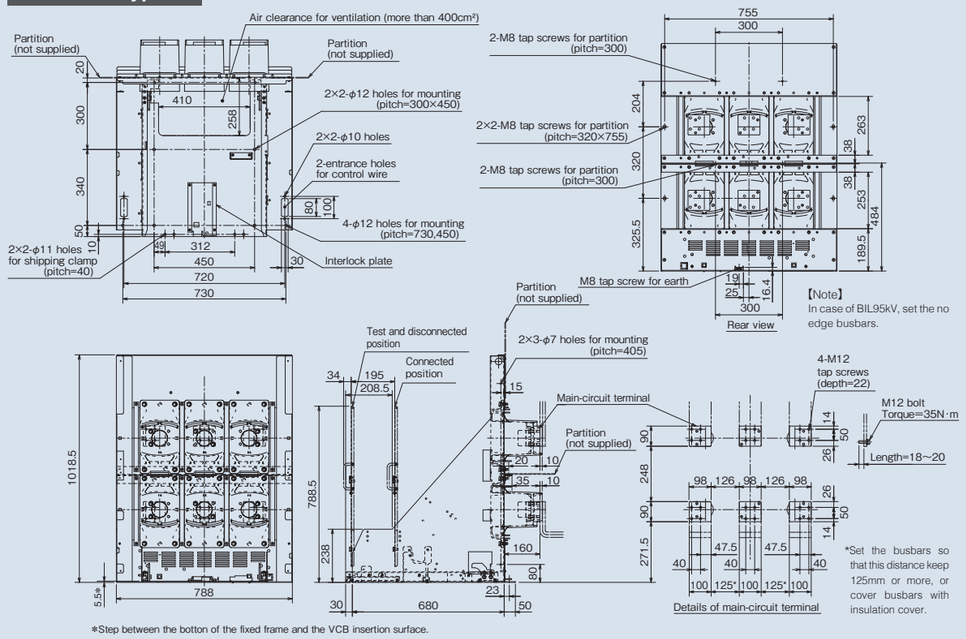


Fig. 25

■ 10-VPR-D 2500A, 3000A/3150A Rating : External Dimensions (Mounting Frame)

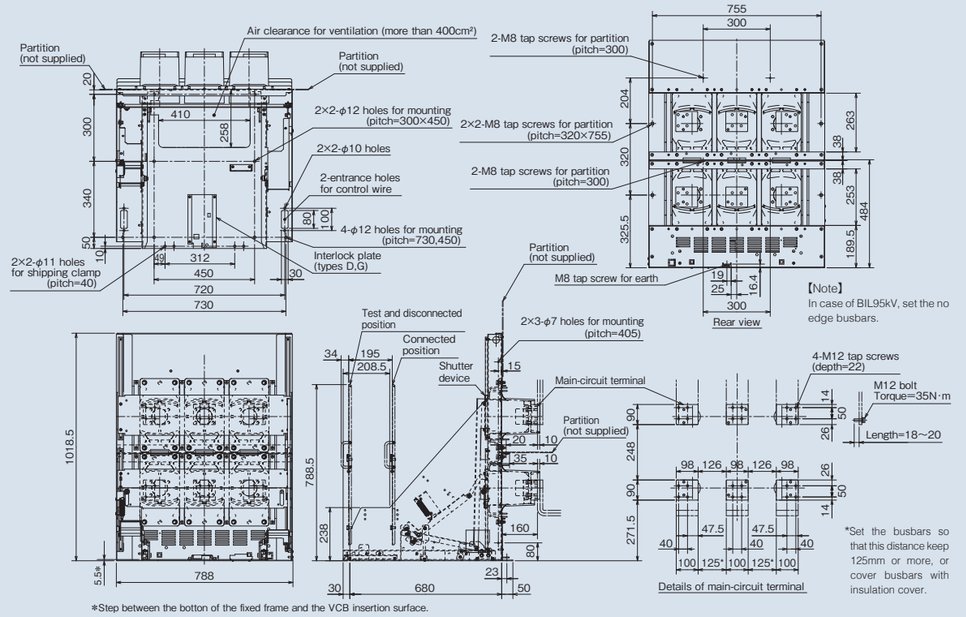
Class CW (type-C)



*Step between the botton of the fixed frame and the VCB insertion surface.

Fig. 26

Classes PW and MW (types M, D and G)



*Step between the botton of the fixed frame and the VCB insertion surface.

Fig. 27

■ 10-VPR50C(D) 4000A Rating External Dimensions (Circuit Breaker)

Withdrawable with door open (types-C, D and G)

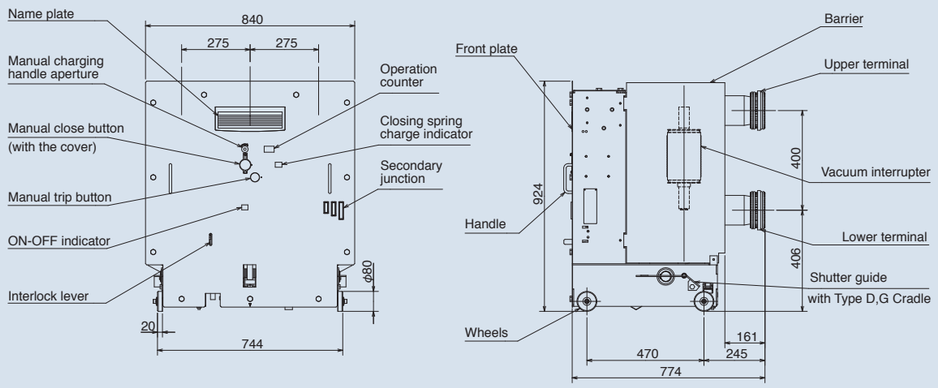


Fig. 28

Withdrawable with door open (types-C, D and G)

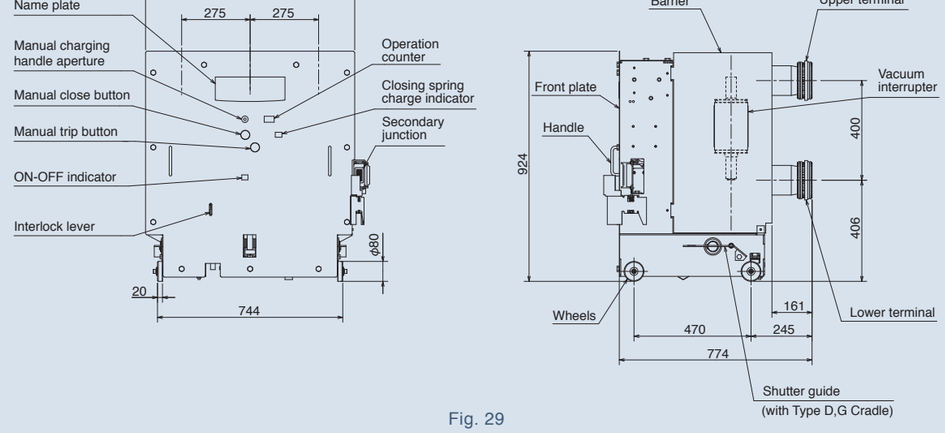
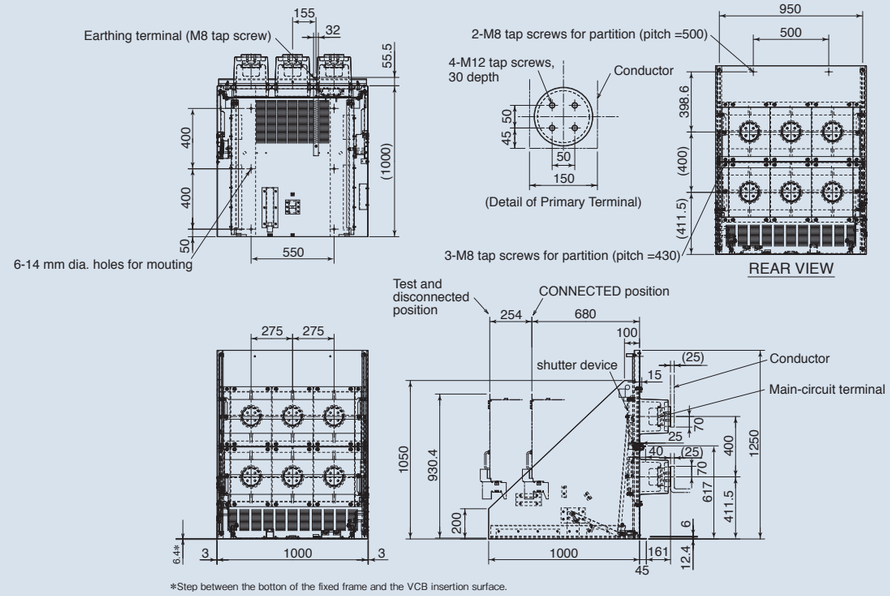


Fig. 29

■ 10-VPR50C(D) 4000A Rating External Dimensions (Mounting Frame)

Classes CW, PW and MW (types-C, D and G)



*Step between the botton of the fixed frame and the VCB insertion surface.

Fig. 30

Note: class CW : Shutter device is not equipped.

5 EXTERNAL DIMENSIONS

■ 20-VPR-D 630A, 1250A Rating External Dimensions (Circuit Breaker)

Withdrawable with door closed (type-M)

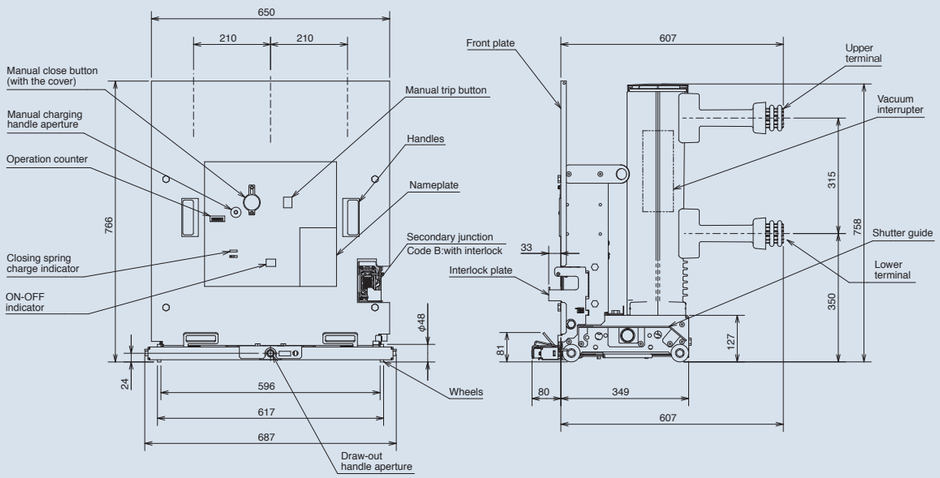


Fig.31

Withdrawable with door open (types C,D and G)

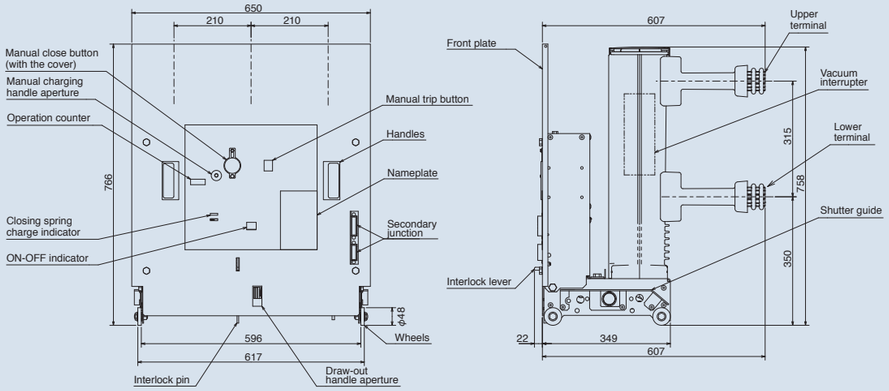
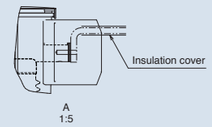
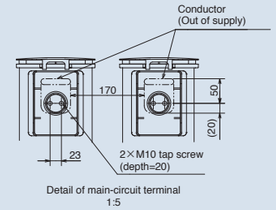


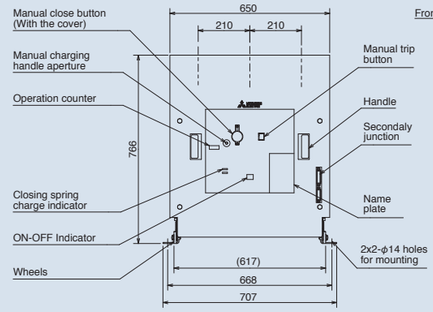
Fig.32

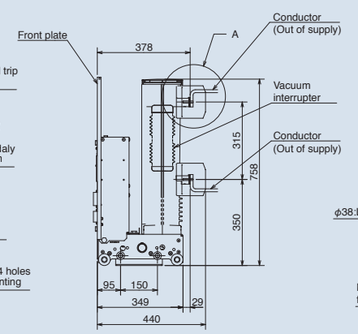
Fixed (type-L)

-NOTE-
Please set the insulation distance to 170mm or more , or cover with the insulation cover the edge part of main circuit.









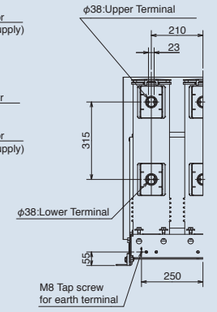
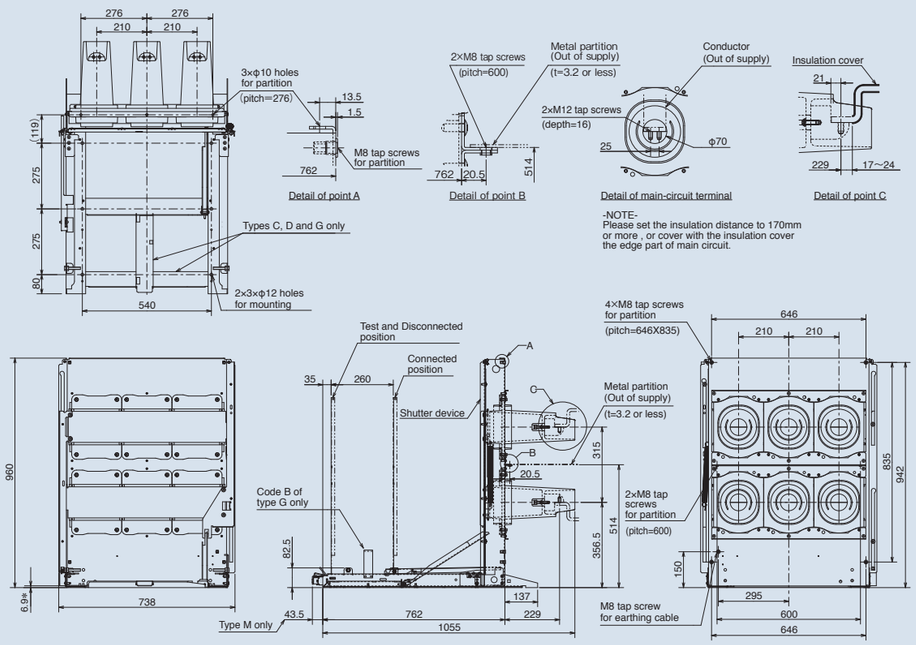


Fig.33

5 External Dimensions (9)

■ 20-VPR-D 630A, 1250A Rating External Dimensions (Mounting frame)

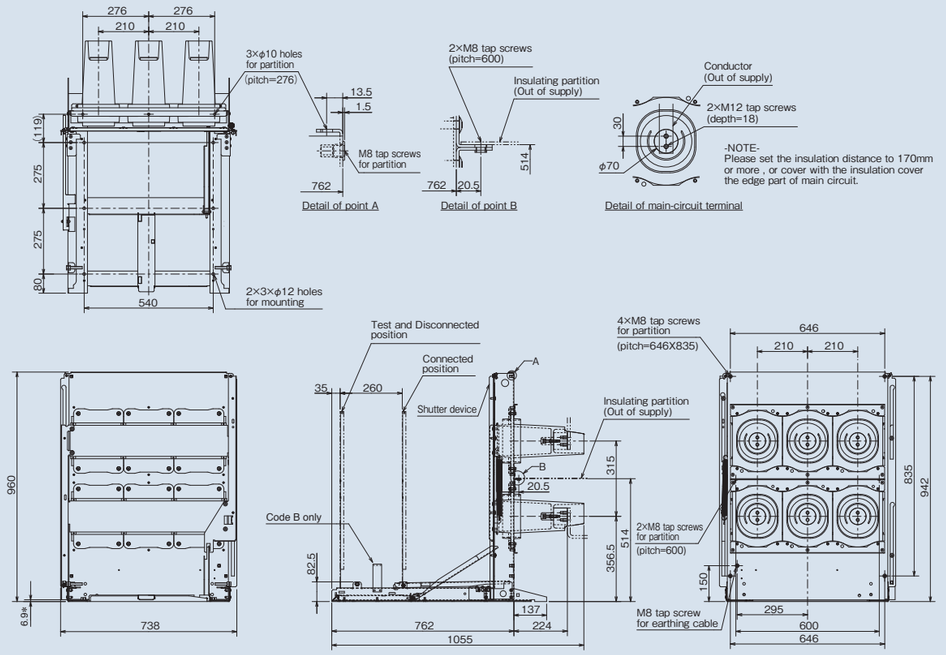
Class MW (types-M and G)



*Step between the botton of the fixed frame and the VCB insertion surface.

Fig.34

Classes CW and PW (types-C and D)



*Step between the botton of the fixed frame and the VCB insertion surface.

Fig.35

Note: class CW : Shutter device is not equipped.

Table 2 Mounting configuration.

Type	Description	High-voltage switchgear standards
M	Withdrawable with door closed and mounting frame (class MW)	LSC2B-PM
G	Withdrawable with door open and mounting frame (class MW)	
D	Withdrawable with door open and mounting frame (class PW)	LSC2B-PI
C	Withdrawable with door open and mounting frame (class CW)	LSC1

Notes: PM : All partitions are provided metallic partitions and shutters.
P I : Partitions are provided one or more non-metallic partitions or shutters.

5 External Dimensions (10)

■ 20-VPR-D 2000A Rating External Dimensions (Circuit Breaker)

Withdrawable with door closed (type-M)

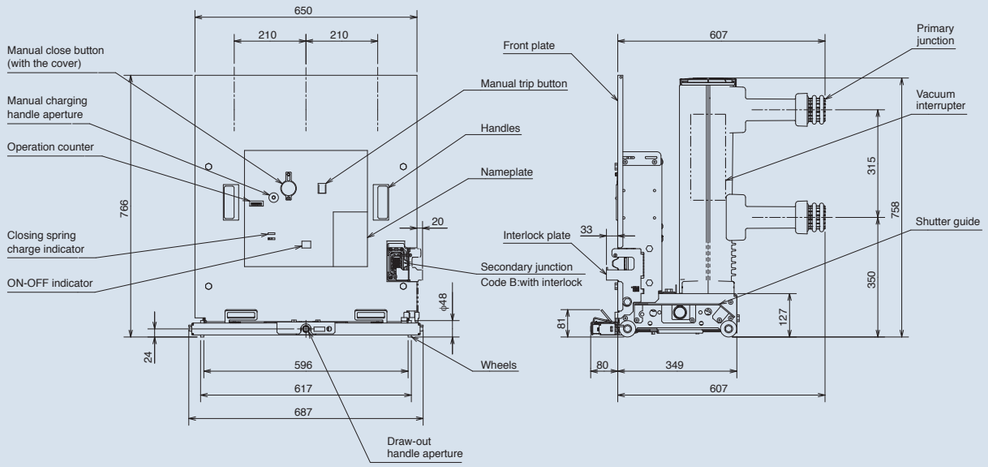


Fig.36

Withdrawable with door open (types-C, D and G)

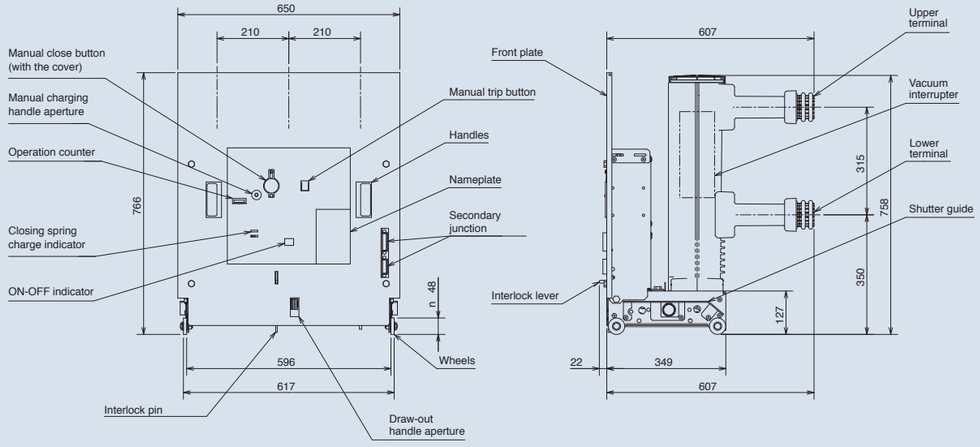
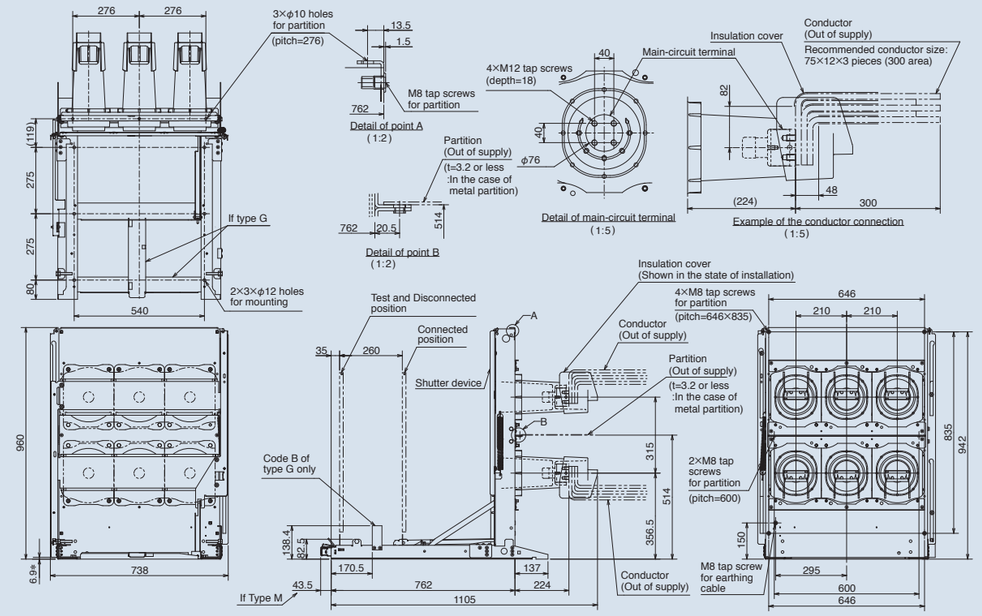


Fig.37

■ 20-VPR-D 2000A Rating External Dimensions (Circuit Breaker)

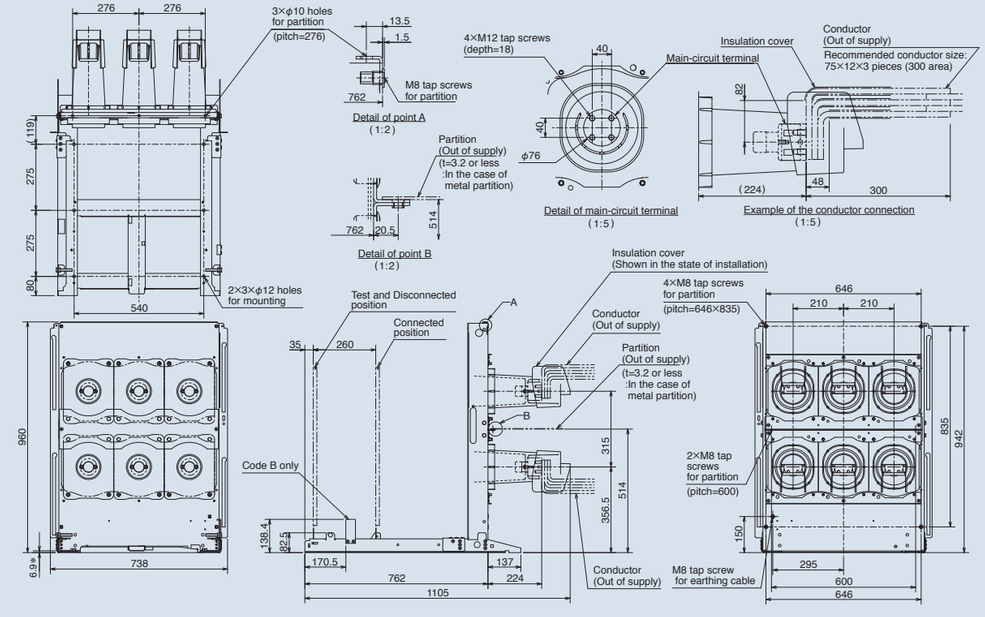
Class MW (types-M and G)



*Step between the botton of the fixed frame and the VCB insertion surface.

Fig.38

Class CW and PW (types-C and D)



*Step between the botton of the fixed frame and the VCB insertion surface.

Fig.39

■ 20-VPR-D 2500A Rating External Dimensions (Circuit Breaker)

Withdrawable with door open (types-C and D)

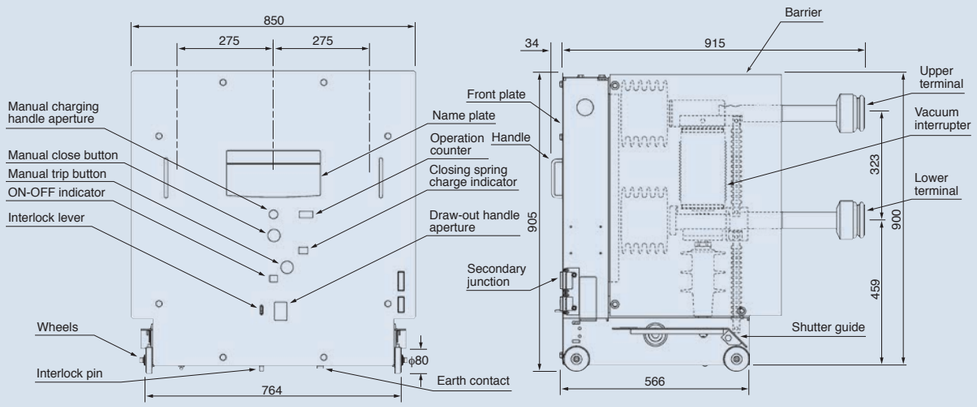
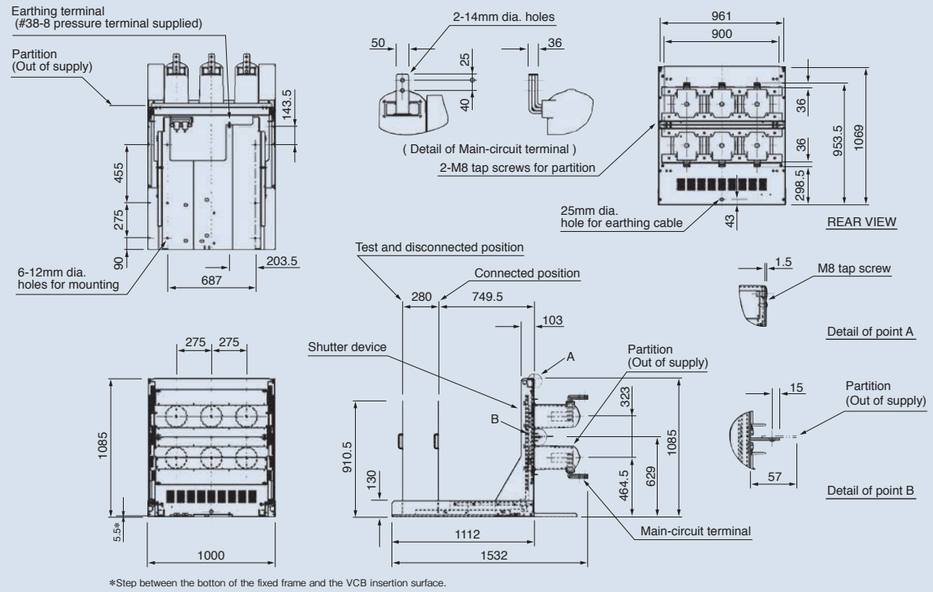


Fig.40

■ 20-VPR-D 2500A Rating External Dimensions (Mounting Frame)

Classes CW and PW (types-C and D)



*Step between the botton of the fixed frame and the VCB insertion surface.

Fig.41

Note: class CW : Shutter device is not equipped.

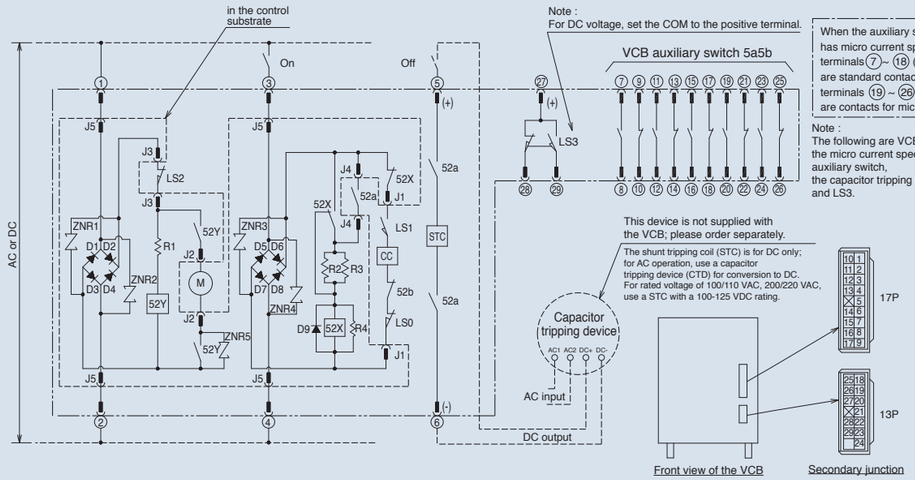
5 EXTERNAL DIMENSIONS

6 Connection Diagrams (1)

■ 3/6-VPR-20D/25D (630A, 1250A)
10-VPR-25D(M)
20-VPR-16D/25D (630A, 1250A, 2000A)

Withdrawable : Standard connection diagram (AC･DC100~125V) (Code A)

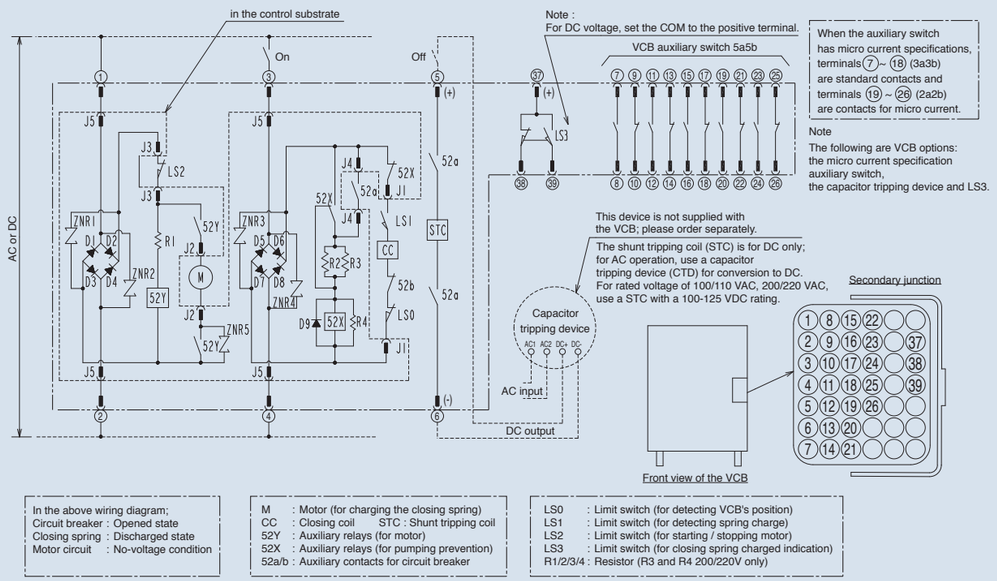
Note: There is no LS0 in a fixed (type-L).



In the above wiring diagram;	M : Motor (for charging the closing spring)	LS0 : Limit switch (for detecting VCB's position)
Circuit breaker : Opened state	CC : Closing coil STC : Shunt tripping coil	LS1 : Limit switch (for detecting spring charge)
Closing spring : Discharged state	52Y : Auxiliary relays (for motor)	LS2 : Limit switch (for starting / stopping motor)
Motor circuit : No-voltage condition	52X : Auxiliary relays (for pumping prevention)	LS3 : Limit switch (for closing spring charged indication)
	52a/b : Auxiliary contacts for circuit breaker	R1/2/3/4 : Resistor (R3 and R4 200/220V only)

Fig.42

Withdrawable : Standard connection diagram (AC･DC100~125V) (Code B)

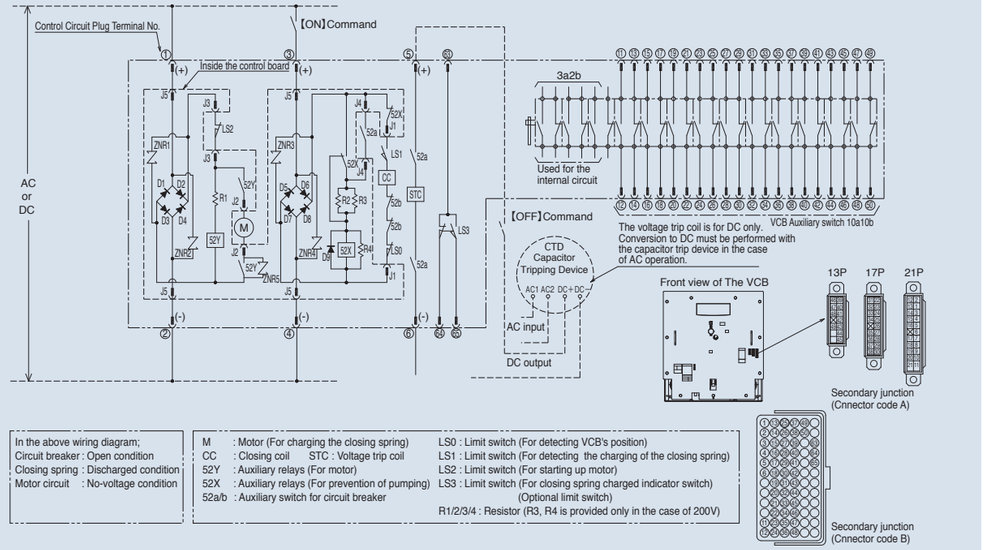


In the above wiring diagram;	M : Motor (for charging the closing spring)	LS0 : Limit switch (for detecting VCB's position)
Circuit breaker : Opened state	CC : Closing coil STC : Shunt tripping coil	LS1 : Limit switch (for detecting spring charge)
Closing spring : Discharged state	52Y : Auxiliary relays (for motor)	LS2 : Limit switch (for starting / stopping motor)
Motor circuit : No-voltage condition	52X : Auxiliary relays (for pumping prevention)	LS3 : Limit switch (for closing spring charged indication)
	52a/b : Auxiliary contacts for circuit breaker	R1/2/3/4 : Resistor (R3 and R4 200/220V only)

Fig.43

■ 10-VPR-50C (D)

Withdrawable : Standard connection diagram (AC･DC100~125V)

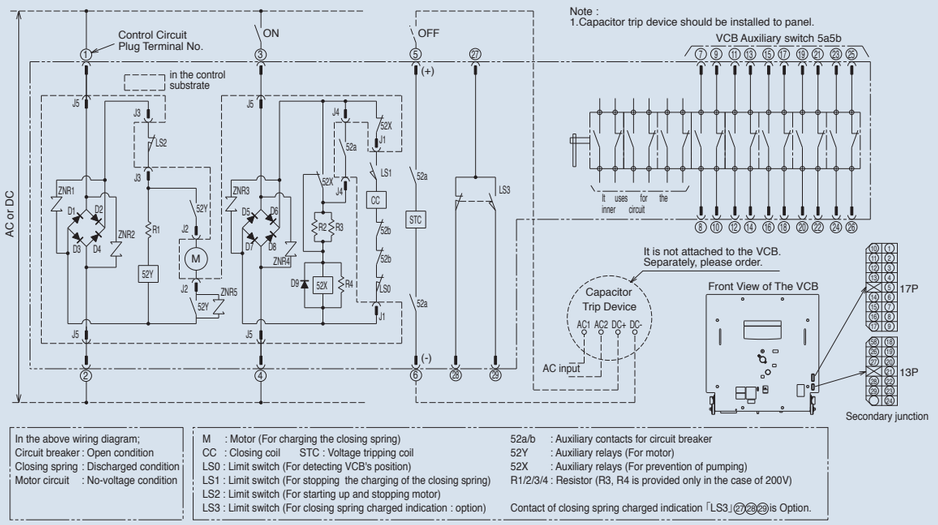


In the above wiring diagram;	M : Motor (For charging the closing spring)	LS0 : Limit switch (For detecting VCB's position)
Circuit breaker : Open condition	CC : Closing coil STC : Voltage trip coil	LS1 : Limit switch (For detecting the charging of the closing spring)
Closing spring : Discharged condition	52Y : Auxiliary relays (For motor)	LS2 : Limit switch (For starting up motor)
Motor circuit : No-voltage condition	52X : Auxiliary relays (For prevention of pumping)	LS3 : Limit switch (For closing spring charged indicator switch)
	52a/b : Auxiliary switch for circuit breaker	(Optional limit switch)
		R1/2/3/4 : Resistor (R3, R4 is provided only in the case of 200V)

Fig.44

■ 20-VPR-25D 2500A

Withdrawable : Standard connection diagram (AC･DC100~125V)



In the above wiring diagram;	M : Motor (For charging the closing spring)	52a/b : Auxiliary contacts for circuit breaker
Circuit breaker : Open condition	CC : Closing coil STC : Voltage tripping coil	52Y : Auxiliary relays (For motor)
Closing spring : Discharged condition	LS0 : Limit switch (For detecting VCB's position)	52X : Auxiliary relays (For prevention of pumping)
Motor circuit : No-voltage condition	LS1 : Limit switch (For stopping the charging of the closing spring)	R1/2/3/4 : Resistor (R3, R4 is provided only in the case of 200V)
	LS2 : Limit switch (For starting up and stopping motor)	
	LS3 : Limit switch (For closing spring charged indication : option)	Contact of closing spring charged indication「LS3」㉗㉘㉕is Option.

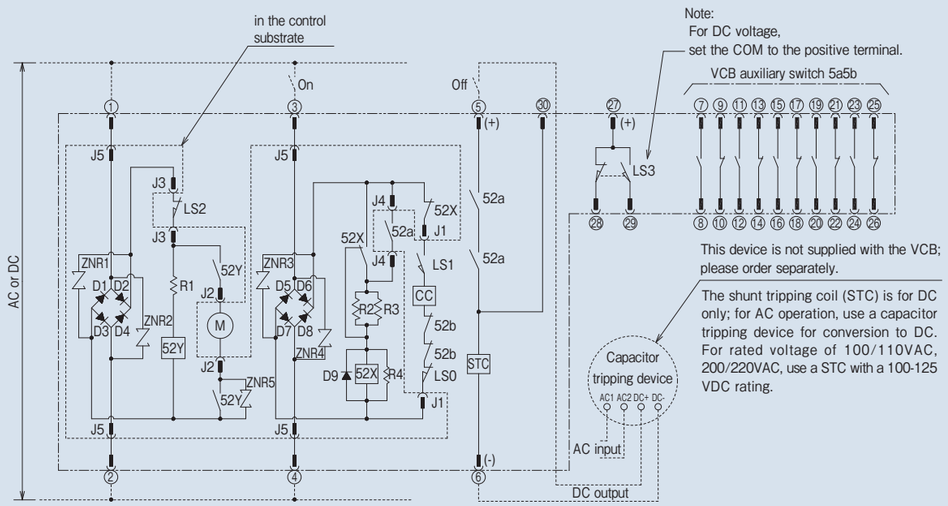
Fig.45

6 Connection Diagrams (2)

■ 3/6/10/15-VPR-25D/32D/40D

Withdrawable : Standard Connection Diagram (Code A)

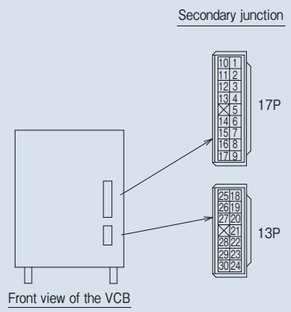
Note: There is no LS0 in a fixed (type-L).



When the auxiliary switch has micro current specifications, terminals ⑦～⑱ (3a3b) are standard contacts and terminals ⑲～㉖ (2a2b) are contacts for micro current.

Note:
The following are VCB options:
the micro current specification auxiliary switch,
the tripping coil disconnection monitoring (terminal No. 30),
the capacitor tripping device and LS3.

In the above wiring diagram;
Circuit breaker : Opened state
Closing spring : Discharged state
Motor circuit : No-voltage condition

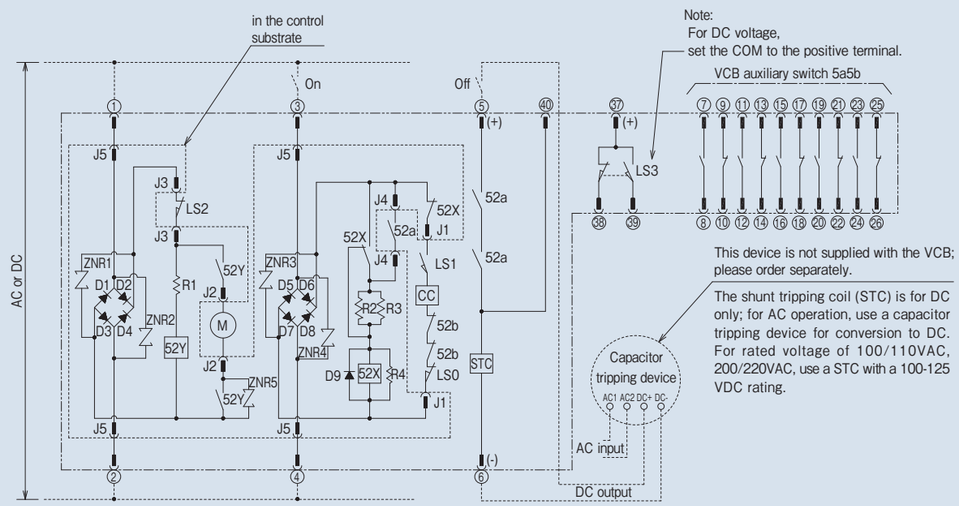


M	: Motor (for charging the closing spring)	LS0	: Limit switch (for detecting VCB's position)
CC	: Closing coil STC : Shunt tripping coil	LS1	: Limit switch (for detecting the charging of the closing spring)
52Y	: Auxiliary relays (for motor)	LS2	: Limit switch (for starting up and stopping motor)
52X	: Auxiliary relays (for prevention of pumping)	LS3	: Limit switch (for closing spring charged indication)
52a/b	: Auxiliary contacts for circuit breaker	R1/2/3/4	: Resistor (R3 and R4 200/220V only)

Fig.46

Withdrawable : Standard Connection Diagram (Code B)

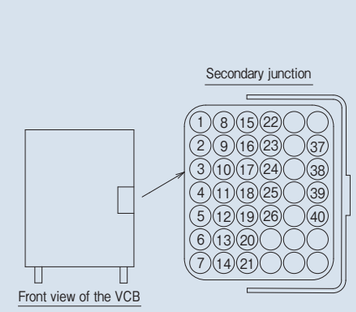
Note: There is no LS0 in a fixed (type-L).



When the auxiliary switch has micro current specifications, terminals ⑦～⑱ (3a3b) are standard contacts and terminals ⑲～㉖ (2a2b) are contacts for micro current.

Note:
The following are VCB options:
the micro current specification auxiliary switch,
the tripping coil disconnection monitoring (terminal No. 40),
the capacitor tripping device and LS3.

In the above wiring diagram;
Circuit breaker : Opened state
Closing spring : Discharged state
Motor circuit : No-voltage condition



M	: Motor (for charging the closing spring)	LS0	: Limit switch (for detecting VCB's position)
CC	: Closing coil STC : Shunt tripping coil	LS1	: Limit switch (for detecting the charging of the closing spring)
52Y	: Auxiliary relays (for motor)	LS2	: Limit switch (for starting up and stopping motor)
52X	: Auxiliary relays (for prevention of pumping)	LS3	: Limit switch (for closing spring charged indication)
52a/b	: Auxiliary contacts for circuit breaker	R1/2/3/4	: Resistor (R3 and R4 200/220V only)

Fig.47

7 Accessories

Table 3 Accessories

Type	3/6-VPR-D				10-VPR-25D(M)	10-VPR-D	10-VPR-50C(D)	15-VPR-D	20-VPR-D	20-VPR-D
	3-VPR-20D	3-VPR-25D	6-VPR-20D	6-VPR-25D	10-VPR-25D(M)	10-VPR-25D/32D/40D	10-VPR-50C(D)	15-VPR-25D/32D/40D	20-VPR-16D/25D	20-VPR-25D(2500A)
Secondary Connector	○	○	○	○	○	○	○	○	○	○
Manual Charging Handle	○	○	○	○	○	○	○	○	○	○
Insertion/Draw-out Handles	○	○	○	○	○	○	○	○	○	○
Lifting Adapter	–	–	–	–	○	○	○	○	○	○
Shipping Clamp	○	○	○	○	○	○	–	○	–	–
Wipe Gauge	–	–	–	–	–	–	○	–	–	○
Sloped Platform	–	–	–	–	–	–	–	–	○	–

■ Secondary Connector (Lead wires 1.5m)

※Lead wires of 10-VPR-50C(D) is 2m.

Code A

Code B

The panel side lead wires connect the input voltage and VCB unit. They are inserted in the control plug section of the VCB.
Number of accessories:1 per unit

Fig.48

■ Manual Charging Handle

This handle enables the closed spring to be charged manually by inserting the handle in the front manual charging handle aperture and rotating clockwise for approximately 15 rotations.
Number of accessories:1 per 1-5 VCBs (min. 1)

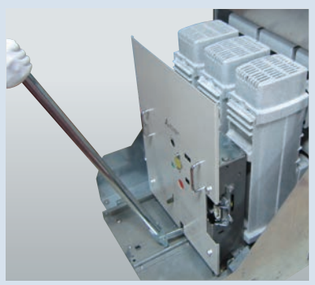
Fig.49

■ Insertion/Draw-out Handles

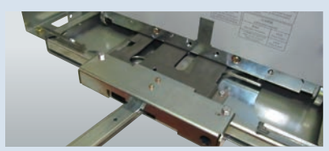
For 3/6-VPR-D 600~1250A
For 10-VPR-D Series 600~1250A
For 20-VPR-D 630~1250A, 2000A

For 10-VPR-D Series Type C,D,G
1600~3150A

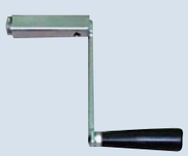
For 10-VPR-D 50C(D)
For 20-VPR-25D 2500A



This is a insertion / draw-out handle to move the VCB unit between the test position and the connected position.
Number of accessories:
1 per 1-5 VCBs (min. 1)



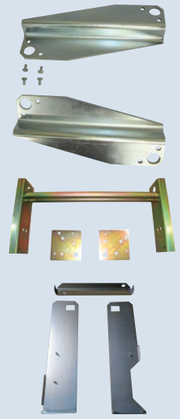
For 10-VPR-D Series Type M



For 20-VPR-D Series Type M

Fig.50

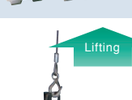
■ Lifting Adapter



For 10-VPR-D Series

For 10-VPR-50C(D)

For 20-VPR-D
(630, 1250A)
For types C, D and G



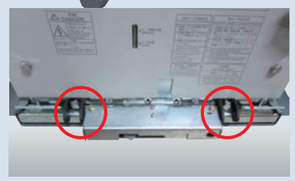
For 20-VPR-25D
(2000A)

A lifting adapter used to lift the VCB. Please refer to the directions for use in the instruction manual.
Number of accessories:
1 per 1-5 VCBs (min. 1)

Fig.51

■ Shipping Clamp (for 10-VPR-D series)

For Type M



600~2000A

2500A~3150A
(shipped with a panel)

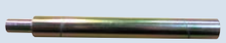
Fig.52

For Types C, D and G

These are fixtures for shipping the VCB and a mounting frame together.
Use them as described in the instruction manual.
Number of accessories:1 per unit

Fig.53

■ Wipe Gauge



For 10-VPR-50C(D)

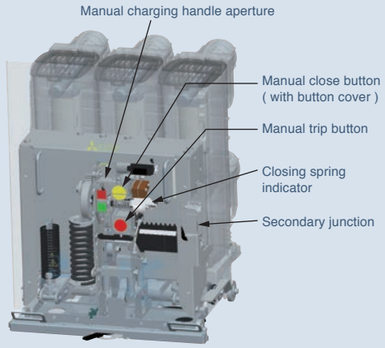
For 20-VPR-D 2500A

Wheter the wipe quantity is within the allowable range or not can be judged using awipe gauge during in spection. Please use according to instruction manual. 1 per 1-5 VCBs(min 1)

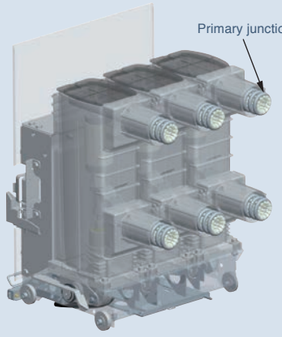
Fig.54

8 Optional Accessories

■ VCB Configuration

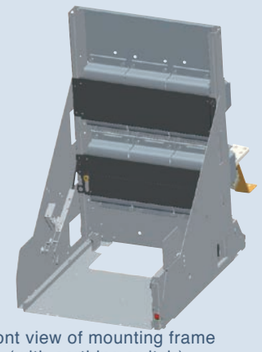


Front view of VCB
Fig.55

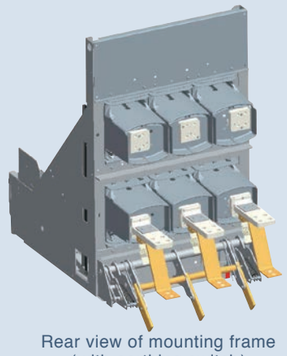


Rear view of VCB
Fig.56

■ Mounting Frame Configuration



Front view of mounting frame
(with earthing switch)
Fig.57



Rear view of mounting frame
(with earthing switch)
Fig.58

Closing spring charged indication switch (page 41)

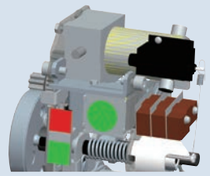


Fig.59

Additional auxiliary switch (page 42)

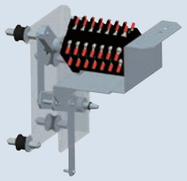


Fig.62

Padlock device for close and trip button (page 42)

Fig.65

Short-circuit capacity earthing (page 45)

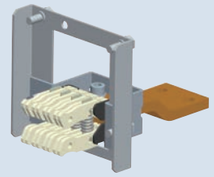


Fig.68

Mechanical locking device (page 41)

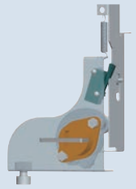


Fig.60

Additional shunt tripping coil (page 42)

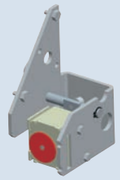


Fig.63

Position switch (page 43, 44)

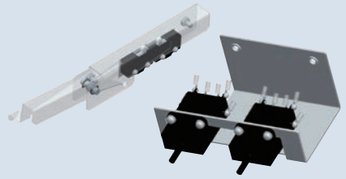


Fig.66

Optional terminal (V : Vertical, H : Horizontal) (page 45)

(Vertical)

(Horizontal)

Fig.69

Tripping coil disconnection monitoring (page 41)

Fig.61

Draw-out mechanism padlock device (page 42)

Fig.64

Earthing switch (page 47, 48)

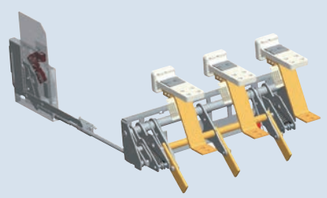


Fig.67

Shutter padlock device (page 46)

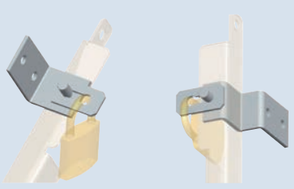


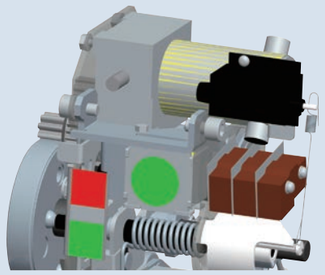
Fig.70

Table 4 Optional Accessories

Type	3/6-VPR-D				10-VPR-25D(M)	10-VPR-D	10-VPR-50C (D)	15-VPR-D	20-VPR-D	20-VPR-D
	3-VPR-20D	3-VPR-25D	6-VPR-20D	6-VPR-25D	10-VPR-25D(M)	10-VPR-25D/32D/40D	10-VPR-50C (D)	15-VPR-25D/32D/40D	20-VPR-16D/25D	20-VPR-25D (2500A)
Low surge	○	○	○	○	–	–	–	–	–	–
Closing spring charged indication switch	○	○	○	○	○	○	○	○	○	○
Mechanical locking device	–	–	–	–	–	○	–	○	–	–
Tripping coil disconnection monitoring	–	–	–	–	–	○	–	○	○	–
Additional auxiliary switch	–	–	–	–	–	○	–	○	–	–
Additional shunt tripping coil	–	–	–	–	–	○	–	○	–	–
Draw-out mechanism padlock device	○	○	○	○	○	○	–	○	○	–
Padlock device for close and trip button	–	–	–	–	○	○	–	○	○	–
Position switch	○	○	○	○	○	○	○	○	○	○
Earthing switch	–	–	–	–	○	○	–	○	○	–
Short-circuit capacity earthing	–	–	–	–	–	○	–	○	–	–
Optional terminal (V:Vertical, H:Horizontal)	–	–	–	–	○	○	–	○	–	–
Shutter padlock device	–	–	–	–	○	○	○	○	○	–

8 Optional Accessories (1)

■ Closing Spring Charged Indication Switch



Used for charging/discharging output of closing springs.
The contact number is 1C.

Table 5 Contact ratings.

Rated voltage (V)	Resistance load (A)	Inductive load (A)
125AC/DC	5.5	5.5
250AC/DC	3	1.5

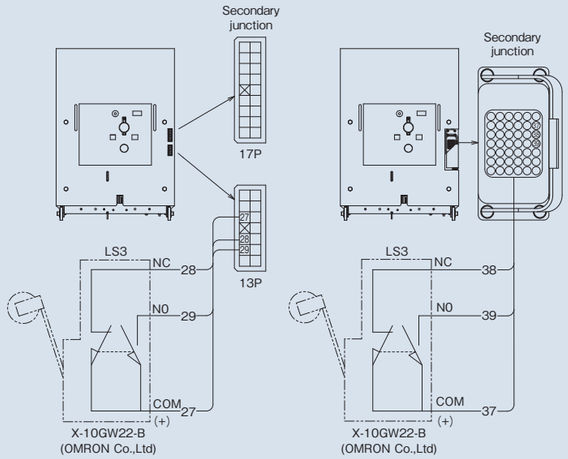


Fig. 71 Wiring diagram

*1: Please refer to the standard connection diagram for the VCB (P33 ~ P36).
*2: Fig. 70 shows a closed spring in a dischrged state.
*3: LS3 (limit switch for the spring charge indicator)
*4: For DC voltage, set the COM to the positive electrode.

■ Mechanical Locking Device

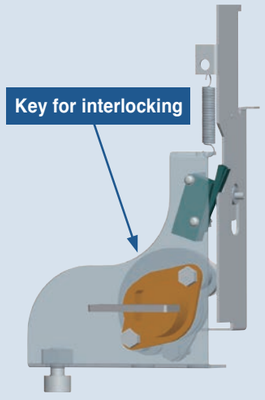


Fig. 72

The interlock system is configured to lock the VCB in the off position. To shut down the VCB either automatically or manually requires the VCB to be locked using the key. The key can only be removed after the VCB has been opened and locked. The VCB cannot be closed in this state.
Note that users are responsible for preparing the interlock key; a key will not be supplied by the manufacturer. In addition, note that this feature cannot be used together with the draw-out mechanism padlock device.

Table 6 Specifications of key for interlocking.

Manufacturer	Castell
Model	FS1
Lock portion symbol	User option
Key rotation	90 degrees clockwise to trap
Spigot dimensions	9.5mm² X 22mm long

■ Tripping Coil Disconnection Monitoring

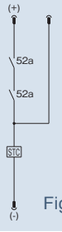


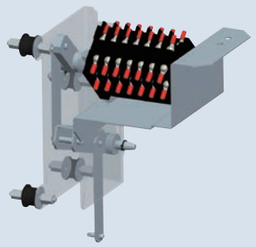
Fig. 73

This function monitors disconnection of the tripping coil and control connector based on output from the input terminal.

Table 7 Disconnection monitoring current.

Type	Disconnection monitoring current
10/15-VPR-25D/32D/40D	30mA or below
20-VPR-16D/25D	8mA or below

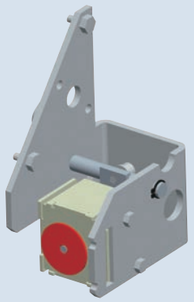
■ Additional Auxiliary Switch (Additional 5a5b)



The switch makes it possible to add 5a5b to a standard 5a5b contact number to create a 10a10b arrangement (the additional auxiliary contact has no settings for micro current contact). It is also possible to create an 8a8b configuration by adding 5a5b to the standard 3a3b contact number through use of the optional additional shunt tripping coil.

Fig. 74

■ Additional Shunt Tripping Coil



An additional shunt tripping coil can be arranged through addition of an independent tripping coil. If one of the tripping coils malfunctions, the other tripping coil can still perform tripping.

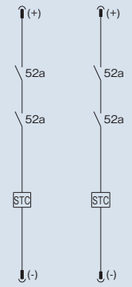
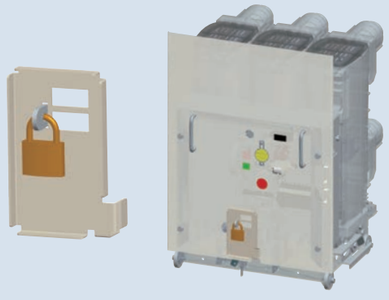


Fig. 75

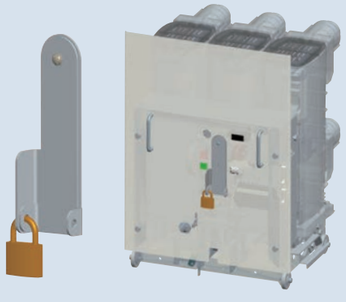
■ Draw-out Mechanism Padlock Device



This padlock can be used to lock the VCB in the connected position or test / disconnected position. Note that users are responsible for preparing a padlock; a padlock will not be supplied by the manufacturer.

Fig. 76

■ Padlock Device for Close and Trip Button



This padlock board can be used to cover the VCB closing and tripping buttons and prevent manual switching operations. Note that users are responsible for preparing a padlock; a padlock will not be supplied by the manufacturer.

Fig. 77

8 Optional Accessories (2)

■ Position switch 3/6-VPR-D (Connected Position/Test and Disconnected Position)

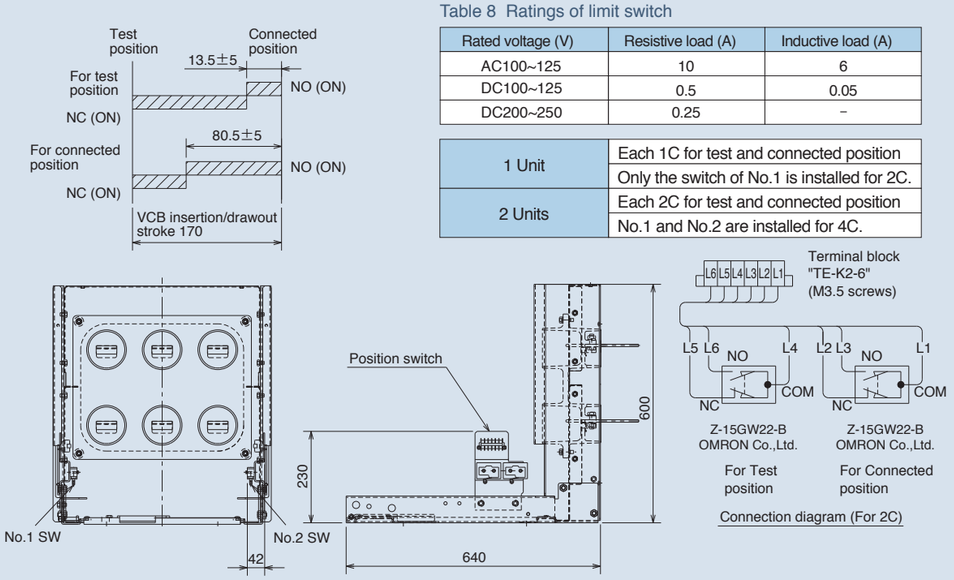


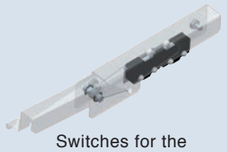
Fig.78

Table 8 Ratings of limit switch

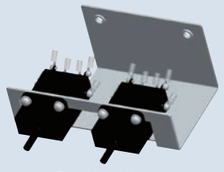
Rated voltage (V)	Resistive load (A)	Inductive load (A)
AC100~125	10	6
DC100~125	0.5	0.05
DC200~250	0.25	–

1 Unit	Each 1C for test and connected position
	Only the switch of No.1 is installed for 2C.
2 Units	Each 2C for test and connected position
	No.1 and No.2 are installed for 4C.

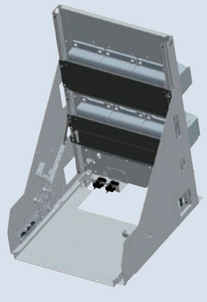
■ Position switch 10-VPR-D, 10-VPR-50C(D), 20-VPR-25D 2500A



Switches for the test position



Switches for the connected position



Output of the test and disconnected position as well as the connected position of the circuit breaker. (The test and disconnected position are only 10-VPR-D.)The maximum output contact number is 2C for the test and disconnected position and 4C for the connected position.

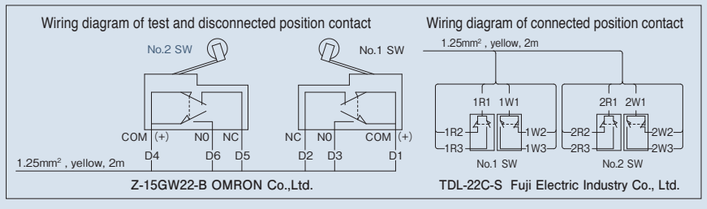
Table 9 Test and disconnected position contact ratings (switching).

Rated voltage (V)	Resistance load (A)	Inductive load (A)
100～125AC	10	6
100～125DC	0.5	0.05
200～250DC	0.25	–

Table 10 Connected position contact ratings (switching).

Rated voltage (V)	Resistance load (A)	Inductive load (A)
100～125AC	15	10
100～125DC	0.5	0.1
200～250DC	0.3	–

1 unit	2C for test and disconnected position	2 units	2C for test and disconnected position
	2C for connected position		4C for connected position



Position detecting switch timing

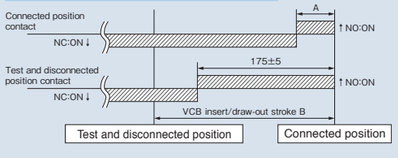
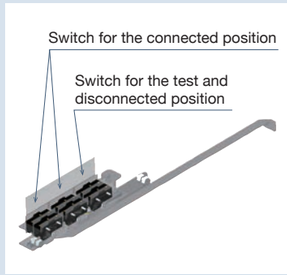


Table 11

Type	A	B
10-VPR-D	5~13	195±5
10-VPR-50C(D)	3~6	254
20-VPR-25D(2500A)	6.5±3	280

Fig.79

■ Position switch 10-VPR-25D(M)



Output of the test and disconnected position as well as the connected position of the circuit breaker. The maximum output contact number is 2C for the test and disconnected position and 4C for the connected position.

Table 12 Position contact ratings(switching).

Rated voltage(V)	Resistance load(A)	Inductive load(A)
100～125AC	10	6
100～125DC	0.5	0.05
200～250DC	0.25	–

Type name of switching : Z-15GW22-B OMRON Co.,Ltd.

1 unit	2C for test and disconnected position	2 units	2C for test and disconnected position
	2C for connected position		4C for connected position

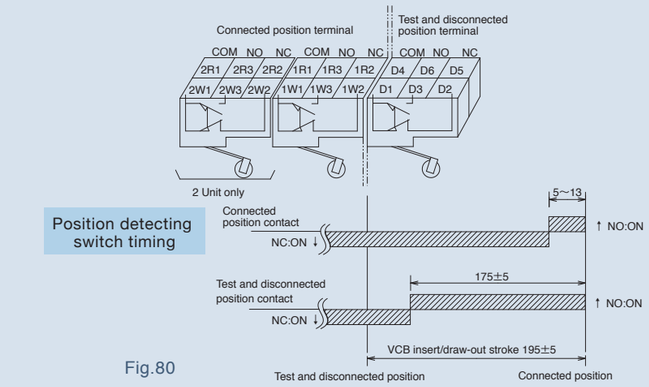
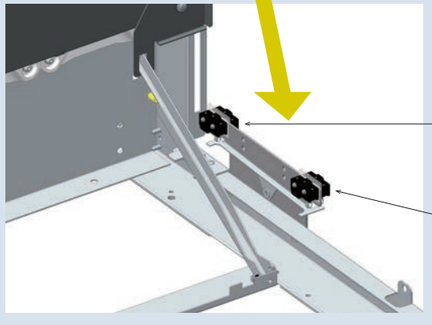


Fig.80

■ Position switch 20-VPR-D

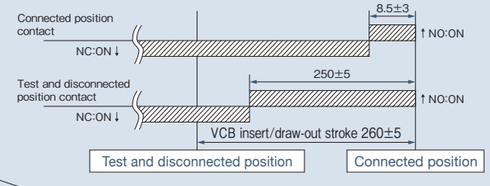


Output of the test and disconnected position as well as the connected position of the circuit breaker. The output contact number is 2C for the test and disconnected position and 2C for the connected position.

Table 13 Position contact ratings (switching).

Rated voltage (V)	Resistance load (A)	Inductive load (A)
100～125AC	10	6
100～125DC	0.5	0.05
200～250DC	0.25	–

Position detecting switch timing



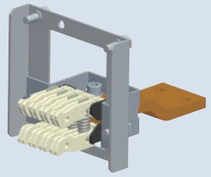
Switch for the connected position
Z-15GM22-B
OMRON Co.,Ltd.

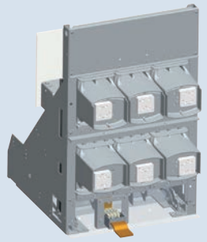
Switch for the test and disconnected position
Z-15GM22-B
OMRON Co.,Ltd.

Fig.81

8 Optional Accessories (3)

■ Short-circuit Capacity Earthing





The ground-fault current to the VCB frame flows into the earth bus on the panel side at the VCB's connected position.
Current flow of 40kA-3 seconds.

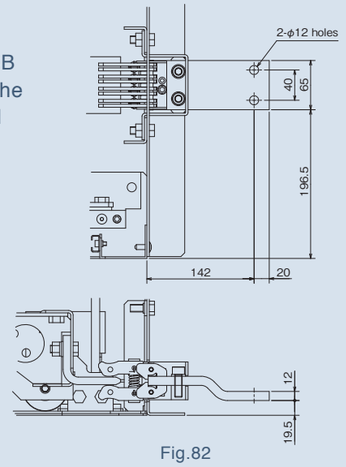
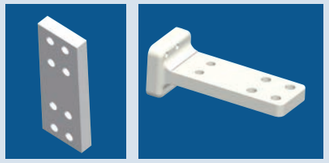
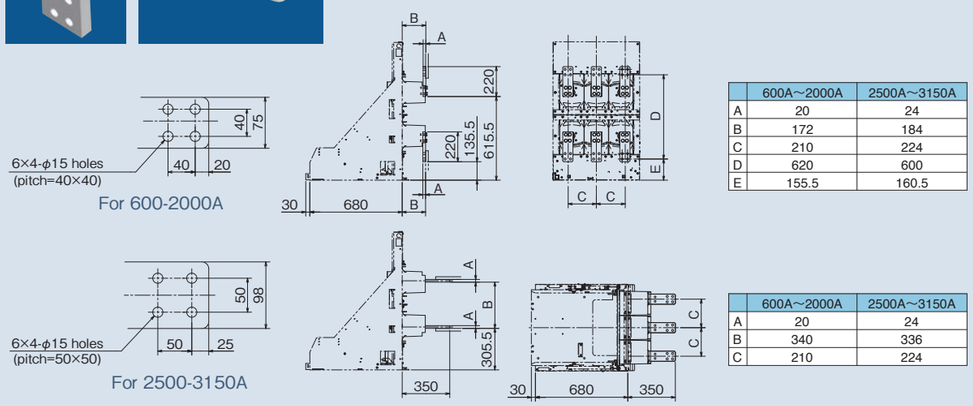


Fig.82

■ Optional terminal



Conductors can be installed vertically and horizontally inside panels through use of horizontal and vertical terminals in the mounting frame terminal area.



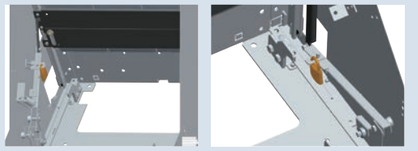
	600A～2000A	2500A～3150A
A	20	24
B	172	184
C	210	224
D	620	600
E	155.5	160.5

	600A～2000A	2500A～3150A
A	20	24
B	340	336
C	210	224

Fig.83

■ Shutter Padlock (10-VPR-D)

This padlock prevents release of the shutter in the mounting frame. Note that users are responsible for preparing a padlock ; a padlock will not be supplied by the manufacturer.



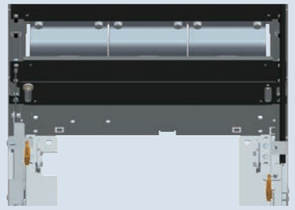
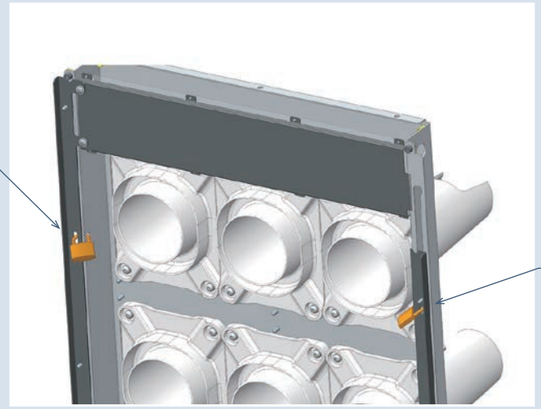


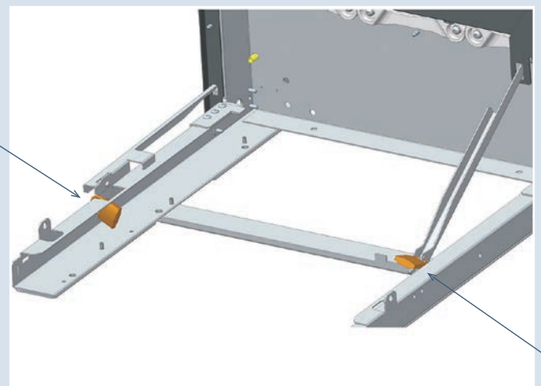
Fig.84

■ Shutter Padlock (20-VPR-D)

This padlock prevents release of the shutter in the mounting frame. Note that users are responsible for preparing a padlock; a padlock will not be supplied by the manufacturer.



The shutter is open position



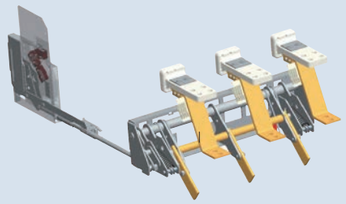
The shutter is close position

Fig.85

Note : This accessory is standard equipment.

8 Optional Accessories (4)

■ Earthing Switch (ES) (10-VPR-D)

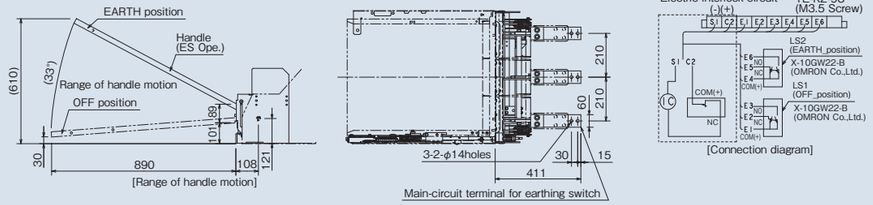


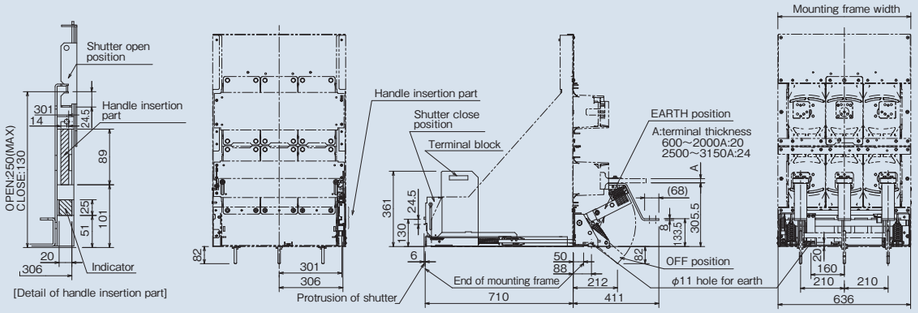
This earthing switch is used to ground the main circuit part (lower side of the mounting frame). It enables simple safety checks at the time of maintenance and inspections.

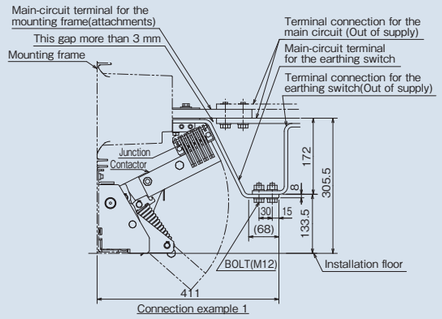
Class E2 (40kA / 3s)
Applicable standards: IEC 62271-102-2012
Accessories: Operating handle: 1 piece / 1-5 ES unit (s)

Table 14 Coil ratings.

Rated voltage	Current flow
100／110V DC	63mA







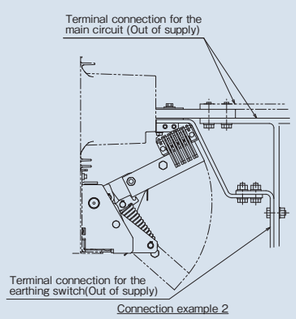


Fig.86

■ Earthing Switch (ES) (20-VPR-D)

This earthing switch is used to ground the main circuit part (lower side of the mounting frame). It enables simple safety checks at the time of maintenances and inspections.

Class E2 (25kA / 3s)
Applicable standards: IEC 62271-102-2018
Accessories: Operating handle: 1 piece / 1-5 ES unit (s)
Not applicable to RoHS standard.

Table 15 Coil ratings.

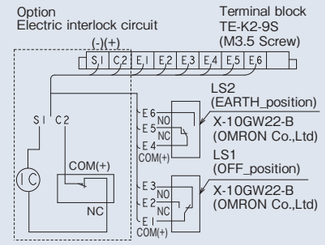
Rated voltage	Current flow
100／110V DC	63mA

Table 16 Indication switch contact ratings.

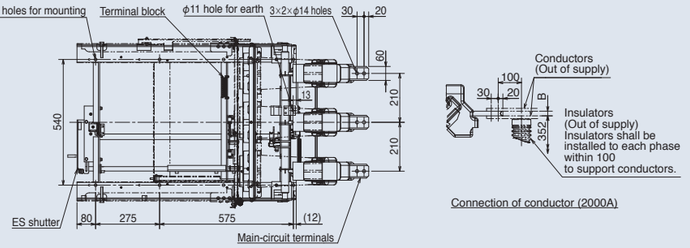
Rated voltage (V)	Resistance load (A)	Inductive load (A)
125AC/DC	5.5	5.5
250AC/DC	3	1.5

Table 17

Rated normal current (A)	A	B
630, 1250	492	12
2000	536	20



Connection diagram.
(This connection diagram shows ES OFF position)



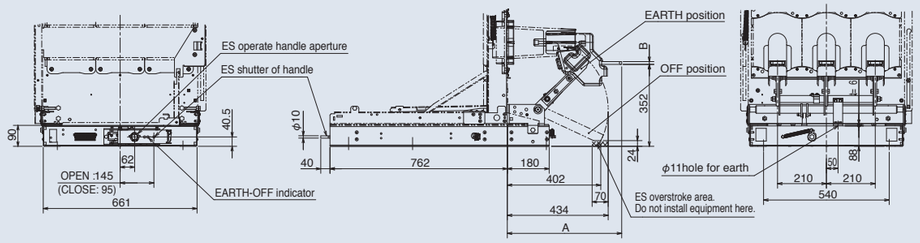


Fig.87

8 OPTIONAL ACCESSORIES

9 Relevant Devices (1)

■ Surge Absorbing Capacitor (CR Suppressor) Sold Separately

This is a device to absorb the surge generated by switching.

Table 18 Ratings.

Type		CR-3	CR-6	CR-12	CR-15
Applicable circuit voltage (kV)		3.3	6.6	11	15
External dimensions (mm) *1	A	150	200	–	–
	B	237	337		
	C	16	20		
Capacitance (μF)		0.05×3 phases	0.05×3 phases	0.1×3 phases	0.1×3 phases
Resistance (Ω)		100×3 phases	100×3 phases	100×3 phases	100×3 phases
Mass (kg)		8.5	10	31	33

◎Precautions

(1) Caution for circuits containing harmonics

As is the case with general high-pressure capacitors, please exercise caution when applying CR suppressors to circuits with higher harmonic waves. Particular care is required regarding multiple-order harmonic waves which may have flowed into circuits used for current control via the thyristor. When using a CR suppressor, set the effective value of resultant current with harmonic waves to the values shown in the table below (values are 1.3 times the rated value).

Table 19 Effective value of resultant current with harmonic waves.

Type	CR-3	CR-6	CR-12	CR-15
Acceptable values for the resultant current of the harmonic wave	0.05A effective value / phase	0.1A effective value / phase	0.37A effective value / phase	0.37A effective value / phase

(2) How to install

Install the CR suppressor vertically; do not install it horizontally or upside down.

(3) Caution for regular inspections

Be sure to ground the secondary terminals of the CR suppressor before touching them.

(4) Caution for withstand voltage tests

1.Please conduct a withstand voltage test after removing any wire connections.

2.Take care to ensure that test voltages and application times are correct. Depending on transformer capacity, excessive current flow may prohibit the test from being performed.
For withstand voltage tests where the panel includes a CR suppressor, the CR suppressor must be disconnected from main circuit.

Table 20 Acceptable test voltage of CR suppressor.

Type				CR-3	CR-6	CR-12	CR-15
Rated test voltage	AC	Between T-T	1 minute	6.6kV	13.2kV	24kV	30kV
		Between T-C		7.6kV	14.2kV	28kV	36kV
		Between T-C	10 minutes	4.95kV	9.9kV	18kV	22.5kV

T: Terminal C: Case

(5) Recommended replacement period : 15 years

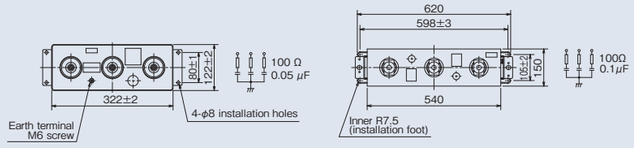
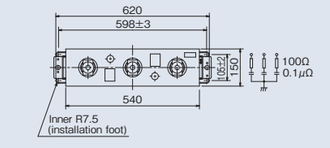
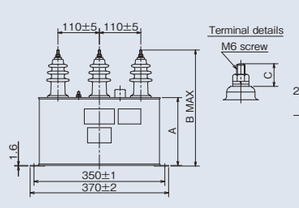
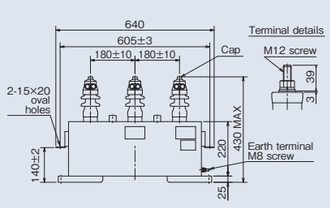


Fig. 88-1 CR-3, CR-6.

Fig. 88-2 CR-12







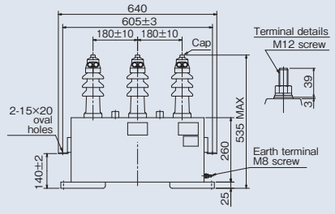


Fig. 88-3 CR-15

*1: Maximum height of the main-circuit terminal.

■ Arresters (for 3.6kV, 7.2kV) Sold Separately

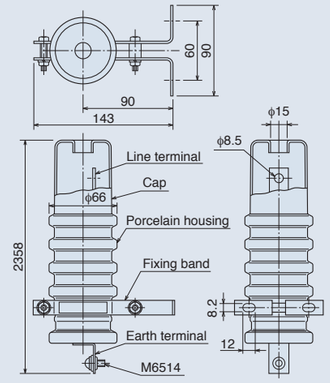


Fig. 89

Table 21 Ratings of Arrester

Brand name	Otowa GL arrester	
Usage	Indoor	
Type name	GLI-3G	GLI-6G
Rated voltage (kV)	4.2	8.4
Applicable circuit voltage (kV)	3.3	6.6
AC discharge starting voltage (kV crest)	6.3	12.6
Impulse discharge starting voltage (kV peak)	17	33
Official discharge current (A)	2500	2500
Mass (kg)	1.5	

Warning

Disconnect wiring to perform withstand voltage test.

9 Relevant Devices (2)

■ Lifter for 3/6-VPR-20D/25D 600A~1250A Sold Separately

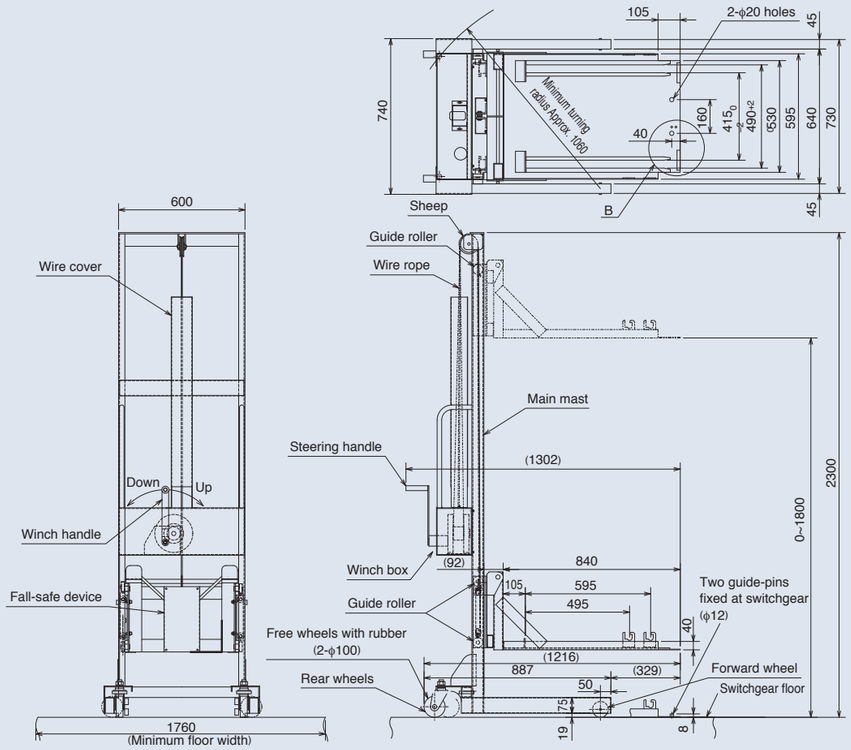


Fig. 90

■ Lifter for 20-VPR-16D/25D 630A~1250A (Types C, D and G) Sold Separately

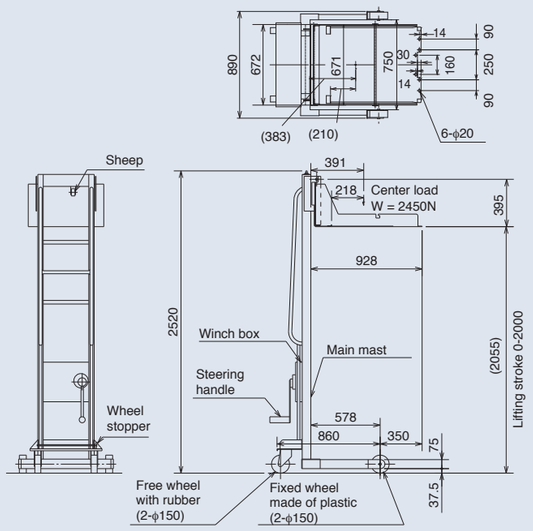


Fig. 91

■ Lifter for 20-VPR-16D/25D 630A~1250A (Type M) and 20-VPR-25D 2000A Sold Separately

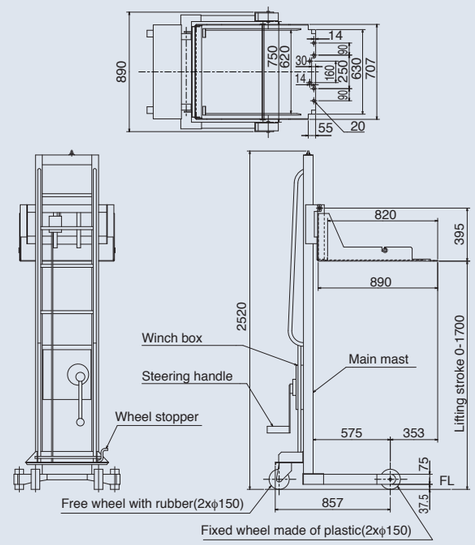


Fig. 92

■ Lifter (F-3C, F-3C + Adapter for Type-M : For 10-VPR-D) Sold Separately

This is the lifter necessary to carry the circuit breaker unit in and out of the panel.
Please use F-3C and adapter for type-M.

Table 22 List of lifter.

Type	Lifter
L, C, D, G	F-3C
M	F-3C + adapter for type-M

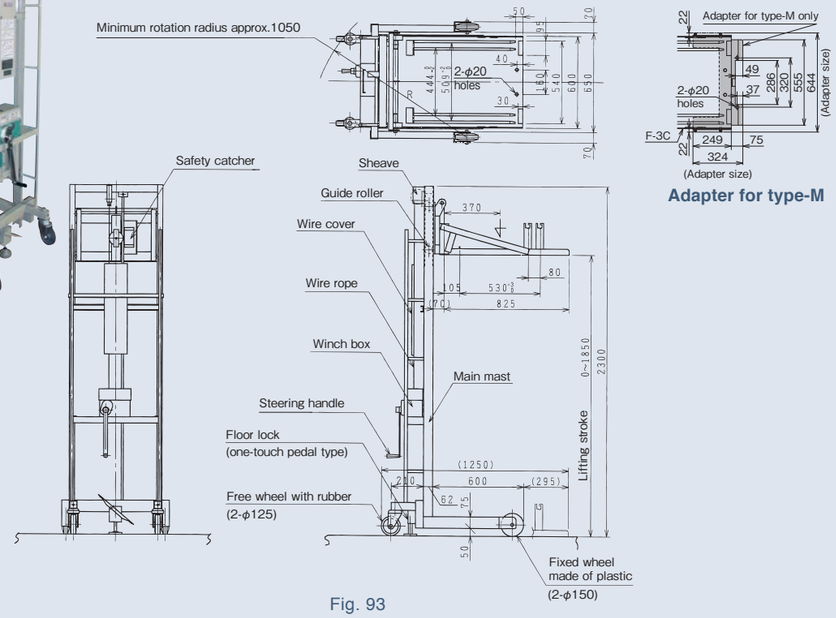
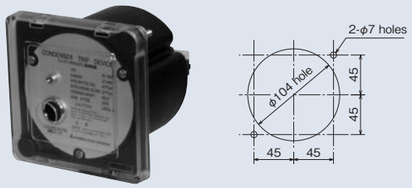


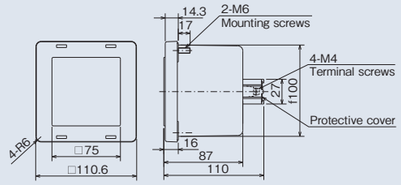
Fig. 93

9 Relevant Devices (3)

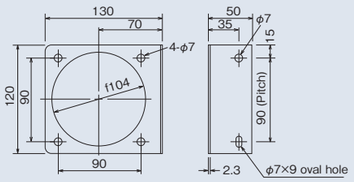
■ Capacitor Tripping Device (CTD) Sold Separately

This device makes it possible to trip the circuit breaker electrically within a fixed time via remote control even when the control power is out.





Dimension of CTD



Device-mounting fixture

Fig. 94

Table 23 Ratings.

Type	Condenser C	Resistance R1	Resistance R2	Resistance R3
KF-100E	820μF	10W300Ω	10W100Ω	0.5W240kΩ
KF-200CD	820μF	10W300Ω	10W100Ω	0.5W240kΩ

Table 24 Table of ratings.

Items	KF-100E	KF-200CD
Rated working voltage (V)	100/110AC	200/220AC
Rated frequency (Hz)	50/60	
Rated output voltage (V)	140/155DC	
Power consumption (steady state) (W)	0.1 or less	
Electric charge time constant	1	2.3
VCB operational voltage (V)	100~125DC	

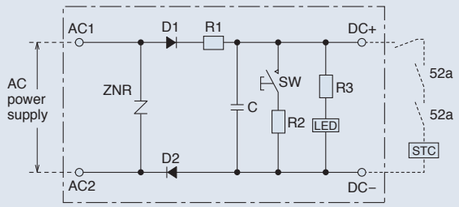


Fig. 95 Circuit diagram (KF-100E).

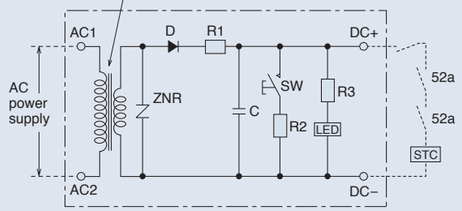


Fig. 96 Circuit diagram (KF-200CD).

Remarks

1. Capacitor tripping devices are mounted on the panel as standard.
2. Mounting fixtures that enable installation inside the panel are optional. The device can be installed facing the left, right, up or down according to the direction of the mounting fixtures.

Caution:

1. Please note that the KF-200CD output voltage is 140/155VDC. It cannot be used to open circuit breakers with a tripping voltage of 200/220VDC and may cause an accident in this case.
2. Be sure to completely charge a capacitor before performing opening operation or giving the opening command.
3. The sole purpose of this device is tripping a VCB. Do not use for any other purpose.
4. One device is required per VCB unit.
5. Recommended replacement period: 6 years

10 Interlocking Process for the Panel Door When Using Withdrawable with Door Closed (Type-M) Operation Mechanism

Through optional processing of the panel door, the VCB unit can be installed together with the following interlock function.

Interlock function with panel door

Function

VCB can only be moved when the panel door is in the closed state.

An insertion/draw-out handle (for type-M) can be used to move the VCB after closing the panel door with the unlocking pin attached to the door.

Unlocking pin must be installed

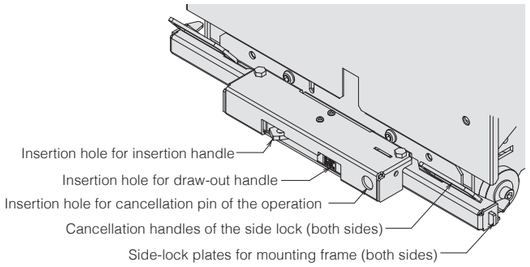


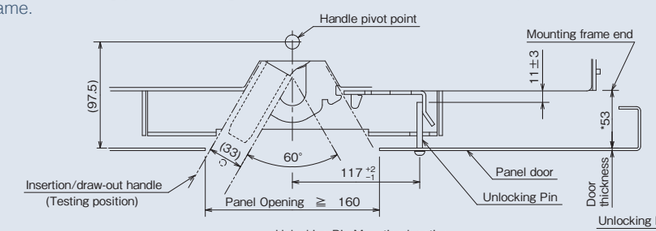
Fig. 97

Example of processing procedure

■ 10-VPR-D

✻In this example, the distance between the inside of the panel door and edge of the mounting frame is 53mm.

- Install a ϕ5mm unlocking pin (figure below shows M5 screw) in the position shown in the figure below (dimensions: 117mm, 32.5mm).
- Use an unlocking pin with a length that enables it to be inserted in a position 11mm from the edge of the mounting frame.



Please process the handle aperture for a panel cover of 160×25 mm or larger.

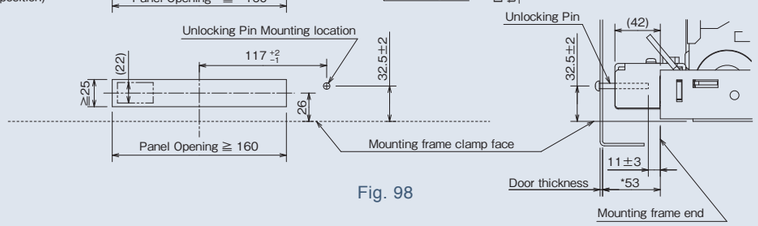
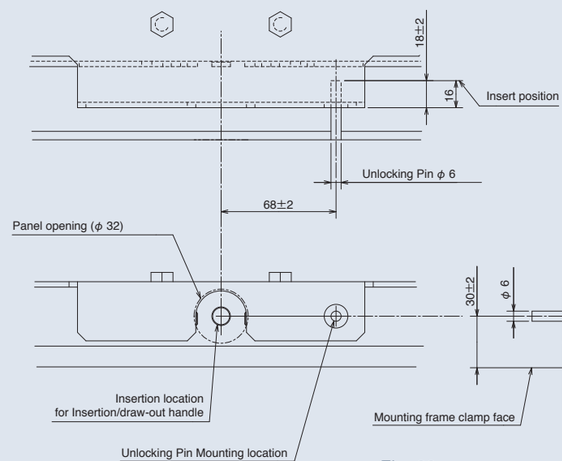


Fig. 98

■ 20-VPR-D

- Install a ϕ6mm unlocking pin in the position shown in the figure below(demensitions 68mm,30.5mm).
- Use an unlocking pin with a length that enables to be inserted in a position 18mm from the edge of the VCB.



Please process the handle aperture for a panel cover of Φ32 or larger.

Fig. 99

11 Technical Information (1)

■ Operation Mechanism and Operating Principles

● Closing Operation

Fig. 100 shows the state where the circuit breaker is opened and the closing spring is discharged.

■ Electrical (Closing) Operation

①When the power supply is connected, auxiliary relay 52Y is excited via limit switch LS2 and the contact of auxiliary relay 52Y closes, which then activates the motor via LS2, and the contact of auxiliary relay 52Y starts to charge the closing spring. When the closing spring is completely charged, limit switch LS2 opens, the motor then stops and limit switch LS1 closes (the closed control circuit is formed).

②By closing the closing command switch CS1 in this state, the closing coil **CC** is excited, the closing latch of the operating mechanism is released and the circuit breaker closes as a result of the energy from the charged closed spring. Through discharging the closed spring, LS2 is closed and LS1 is opened.

③When limit switch LS2 closes, the motor activates and charges the closing spring to prepare for the next closing operation.

④When the circuit breaker is closed, circuit breaker auxiliary contact 52b opens and shuts off excitation of closing coil **CC**. At the same time auxiliary contact 52a closes and forms a trip circuit of the shunt tripping coil **STC** and at the same time excites the auxiliary relay (for anti-pumping prevention) **52X**.

● When Closing Commands are Consecutively Given While Charging Closed Spring

If consecutive closing commands are given to the closing operation switch CS1 while charging the closed spring (charge time of motor: 10 seconds or less): limit switch LS1 closes, the closing coil **CC** is excited, and the circuit breaker closes after completing the charging of the closing spring.

● Tripping Operation

①By closing the trip command switch CS2, the shunt tripping coil **STC** is excited, the engagement of the tripping latch at the operating mechanism is released and the circuit breaker opens.

②When the circuit breaker is opened (tripped), circuit breaker auxiliary contact 52a opens and shuts off excitation of **STC** to prepare for the next closing operation.

● Trip-free Operation

If the closing command and trip command are given simultaneously when the circuit breaker is in an opened state and the closing spring is in a charged state (closing preparation):

①Operation takes place in the order of ②, ③, and ④ of the electrical (closing) operation. Then, because the trip command is being continued, operation ① of the electrical (trip) operation occurs.

②Electrical (closing) operation ① is returned but since the auxiliary relay **52X** is continuously being excited, a closed circuit is not formed by contact 52Xb and the circuit remains in the opened state.

③When performing the closing operation, it is necessary to release the closing command by closing command switch CS1 and then restore auxiliary relay **52X**.

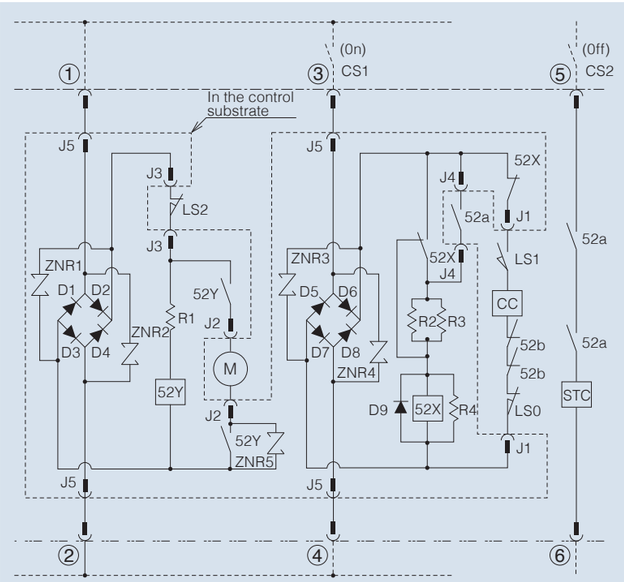


Fig. 100 Basic control circuit diagram.

The wiring diagram on the left indicates:
Circuit breaker : Opened state
Closing spring : Discharged state
Motor circuit : No-voltage condition

CS1 : Closing command switch
CS2 : Thip command switch
M : Motor (for charging closing spring)
CC : Closing coil
STC : Shunt tripping coil
LS0 : Limit switch (for detecting VCB's position)
LS1 : Limit switch (for detecting spring charge)
LS2 : Limit switch (for starting/stopping motor)
52a/b : Auxillarry contacts for circuit breaker
52Y : Auxiliary relay (for motors)
52X : Auxiliary relay (for pumping prevention)
R1/2/3/4 : Resistor (R3 and R4 are equipped only for 200/220V)

■ Operation/Control Voltage (Current)

Table 25 Variation range of operation/control voltage.

Items \ Standard		JEC-2300	IEC-62271-100
Closing operation voltage (motor circuit)	DC	85～110%*	85～110%
	AC		
Closing control voltage (closing circuit)	DC	75～125%	85～110%
	AC	85～110%	
Opening control voltage (tripping circuit)	DC	60～125%	70～110%
	AC		85～110%

*Due to electric spring operation

Table 26 Closing and tripping control current and current-flow time for DC and AC (see Fig. 101)*1.

≪Closing control current≫

Control voltage (V)			VDC										VAC			
			24		48		100/110		125		200/220		100/110		200/220	
Current (A), Time (s)			I	T	I	T	I	T	I	T	I	T	I	T	I	T
Type	3/6-VPR-D	Closing	12	0.05	7	0.05	3.5	0.05	4.5	0.05	1.5	0.05	3.5	0.05	1.8	0.05
	10-VPR-D		12	0.05	7	0.05	3.5	0.05	4.5	0.05	1.5	0.05	4	0.05	1.8	0.05
	10-VPR-50C (D)		-				3.2	0.08	-		1.5	-	3.2	0.08	1.8	0.05
	20-VPR-16D/25D, 10-VPR-25D (M)		12	0.05	7	0.05	4	0.05	4.5	0.05	1.5	0.05	4	0.05	1.8	0.05
	20-VPR-25D (2500A)		12	0.05	7	0.05	4.5	0.05	5	0.05	1.5	0.05	4.5	0.05	1.8	0.05

Is: Maximum flowing current at the time of disconnection monitoring
*1 When VCB and fault indicator are combined, please perform operation check of VCB and fault indicator.

≪Opening control current≫

Control voltage (V)			VDC														VAC					
			24			48			100/110			125			200/220			100/110			200/220		
Current (A), Time (s)			I	T	Is	I	T	Is	I	T	Is	I	T	Is	I	T	Is	I	T	Is	I	T	Is
Type	3/6-VPR-D	Tripping	13	0.03	-	8	0.03	-	3.5	0.05	-	5	0.03	-	2	0.03	-	-	0.03	-	-	0.03	-
	10-VPR-D		13	0.03	0.03	8	0.03	0.03	4	0.03	0.03	5	0.03	0.03	2	0.03	0.03	-	0.03	-	-	0.03	-
	10-VPR-50C (D)		-						3.2	0.03	-	-			2	0.03	-	-	0.03	-	-	0.03	-
	10-VPR-25D (M)		13	0.03	-	8	0.03	-	3.4	0.03	-	5	0.03	-	2	0.03	-	-	0.03	-	-	0.03	-
	20-VPR-16D/25D		13	0.03	-	8	0.03	-	3.4	0.03	0.008	5	0.03	0.008	2	0.03	-	-	0.03	-	-	0.03	-
	20-VPR-25D (2500A)		13	0.03	-	8	0.03	-	3.4	0.03	-	5	0.03	-	2	0.03	-	-	0.03	-	-	0.03	-

Is: Maximum flowing current at the time of disconnection monitoring

Table 27 Motor operation control current and current-flow time for DC and AC (see Fig. 102).

Control voltage (V)		VDC																VAC					
		24				48				100/110				125				200/220				100/110				200/220			
Current (A), Time (s)		I_1	I_2	T_1	T_2	I_1	I_2	T_1	T_2	I_1	I_2	T_1	T_2	I_1	I_2	T_1	T_2	I_1	I_2	T_1	T_2	I_1	I_2	T_1	T_2	I_1	I_2	T_1	T_2
Type	3/6-VPR-D	12	3.5	0.1	8	8	1.5	0.1	8	4	0.8	0.1	8	5	1	0.1	8	2	0.5	0.1	8	5.5	2	0.1	8	2.5	1.3	0.1	8
	10/15-VPR-25D/32D/40D	18	6.5	0.1	6	12	2.5	0.1	6	6	1.2	0.1	6	7.5	1.5	0.1	6	3.5	0.6	0.1	6	8.5	3	0.1	6	4.5	1.5	0.1	6
	10-VPR-50C (D)	-								6	1.5	0.1	10	7.5	1.9	10	6			0.6	0.1	6	11.5	6	0.1	6	4.5	1.5	0.1	6
	20-VPR-16D/25D, 10-VPR-25D (M)	12	3.5	0.1	8	8	1.5	0.1	8	4	0.8	0.1	8	5	1	0.1	8	2	0.5	0.1	8	4	0.8	0.1	8	2.5	1.3	0.1	8
	20-VPR-25D (2500A)	18	6.5	0.1	6	12	2.5	0.1	6	6	1.2	0.1	6	7.5	1.5	0.1	6	3.5	0.6	0.1	6	6	1.2	0.1	6	4.5	1.5	0.1	6

■ Operation/Control Current Waveform for DC.

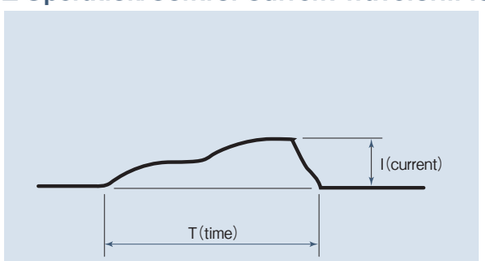


Fig. 101 Closing / tripping control current waveform.

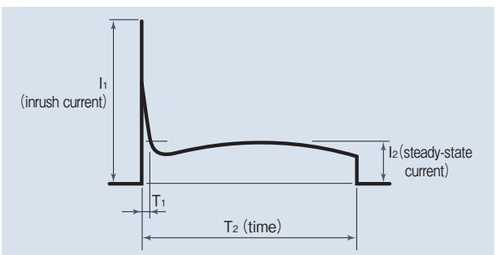


Fig. 102 Motor operation current waveform.

■ Operation/Control Voltage (Current)

Table 28 Burden VA of closing coil and electrifying time for AC operation.

Control voltage (V) / Type	100/110AC	
	Burdern (VA)	Time (s)
3/6-VPR-D	350	0.05
Model name other than above	680	0.05

Table 29 Motor burden VA and drive time for AC operation.

Control voltage (V) / Type	100/110AC	
	Burdern (VA)	Time (s)
3/6-VPR-D	120	8
Model name other than above	180	6

11 Technical Information (2)

Table 30 Table of auxiliary switch ratings.

Ratings and specifications \ Type				10/15-VPR-25D/32D/40D 10-VPR-50C(D) 20-VPR-25D 2500A
Rated insulation voltage (V)				250 AC/DC
Standard contact	Rated working voltage (V)			220 AC/DC
	Rated operational current (A)	AC	100~125V AC	5 (power factor 0.3~0.4)
			200~220V AC	4 (power factor 0.3~0.4)
		DC	24~55V DC	6 (time constant 40ms)
			100~110V DC	3 (time constant 40ms)
			200~220V DC	1 (time constant 40ms)
	Minimum operational current (mA)	AC/DC	100V AC / V DC	30
			24V AC / V DC	50
	Rated continuous current (A)			5
For micro current	Rated operational voltage (V)			125 AC/DC
	Rated operational current (mA)	AC ratings	100~125V AC	1~500
		DC ratings	24~125V DC	1~500
	Rated continuous current (A)			0.5

Table 31 Table of auxiliary switch ratings.

Ratings and specifications \ Type				3/6-VPR-D 20-VPR-16D/25D (630~2000A) 10-VPR-25D(M)
Rated insulation voltage (V)				250 AC/DC
Standard contact	Rated working voltage (V)			220 AC/DC
	Rated operational current (A)	AC	100~125V AC	5 (power factor 0.3~0.4)
			200~220V AC	5 (power factor 0.3~0.4)
		DC	24~55V DC	5 (time constant 40ms)
			100~110V DC	1 (time constant 40ms)
			200~220V DC	0.5 (time constant 40ms)
	Minimum operational current (mA)	AC/DC	100V AC / V DC	30
			24V AC / V DC	50
	Rated continuous current (A)			5
For micro current	Rated operational voltage (V)			220 AC/DC
	Rated operational current (mA)	AC ratings	100~125V AC	1~200
		DC ratings	24~125V DC	1~200
	Rated continuous current (A)			2

Classification as for Mechanical Endurance (M1 and M2)

The IEC standards broadly divide the mechanical operating test into classes M1 and M2. At the control voltages shown in Fig.103, class M1 requires the rated operation sequence to be performed 2000 times in total while class M2 requires the rated operation sequence to be performed 10000 times in total. At five times the actuating cycle of class M1, class M2 represents a highly reliable operation class.

Table 32 M1 and M2 operating sequence.

Sequence	Control voltage	Actuating cycle	
		M1	M2
C-O	85%	500	2500
C-O	100%	500	2500
C-O	110%	500	2500
O-C-O	100%	250	1250

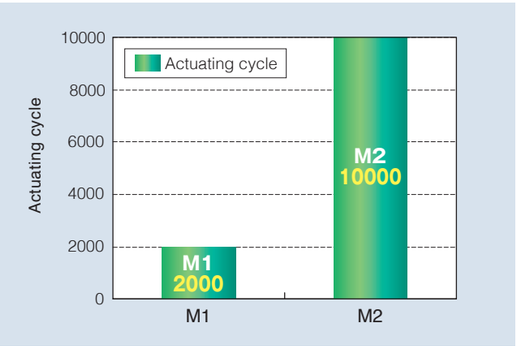


Fig.103

Classification as for Electrical Endurance (E1 and E2)

Electrical endurance test that is specified in the IEC standards is broadly divided into classes E1 and E2.
Class E2 has a longer breaking times than class E1, and is a highly reliable class due to huge energy arcs.

Table 33 E1 and E2 operating sequence.

Testing current (percentage of rated short-circuit breaking current)	Operating sequence	Number of operating sequence	
		E1	E2(※)
10%	O-CO-CO	1	1
30%	O-CO-CO	1	1
60%	O	—	15
	O-CO-CO	1	15
100% (symmetry)	O-CO-CO	1	2
100% (asymmetry)	O-O-O	1	—

※ Class E2 contains the number of breaking test of class E1.

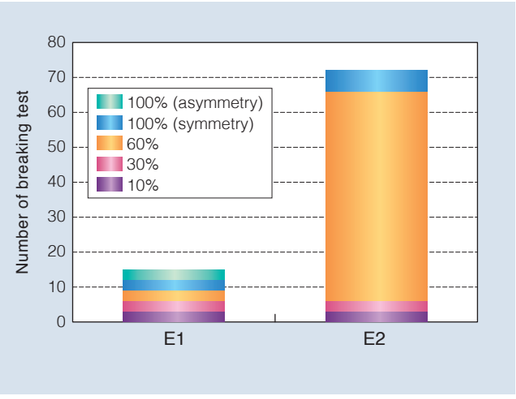


Fig.104

Probability of Restrike during Capacitive Current Switching (C1 and C2)

Performance in capacitive current swiching test is broadly divided into classes C1 and C2; class C2 is highly reliable.

Class C1: Low probability of arc restrike at the time of capacitive current switching test (2 restrikes are allowed during O 24 operations and CO 24 operations).
Class C2: Very low probability of arc restrike at the time of capacitive current switching test (Restrikes is not allowed during O 24 operations and CO 24 operations).

*Arc restrike is the phenomenon that occurs when current flows later than a 1/4 of a cycle after zero when there are insufficiencies in the VCB arc extinction or in insulation stress between VCB poles for recovery voltage.

12 Applicable Standards (1)

■ Operating Environment and Application

● Operating Environment

VPR series are designed and manufactured as an indoor unit and comply with JEC-2300 (AC circuit breakers) and IEC 62271-100. Accordingly, these VCBs require a normal service conditions specified in Table 34. Furthermore, sufficient maintenance and inspections must be performed in accordance with the VCB instruction manual. Please consult the manufacturer regarding operation of VCBs under special conditions.

● Caution for Installation Site and Surrounding Environment

The VCB service conditions must comply with the specifications shown in Table 34. Do not use the VCBs in environments that do not meet these conditions. For use in outdoor panels and special environments where there is excessive dust, corrosive gas, water/condensation or abnormal vibration/shock, be sure to take appropriate countermeasures. Non-adherence to these cautions may result in damage to the products or degraded performance in areas such as switching, current carrying capacity and insulation.

Table 34 Normal service conditions.

1	Ambient temperature	-5℃ - 40℃ (The average temperature for 24 hours must not exceed 35℃.)
2	Influence of solar radiation	There must be no influence of solar radiation.
3	Altitude	1,000m or lower
4	Powder dust	There must be no excessive powder dust. (As a guideline, the powder dust should be 2mg/m^3 or less.)
5	Humidity	Relative humidity: 45 – 85% (There must be no dew condensation.)
6	Vibration	There must be no excessive vibration.
7	Degree of pollution	There must be no pollution. (As a guideline, the equivalent salt deposit density should be less than 0.01mg/cm^2.)
8	Poisonous gas	There must be no corrosive gas.

■ Application of Surge Protection Device

Table 35 outlines surge protection standards for the load circuit. Please use this table as a reference when selecting VCB types for actual applications.

● Surge Protection Standards

Table 35

Type \ Load device	Generator	Motor	Dry transformer	Oil transformer	Mitsubishi Electric molded transformer	Phase-advanced capacitor
3/6-VPR-D (General purpose product)	CR suppressor used		General purpose *1 arrester used	Not required *1,4	Not required *2,4	Not required
3/6-VPR-D (Low-surge product)	Not required *4					
Other than the above	CR suppressor used		General purpose *1 arrester used	Not required *1	General-purpose *2 arrester used	Not required

*1: To directly switch the semiconductor rectifier unit (for example, a electric power thyristor rectifier unit) to the secondary side of a transformer, use a transformer with a contact-protective plate. Use a general-purpose arrester on the primary side and the surge protective device (such as a filter capacitor) on the secondary side.
*2: Avoid interrupting the no-load excitation inrush current of a molded transformer oil transformer. When such current must be interrupted, use a general-purpose arrester. Before using any oil transformer or molded transformer made by other manufacturers, consult the manufacturer.
*3: For motors in applications where inching operation is frequently performed and inching is the predominant switching duty (cranes, conveyors, etc.), use a CR suppressor.
*4: Mitsubishi molded transformer and oil transformer are for 6kV with the impulse withstand voltage 60kV and for 3kV with the impulse withstand voltage 45kV.

● Surge Voltage for Breaking Current

Surge voltage at the time of interrupting current generally includes the current chopping surge when interrupting an inductive small current. If small current is interrupted by a switch that is superior in arc extinction capacity like the vacuum circuit breaker, the arc suddenly dissipates before forcing the current to zero and then interrupts current. This is called the current chopping phenomenon, and a high surge voltage may be generated if the phenomenon occurs at the time of inductive small current breaking.
It is possible to calculate the current chopping surge voltage by the following general equations.

Circuit conditions	Surge voltage equation
(1) Without reverse voltage (inching switching of transformer circuit/motor)	$Es = \sqrt{E^2 + (\eta \times \sqrt{Lm/Cm} \times Ic)^2}$
(2) With reverse voltage (motor switching of the constant - velocity drive)	$Es = E + \eta \times \sqrt{Lm/Cm} \times Ic$

Es : Surge voltage (peak value)
E : Power voltage to ground (peak value)
η : Attenuation coefficient (for transformer: approx. 0.65, for motor: 0.85)
$\sqrt{Lm/Cm}$: Surge impedance
Lm : Inductance of load circuit including a transformer or motor
Cm : Earth capacity of load circuit including a transformer or motor
Ic : Chopping current

● Application to the Capacitor Circuit

Although a capacitor circuit can be used, please exercise caution in regard to the following:

Before re-closing the capacitor, make sure the capacitor is fully discharged to prevent the risk of overvoltage being generated.

● Application to the Different System Butt Welding Circuit (Excluding 20-VPR-D 630/1250A)

Application to different-system circuits
Application to different-system circuits is possible. In this case, it is necessary to shorten the maintenance, inspection and cleaning cycle because the voltage added between VCB poles will be higher than under normal conditions. A more frequent maintenance and inspection cycle is especially important in environments where there is pollution or high humidity.

● Caution for Korndorfer Start Circuit

For a korndorfer start, a neutral point release of the auto-transformer should be conducted after the start current is completely diminished.
Alternatively, for an auto-transformer that is used as a starting compensator, please use a korndorfer system startup transformer specified in "power transformer (JEC-2201)."

● Application to Electric Furnace Circuit (Excluding 10-VPR-50C(D), 20-VPR-D)

High frequency switching of the circuit breaker for an electric furnace increases the possibility of generating a switching surge, and when a filter capacitor is connected there is a risk of generating high overvoltage. In addition to adopting a surge protection device, please use a circuit breaker with a high withholding voltage or select a circuit breaker with a rated voltage in one of the top classes.

For a motor direct switch (with line and reduced voltage starting)

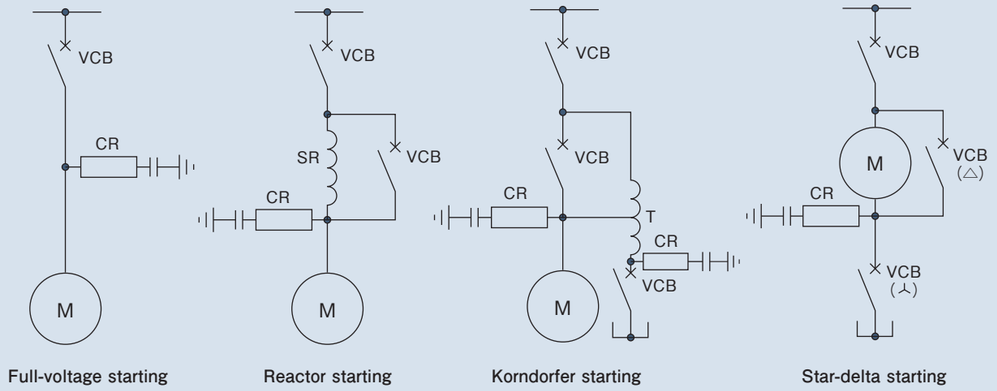


Fig. 105-1 Application example of a surge protection device (for general-purpose vacuum circuit breakers).

12 Applicable Standards (2)

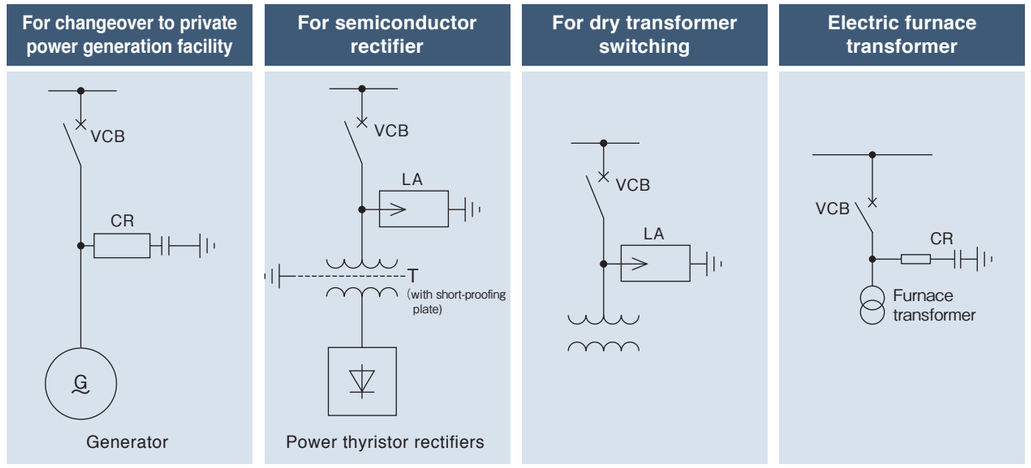


Fig. 105-2

Service Life and Applications

The service life of VCBs is specified in terms of the vacuum service life of VI, as well as the electrical and the mechanical service lives.

●Vacuum Service Life of VI

The high vacuum of the VI in the VCB ensures interrupting and insulation characteristics. It is very important that this vacuum be maintained.
Our VIs are manufactured on our advanced production line and provide safe, long term use guaranteed by our original method of service life testing and control. Vacuums can be inspected simply as part of regular inspections via the withstand voltage method or through use of portable vacuum checkers.

●Electrical Service Life of VI (see Table 36)

The electrical service life of a VI is determined by the electrode consumption and the number of switchings. For VPR-D, the service life can be determined by the number of load switchings, because the electrode consumption is extremely small. Therefore, it is not required to measure the electrode consumption (wipe) at the time of maintenance and inspection.

●Mechanical Service Life

This can be determined by the operation counter provided in the VCB (provided in all types as standard specification).

●Replace When Service Life Expires

The estimated service life is 20 years when used under normal environmental conditions. When the VCB reaches the end of its mechanical service life or its specified operation count, it is necessary to replace the VCB.

Table 36 Switching service lives.

Items / Type	Load switching service life (times)	Mechanical switching service life (times)
VPR series	10000	10000

*1: Values shown in the table above are based on the continuous switching test and apply to the short term; they are not guaranteed in the long term. To ensure optimum performance, please follow the maintenance and inspection procedures described in the instruction manual.

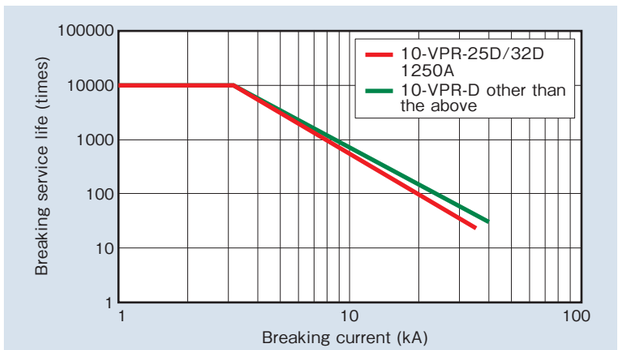


Fig. 106 Breaking service life criterion for breaking current.(10-VPR-D)

Table 37 Capacitor load applicable capacities.

Items / Type	Maximum switching capacity (kVar)	Multiple switching capacity (kVar)
3-VPR-20D/25D	2500	1500
6-VPR-20D/25D	5000	3000
10/15-VPR-D	7000	4000
20-VPR-16D	12000	6000
20-VPR-25D	17000	8500

*1: Electrical service life for the max. switching capacity is approx 2000 times; multiple switching capacity is 10000 times.
*2: Applicable capacities with 6-13% series-connected reactor.

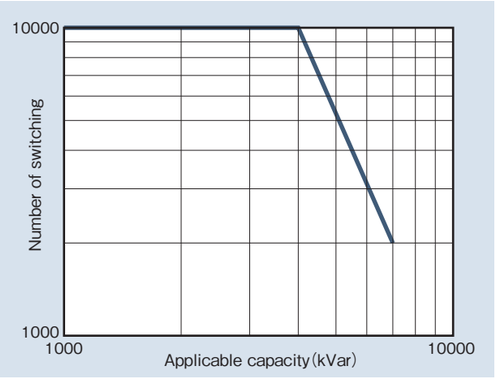


Fig. 107 Guidelines on the switching times for applicable capacity (for 12, 15kV).

Table 38 Maximum applicable capacity.

Items / Type	Three-phase induction motor										Distribution transformer (kVA)				
	Full-load current (A)*1					Motor output (kW)*2									
	3.3kV	6.6kV	11kV	13.8kV	22kV	3.3kV	6.6kV	11kV	13.8kV	22kV	3.3kV	6.6kV	11kV	13.8kV	22kV
3/6-VPR-20D/25D(630A)	630		–			2450	4900	–			3500	7000	–		
3/6-VPR-20D/25D(1250A)	1250		–			4900	9800	–			7000	14000	–		
10-VPR-25D(M) (600/630A))	630		–			–	–	–	–		7000	14000	23000	–	
10-VPR-25D(M) (1200/1250A)	1250		–			–	–	–	–		7000	14000	23000	–	
10/15-VPR-D(600/630A, 1200/1250A)	1250				–	4900	9800	16100	20300	–	7000	14000	23000	29000	–
10/15-VPR-D(1600A, 2000A)	2000				–	7700	15400	26600	32900	–	11000	22000	38000	47000	–
10/15-VPR-D(3000/3150A)	3150				–	12600	25200	42000	52500	–	18000	36000	60000	75000	–
10-VPR-50C(D)	–	4000		–		–		53200	–		–		76000	–	
20-VPR-16D/25D(600/630A)	–				630	–				16800	–				24000
20-VPR-16D/25D(1200/1250A)	–				1250	–				32900	–				47000
20-VPR-25D(2000A)	–				2000	–				53200	–				76000
20-VPR-25D(2500A)	–				2500	–				66500	–				95000

*1 Maximum applicable full-load current (A) is for a single breaker.
*2 Motor output (kW) is: calculated by power factor × efficiency=0.7.

Polarity in Connecting to Main Circuit

It is unnecessary to classify the polarity in the power/load sides when connecting the main circuit of the VCB.
(Electrical or mechanical performance is not changed regardless of whether it is connected to the power side of load side.)

■Calorific Value

The contact resistance and calorific value of each rated current are shown. Use this as a reference when selecting models.

Table 39 Contact resistance and calorific value of each rated current.

Items / Type	Rated current (A)	Contact resistance Rc(μΩ) between ① and ②*1	Calorific value (W) / three phases
3/6-VPR-20D/25D	630	82	99
	1250	60	328
3/6-VPR-20DG/25DG	630	88	105
	1250	73	342
10-VPR-25D(M)	600/630	106	126
	1200/1250	79	370
10-VPR-25D/32D	600/630 1200/1250	72	338*2
15-VPR-32D 10/15-VPR-40D	600/630 1200/1250	63	296*2
10/15-VPR-D	1600/2000	42	504
10-VPR-D	3000/3150	24	715
20-VPR-16D	600/630	88	105
20-VPR-25D	600/630	99	118
20-VPR-16D	1200/1250	65	305
20-VPR-25D	1200/1250	62	291
20-VPR-25D	2000	39	468
20-VPR-25D	2500	38	600
10-VPR-50C(D)	4000	33	1584

*1: Measured value using the direct current voltage potential drop method.
*2: Value at the time of applying a 1250A electrical current.

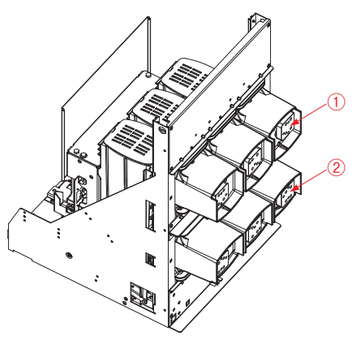


Fig. 108

12 Applicable Standards (3)

■ Lifting the VCB

Lift the VCB using the mounting holes as shown below.

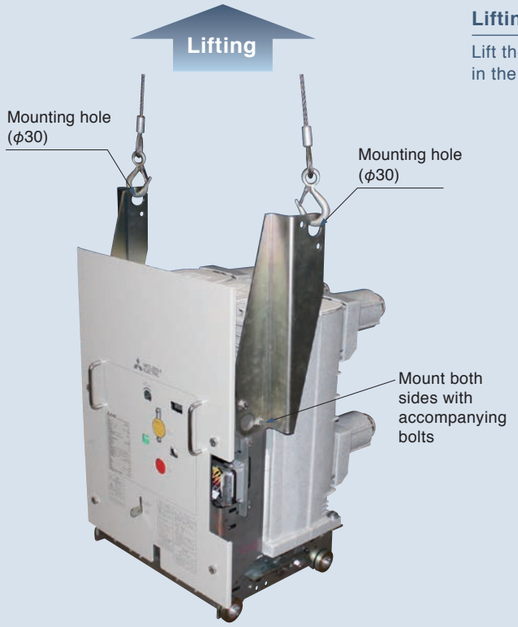


Fig. 109

Lifting the mounting frame

Lift the mounting frame using the mounting holes as shown in the figure below.

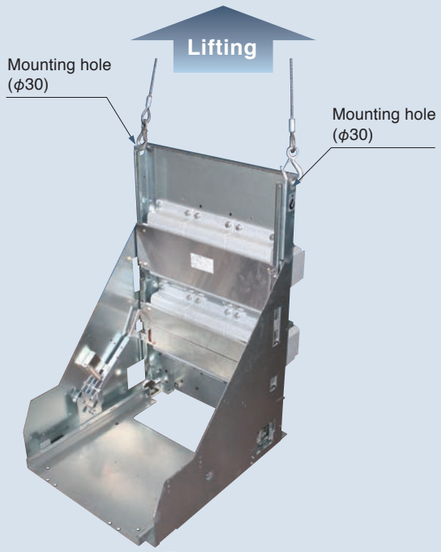


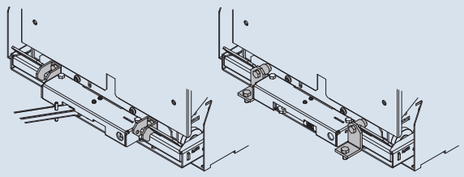
Fig. 110

Do not lift VCBs while they are inserted in the mounting frame. When lifting the VCB or mounting frame, please refer to the instruction manual and follow the specific conditions provided.

■ Shipping Clamps (10-VPR-D)

When a switchgear is supplied with the mounting frame and VCB (in test position), it is necessary to mount the frame and VCB on the switchgear. Follow the directions in the instruction manual and the accessories section of this catalog (page 38) to mount the devices using screws (M10) in the positions shown in the figure.

● For withdrawable with door closed (type-M)



For 600-2000A For 2500A, 3000/3150A

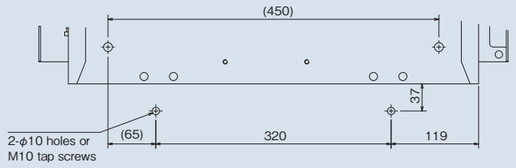
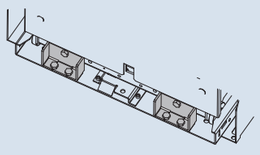


Fig. 111 Mounting hole positions on the panel side (type-M【2500A, 3000/3150A】)

● For withdrawable with door open (types C,D and G)



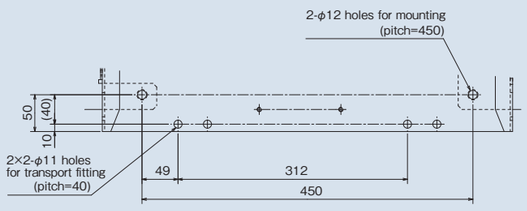


Fig. 112 Mounting hole positions on the panel side (types C, D and G)

■ Altitude

When using the VCB in altitudes over 1,000m above sea level, the insulation withstand level is reduced due to differences from the standard ambient conditions.
To make corrections for altitude, please confirm and apply the insulation withstand levels for higher altitudes as listed in IEC 62271-1-2011.

For installations at an altitude 2500 m, if VCB is required with BIL 75kV, VCB with BIL 95kV should be used in accordance with Figure 113. “75 multiplied by 1.2 is 90.”

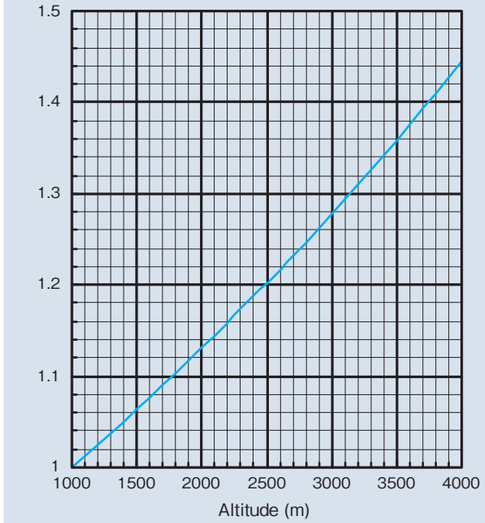


Fig. 113

■ Recommendations for VCB Maintenance

1.Standards for the replacement of parts

Replace parts according to the following schedule (applies to all types) to ensure reliable operation for the full term of the service life (20 years).

Table 40 Standards for the replacement of parts.

Part		Replacement standard		Reason for replacement
		Actuating cycle	Usage period	
Dumper		5000	6 years	Degradation over time
Auxiliary switch		5000	10-15 years	Preventive maintenance
Motor		5000		
Limit switch		5000		
VI	Switching service life of the rated short-circuit breaking current	10 times*1	—	Electrical service life
	Insulation performance	When defects occur in vacuum and withstand voltage		Degradation

*1: 10-VPR-D is 30 times.

2.Types of inspections

Table 41 Maintenance and inspection cycle.

Maintenance and inspection classification	Maintenance and inspection cycle	
	Normal environment	Substandard environment (especially dew condensation, salt and powder dust)
Patrol inspection	6 months	1 month
Periodic inspection	First time: 1-2 years Second time and later: 3 years	1-2 years
Detailed inspection	6 years	2-4 years
Special inspection	Maintenance and inspection cycle	

*1: Please replace a VCB when the number of switching operations reaches 10000 times.
*2: Please consider replacing the product after 20 years of use under normal environmental conditions.

3.VCB Replacement Condition

VCBs are recommended for replacement when any of the following conditions are true:

1 .Twenty years have passed since manufacture.
2 .Switching service life has expired (see page 61).
3. Abnormalities are identified in the inspection described in Table 41 and there is no chance of restoring the abnormalities through repair of parts.

*Make sure to refer to the instruction manual before inspection.

13 Ordering Information (1)

Standard Table 42 3/6-VPR-20/25D

①	②	③④⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰	⑱	⑲
		VPR			D		I									

Specifications	Rated voltage	Type	Rated short-circuit Breaking current	Series name	Classification	Standards	Mounting configuration	Rated current	Closing operation /control voltage	Tripping control voltage	Position switch	Secondary connector	Auxiliary switch	Closing spring charge indication switch
Codes and descriptions	03 3.6kV	VPR	20 20kA	D	– Standard	I IEC 62271-100(2008)	C Withdrawable with dooe open (type-C) and class CW	06 630A	1 100~125 VAC/VDC	1 100~125 VDC	0 ×	A CodeA (Without interlock)	0 Standard (5a5b)	0 ×
	06 7.2kV		25 25kA		G Low surge		D Withdrawable with dooe open (type-D) and class PW	12 1250A	2 200/220 VAC/VDC	2 200/220 VDC	1 1unit (Connected position 1C+ Test position 1C)	B CodeB (With interlock)	S For microcurrent (Standard 3a3b contact For microcurrent 2a2b contact)	1 With 1C
							L Fixed (type-L)		7 24VDC	7 24VDC	2 2 unit (Connected position 2C+ Test position 2C)			
									8 48VDC	8 48VDC				

Caution: • When the tripping power is AC and the capacitor tripping decive (CTD) is selected, select 100-125V for the tripping contol voltage ⑮.
• The application standard of 3/6-VPR-20D/25D is only IEC.

Standard Table 43 10-VPR-25D(M)

①	②	③④⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫⑬	⑭	⑮	⑯	⑰	⑱	⑲	⑳	㉑
1	0	VPR	2	5	D	M											

Specifications	Rated voltage	Type	Rated short-circuit Breaking current	Series name	Classification	Standards	Mounting configuration	Rated current	Closing operation /control voltage	Tripping control voltage	Position switch	Secondary connector	Auxiliary switch	Closing spring charge indication switch	Mounting frame	Optional accessories
Codes and descriptions	10 12kV	VPR	25 25kA	D	M Class E1	J JEC 2300 (2010)	C Withdrawable with dooe open (type-C) and class CW	06 600/630A	1 100~125 VAC/VDC	1 100~125 VDC	0 ×	A CodeA (Without interlock)	0 Standard (5a5b)	0 ×	0 With mounting frame	0 ×
						I IEC 62271-100(2012)	D Withdrawable with dooe open (type-D) and class PW	12 1200/1250A	2 200/220 VAC/VDC	2 200/220 VDC	1 1unit (Connected position 1C+ Test position 1C)	B CodeB (With interlock)	S For microcurrent (Standard 3a3b contact For microcurrent 2a2b contact)	1 With 1C	X Without mounting frame	A With optional accessories
							G Withdrawable with dooe open (type-G) and class MW		7 24VDC	7 24VDC	2 2 unit (Connected position 2C+ Test position 2C)					
									8 48VDC	8 48VDC						

Optional Accessories Table 44 10-VPR-25D(M) (special specifications)

□	□	□	□	□	□

Specifications	Draw-out mechanism padlock device (P)	Padlock device for close and trip button (B)	Capacitor tripping device (1), (2)	Earthing switch (Class E2) (1), (2)	Optional terminal (V:Vertical, H:Horizontal)	Shutter padlock device (S)
Codes and descriptions	P	B	1	E With electrical interlock	V	S
			2	F Without electrical interlock	H	

Caution: • When selectiong BIL95 k V, withdrawable with door closed (type-M), Fixed(type-L), mechanical locking device, tripping coil disconnection monitoring, additional auxiliary switch(additional 5a5b), additional shunt tripping coil snd short-circuit capacity earthing, select 10-VPR-D.

Example for Order No.

10VPR25DMID12110B0000 (without optional accessores)

10VPR25DMID12110B000APB (with mechanical locking device and padlock device for close and trip button)

13 Ordering Information (2)

Standard Table 45 10/15-VPR-D

①	②	③④⑤	⑥⑦	⑧	⑨	⑩	⑪	⑫⑬	⑭	⑮	⑯	⑰	⑱	⑲	⑳	㉑
□	□	VPR	□	□	D	□	□	□	□	□	□	□	□	□	□	□

Specifications / Codes and descriptions	Rated voltage	Type	Rated short-circuit Breaking current	Series name	Classification	Standards	Mounting configuration	Rated current	Closing operation /control voltage	Tripping control voltage	Position switch	Secondary connector	Auxiliary switch	Closing spring charge indication switch	Mounting frame	Optional accessories
	10		25		1	J	M	06	1	1	0	A	0	0	0	0
	12kV	VPR	25kA	D	Class E1	JEC 2300(2010)	Withdrawable with door closed (type-M) and class MW	600A/630A	100~125 VAC/VDC	100~125 VDC	×	CodeA (Without interlock)	Standard (5a5b)	×	With mounting frame	×
	15		32		2	I	C	12	2	2	1	B	S	1	X	A
	15kV (Except for the fixed (type-L))		31.5kA		Class E2	IEC 62271-100(2012)	Withdrawable with door opened (type-C) and class CW	1200/1250A	200/220 VAC/VDC	200/220 VDC	1unit (Connected position 2C+ Test position 2C)	CodeB (Without interlock)	For micrcurrent (Standard 3a3b contact For microcurrent 2a2b contact)	With 1C	Without mounting frame	With Optional accessories
			40		3		D	16	7	7	2					
			40kA		Class E1 BIL95kV (12kV)		Withdrawable with door opened (type-D) and class PW	1600A	24VDC	24VDC	1unit (Connected position 4C+ Test position 2C)					
					4		G	20	8	8						
					Class E1 BIL95kV (12kV)		Withdrawable with door opened (type-G) and class MW	2000A	48VDC	48VDC						
							L	25	1 1 is standard. 2 7 8 2, 7 and 8 will be manufactured upon receipt of order							
							Fixed (type-L) (Except for 15kV)	2500A (Except for 15kV)								
								30								
								3000A/3150A (except for 15kV)								

Caution: • Rated short-circuit breaking current of 40kA with E2 class cannot be manufactured.
• Withdrawable with door closed (type-M) is not compatible with mounting configuration class CW.
• Fixed (type-L) is not compatible with the rated voltage 15kV, BIL95kV, and code B.
• When selecting withdrawable (type-M), additional auxiliary switch and additional shunt tripping coil the control circuit plug configuration of code B should be applied.
• When selecting JEC 2300-2010 for standard, select class E1 for classification ⑨

Optional Accessories Table 46 Code description chart (special specifications)

	□	□	□	□	□	□	□	□	□	□	□
Specifications	Mechanical locking device (K)	Tripping coil disconnection monitoring (T)	Additional auxiliary switch (additional 5a5b) (A)	Additional shunt tripping coil (D)	Draw-out mechanism padlock device (P)	padlock device for close and trip button (B)	Capacitor tripping device (1), (2)	Earthing switch (Class E2) (E), (F)	Short-circuit capacity earthing (J)	Optional terminal (V: Vertical, H: Horizontal)	Shutter padlock device (S)
Codes and descriptions	K	T	A	D	P	B	1 For 100/110V AC	E With electrical interlock	J	V	S
							2 For 200/220V AC	F Without electrical interlock		H	

Caution: • Mechanical locking device (K) and draw-out mechanism padlock device (P) should not be used together.
• Earthing switches are not compatible with type-C in the mounting configuration.
• When the tripping power is AC and the capacitor tripping device (CTD) is selected, select 100 - 125V for the tripping control voltage⑮.
• When selecting an additional auxiliary switch and additional shunt tripping coil, it will be compatible only for control circuit plug: code B.
• The tripping coil disconnection monitoring and the capacitor tripping device should not be used together.
• The fixed (type-L) is not compatible with earthing switches, short-circuit capacity earthing, optional terminals or shutter padlock device.

Example for Order No.

10VPR40D1ID12110B0000 (without optional accessories)

10VPR40D1ID12110B000AKD (with mechanical locking device and additional shunt tripping coil)

To order any of the products below (sold separately), please contact a local service representative.

☐ Lifter ☐ CR suppressor ☐ Vacuum checker

Standard Table 47 10-VPR50C(D)

①	②	③④⑤	⑥⑦	⑧	⑨	⑩	⑪	⑫⑬	⑭	⑮	⑯	⑰	⑱	⑲
1	0	VPR	5	0C(D)	–	□	□	4	0	□	□	□	□	□	□

Specifications / Codes and descriptions	Rated voltage	Type	Rated short-circuit Breaking current	Series name	Classification	Standards	Mounting configuration	Rated current	Closing operation /control voltage	Tripping control voltage	Position switch	Secondary connector	Auxiliary switch	Closing spring charge indication switch
	10		50		–	J	C	40	1	1	0	A	0	0
	12kV	VPR	50kA	C(D)	Standard	JEC 2300(1998)	Withdrawable with door opened (type-C) and class CW	4000A	100~125 VAC/VDC	100~125 VDC	×	CodeA (Without interlock)	Standard (10a10b)	×
						I	D		2	2	1	B	S	1
						IEC 62271-100(2003)	Withdrawable with door opened (type-D) and class PW		200/220 VAC/VDC	200/220 VDC	1unit (Connected position 2C)	CodeB (With interlock)	For micrcurrent (Standard 8a8b contact For microcurrent 2a2b contact)	With 1C
							G				2			
							Withdrawable with door opened (type-G) and class MW				2unit (Connected position 4C)			

Caution: • When the tripping power is AC and the capacitor tripping decive (CTD) is selected, select 100-125V for the tripping contol voltage ⑮.

13 Ordering Information (3)

Standard Table 48 20-VPR-D

①	②	③④⑤	⑥⑦	⑧	⑨	⑩	⑪	⑫⑬	⑭	⑮	⑯	⑰	⑱	⑲	⑳	㉑
2	0	VPR	□	□	D	1	I	□	□	□	□	□	□	□	□	□

	Rated voltage	Type	Rated short-circuit Breaking current	Series name	Classification	Standards	Mounting configuration	Rated current	Closing operation /control voltage	Tripping control voltage	Position switch	Secondary connector	Auxiliary switch	Closing spring charge indication switch	Mounting frame	Optional accessories
Specifications																
Codes and descriptions	20 24kV	VPR	16 16kA (Except for 2000A rated current)	D	1 (Class E1 (New optional functions))	I IEC 62271-100	M Withdrawable with door closed (type-M) and class MW	06 630A	1 100~125 VAC/VDC	1 100~125 VDC	0 ×	A CodeA (Without interlock)	0 Standard (5a5b)	0 ×	0 With mounting frame	0 ×
			25 25kA				C Withdrawable with door open (type-C) and class CW	12 1250A	2 200/220 VAC/VDC	2 200/220 VDC	1 1unit (Connected position 2C)	B CodeB With interlock	S For micrcurrent (Standard 3a3b contact For microcurrent 2a2b contact	1 With 1C	X Without mounting frame	A With Optional accessories
							D Withdrawable with door open (type-D) and class PW	20 2000A (Except for 16kA)	7 24VDC	7 24VDC	2 2unit (Connected position 4C)					
							G Withdrawable with door open (type-G) and class MW		8 48VDC	8 48VDC						
									1 1 is standard. 2 7 8 2, 7 and 8 will be manufactured upon receipt of order							

Caution: • Withdrawable with door closed (type-M) is not available with mounting configuration class CW.
- In the case of position switch code 1, withdrawable with door open (types-C,D and G) is connected position 2C.
- In the case of position switch code 1, withdrawable with door closed (type-M) is connected position 2C + test position 2C.
- In the case of position switch code 2, withdrawable with door open (types-C,D and G) is connected position 4C.
- Withdrawable with door closed (type-M) is not available with position switch code 2.
- Rated currents of 630A and 1250A are IEC62271-100 (2012).
- Rated current of 2000A is IEC62271-100 (2017).

Optional Accessories Table 49 20-VPR-D

	□	□	□	□	□	□
Specifications	Tripping coil disconnection monitoring (T)	Draw-out mechanism padlock device (P)	padlock device for close and trip button (B)	Capacitor tripping device (1), (2)	Earthing switch (Class E2) (E), (F)	Optional terminal (V)
Codes and descriptions	T	P	B	1 For 100/110V AC	E With electrical interlock	V Terminal for vertical connecting
				2 For 200/220V AC	F Without electrical interlock	

Caution: • Earthing switches are not available with type-C in the mounting configuration.
- When the tripping power is AC and the capacitor tripping device (CTD) is selected, select 100 - 125V for the tripping control voltage⑮.
- The tripping coil disconnection monitoring and the capacitor tripping device should not be used together.
- Withdrawable with door closed (type-M) is not available with Draw-out mechanism padlock device.
- Code V is not available with types-C,D.(Types-C,D are equipped.)

Example for Order No.

20VPR25D1ID12110B0000 (without optional accessories)

20VPR25D1ID12110B000APE
(With Draw-out mechanism padlock device and Earthimg switch with electrical interlock)

Standard Table 50 20-VPR-D Fixed (type-L)

①	②	③④⑤	⑥⑦	⑧	⑨	⑩	⑪	⑫⑬	⑭	⑮	⑯	⑰	⑱	⑲
2	0	VPR	□	□	D	–	□	L	□	□	□	0	A	□	□

	Rated voltage	Type	Rated short-circuit Breaking current	Series name	Classification	Standards	Mounting configuration	Rated current	Closing operation /control voltage	Tripping control voltage	Position switch	Secondary connector	Auxiliary switch	Closing spring charge indication switch
Specifications														
Codes and descriptions	20 24kV	VPR	16 16kA	D	– Standard	J JEC 2300(1998)	L Fixed (type-L)	06 600A/630A	1 100~125 VAC/VDC	1 100~125 VDC	0 ×	A CodeA (Without interlock)	0 Standard (5a5b)	0 ×
			25 25kA			I IEC 60056		12 1200A/1250A	2 200/220 VAC/VDC	2 200/220 VDC			S For micrcurrent (Standard 3a3b contact For microcurrent 2a2b contact	1 With 1C
									7 24VDC	7 24VDC				
									8 48VDC	8 48VDC				

Caution: • When the tripping power is AC and the capacitor tripping decive (CTD) is selected, select 100-125V for the tripping contol voltage ⑮.

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①	②	③④⑤	⑥⑦	⑧	⑨	⑩	⑪	⑫⑬	⑭	⑮	⑯	⑰	⑱	⑲
2	0	VPR	2	5	D	–	□	□	2	5	□	□	□	□	□	□

	Rated voltage	Type	Rated short-circuit Breaking current	Series name	Classification	Standards	Mounting configuration	Rated current	Closing operation /control voltage	Tripping control voltage	Position switch	Secondary connector	Auxiliary switch	Closing spring charge indication switch
Specifications														
Codes and descriptions	20 24kV	VPR	25 25kA	D	– Standard	J JEC 2300(1998)	C Withdrawable with door open (type-C) and class CW	25 2500A	1 100~125 VAC/VDC	1 100~125 VDC	0 ×	A CodeA (Without interlock)	0 Standard (5a5b)	0 ×
						I IEC 62271-100	D Withdrawable with door open (type-D) and class PW		2 200/220 VAC/VDC	2 200/220 VDC	1 1unit (Connected position 2C)	B CodeB With interlock	S For micrcurrent (Standard 3a3b contact For microcurrent 2a2b contact	1 With 1C
									7 24VDC	7 24VDC	2 2unit (Connected position 4C)			
									8 48VDC	8 48VDC				

Caution: • When the tripping power is AC and the capacitor tripping decive (CTD) is selected, select 100-125V for the tripping contol voltage ⑮.