for a greener tomorrow

MITSUBISHI ELECTRIC
Changes for the Better

VACUUM CIRCUIT BREAKER (RETROFIT)

Retrofit VCBs for Replacement of Existing GCB (10-SFG-40)

10-VPR-40D (GV)

Safety & Quality

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.

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Recommendation to replace the existing GCBs*1 with new VCBs*2 in order to ensure the safe and reliable operation of your switchgear.

*1 GCB : Gas Circuit Breaker
*2 VCB : Vacuum Circuit Breaker

GV General Background of Replacement

Use of the aged equipment can increase the incidence of accidents, and jeopardize the reliable operation failure of the system.

Problems caused by aging equipment	Reasons for replacement	Effects of upgrade
• Increase in the number of accidents • Increase in maintenance work • Increase of damage due to power failure	• Deterioration • Increase in maintenance cost • No spare parts is available	• Improvement in reliability of power supply • Saving of running cost and maintenance work and duration

Solution for the aging GCB

Major trouble for GCB
Depletion of grease for piston rod

Other trouble
Increase of contact resistance
Wear of the contacts

Impossible to re-apply the grease at site.
Many parts need to replace.

Recommendation : Replacement to VCB from GCB

Features of VCB compared with GCB

Simple mechanism	1 Outstanding reliability
Low maintenance	2 Saving running cost
SF_6 gas free	3 Environmental friendly
Complete interchangeability	4 Saving replacement work

GV Features of Retrofit VCB

1 Outstanding reliability

- The highly reliable operating mechanism is incorporated in the Retrofit VCB. This operating mechanism is used in Mitsubishi's latest VCBs.
- Self-cooling VCBs that do not require a fan to be mounted on the panel. Available in a wide range, from rated current of 1,250 to 3,150A.
- Compliant with IEC 62271-100-2012 and has passed type tests for classes M2, E1 and C2, which represent the highest levels of quality.

2 Saving running cost

- By application of VCB, no need to treat the SF_6 gas and to carry out the overhaul with dismantle work for inspection and cleaning inside of the tank.
- 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.

3 Environmental friendly

- No use of SF_6 gas of having high global warming potential.
- 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.

4 Saving replacement work

- Interface with the existing panel between GCB and Retrofit VCB is same.
- No modification is required. ⇒No need long shutdown.

GV Ratings

Table 1 List of Ratings (IEC Standards)

Type		10-VPR-40D (GV)			
CR suppressor[*1]	for sub code name C,L[*2]	mounted	none		
	for sub code name S[*2]	none			
Closing operating mechanism		Motor-spring charged mechanism			
Standards[*3]		IEC62271-100-2012			
Rated voltage (kV)		12			
Rated normal current (A)		1,250	1,250	2,000	3,150
	In the case of ambient temperature 50℃	1,000	1,000	1,600	2,700
Rated frequency (Hz)		50/60			
Rated short-circuit breaking current (kA)		40			
Rated short-circuit Making current (kA) (Peak)		104			
Rated short-time withstand current (kA)		40 (3s)			
Rated opening time (s)		0.03			
Rated breaking time (cycles)		3			
Rated withstand voltage (kV)	Power frequency	28	36		
	Lightning impulse	75	95		
Type test class[*4]	Mechanical	M2			
	Electrical	E1			
	Small capacitive current switching	C2			
Rated operating sequence		O-3min-CO-3min-CO CO-15s-CO O-0.3s-CO-1min-CO			
No-load closing time(s)		0.1			
Closing operating / control current (A)[*5]	Motor	1.2 (motor charging time: 6s)			
	Control current (Closing coil)	3.5			
Tripping device		Shunt tripping coil (STC)			
Opening control current (A) (STC coil)[*5]		4			
Auxiliary switch		5a5b			
Operating counter (Mechanical)		Standard equipment			
Mass (kg)	for sub code name C,L[*2]	250	225	265	370
	for sub code name S[*2]	—	225	255	350
Type of interchangeable GCB		10-SFG-40			

*1 : CR suppressor is a device to absorb the surge generated by switching.(Refer to page 7)

*2 : Sub code name C : mounted CR suppressor for power stations.
Sub code name L : none CR suppressor for power stations.
Sub code name S : none CR suppressor for transformer substations .

*3 : IEC : International standards, IEC 62271-100-2012.

*4 : Type test class described in IEC 62271-100-2012.

*5 : Closing operation/control current and opening control current show the value of 110V DC.

GV Outstanding Reliability

1. Vacuum Interrupter (VI)

- VIs with even higher reliability through utilization of computer-aided engineering (CAE) technology and backed by record of manufacturing 4 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 size reduction compared to the VI in the previous.

*1 : As of 2016

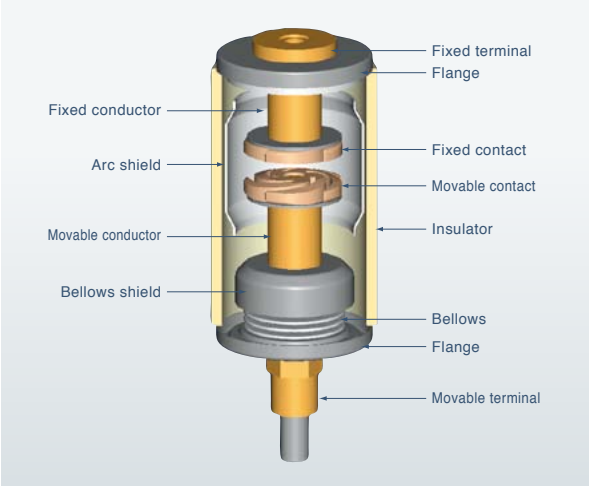


Fig. 1 Three-dimensional model of a VI.

Optical Observation for Arc Behavior

Arc behavior was observed via a high-speed camera at the time of interruption between the fixed and moving contacts (see Fig. 2) .

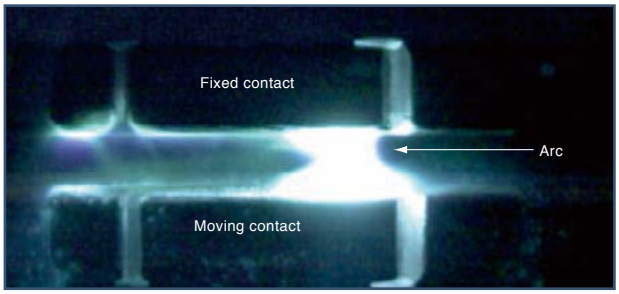


Fig. 2 Observation of arc behavior in an internal VI.

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.

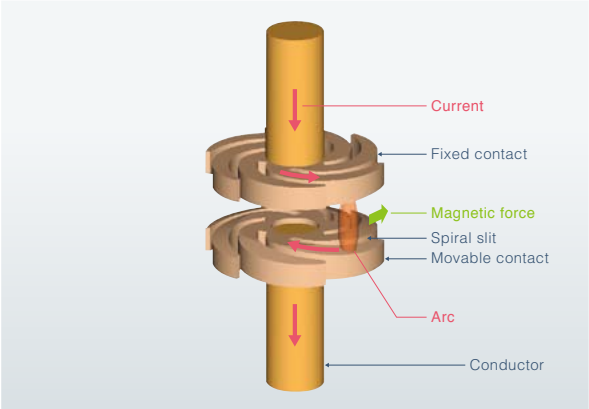


Fig. 3 Current flow at the time of breaking.

2. Operating Mechanism

- 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.

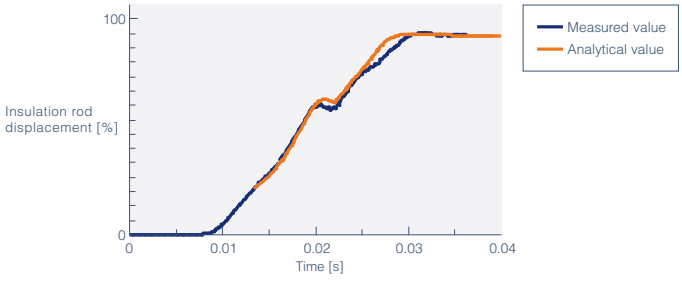


Fig. 4 Example of the three-dimensional mechanism simulation.

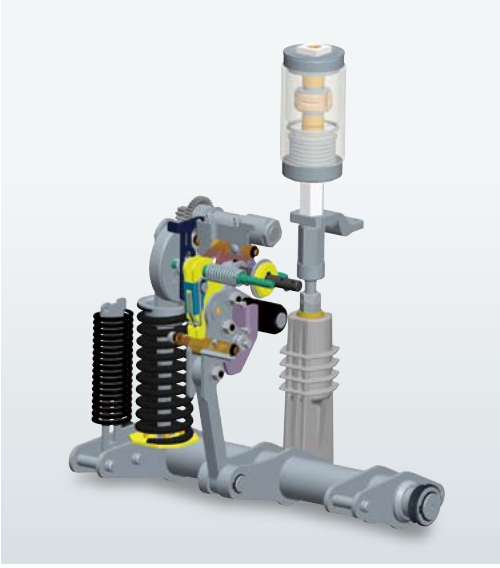


Fig. 5 Operating mechanism.

GV Technical Information

Operation / Control Voltage (Current)

Table 2 Variation range of operation/control voltage.

Items	Standard	IEC-62271-100
Closing operation voltage (motor circuit)	DC	85~110%
	AC	
Closing control voltage (closing circuit)	DC	
Opening control voltage (tripping circuit)	DC	70~110%

Table 3 Closing and tripping control current and current-flow time for DC and AC (see Fig. 6).

<Closing and tripping control current>

Type \ Control voltage (V) / Current (A), Time (s)		VDC									
		24		48		100/110		125		200/220	
		I	T	I	T	I	T	I	T	I	T
10-VPR-40D (GV)	Closing	12	0.05	7	0.05	3.5	0.05	4.5	0.05	1.5	0.05
	Tripping	13	0.03	8	0.03	4	0.03	5	0.03	2	0.03

Maximum flowing current at the time of disconnection monitoring: 0.03A

Table 4 Motor operation control current and current-flow time for DC and AC (see Fig. 7).

Type \ Control voltage (V) / Current (A), Time (s)	VDC																VAC							
	24				48				100/110				125				200/220				100/110				200/220			
	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
10-VPR-40D (GV)	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

Operation / Control Current Waveform for DC.

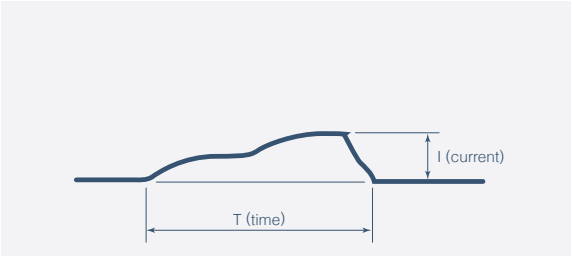


Fig. 6 Closing / tripping control current waveform.

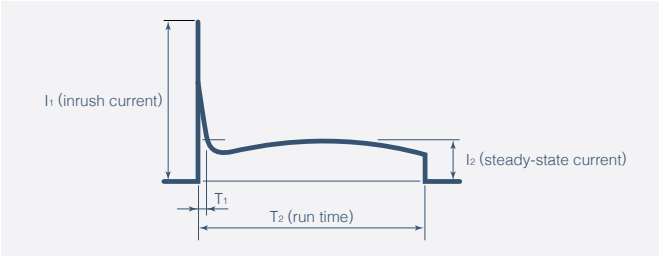


Fig. 7 Motor operation current waveform.

CR Suppressor (Surge Absorbing Capacitor) *Applied to option with 1,250A Rating

Table 5 List of Ratings

Type	CR-12GV
Capacitance (μF)	0.1×3phases
Resistance (Ω)	100×3phases
Mass (kg)	30
Acceptable values for the resultant current of the harmonic wave (A)	0.37 Effective value / phase
Rated test Voltage (kV) AC 1minute	24 (Between the terminals) 28 (Between the case to the terminal)

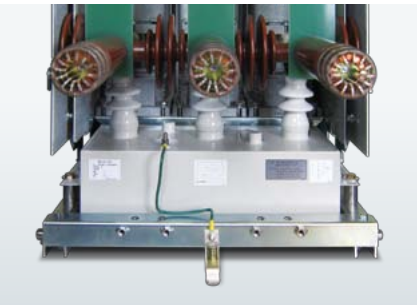


Fig. 8 CR suppressor mounted on VCB truck.

GV VCB & GCB Comparison

Comparison of Life of VCB & GCB

Table 6 List of open and close expected life

Unit	Item	Retrofit VCB	GCB
Mechanical life	Number of operations	10,000 times	10,000 times
Electrical life	Short circuit breaking	30 times	10 times
	Load current breaking	10,000 times	1,000 times
	Small current (less than 100 A) breaking	10,000 times	3,000 times
Life of whole circuit breaker	Number of operations	10,000 times	10,000 times

NOTE : The above switching number of time is the actual capacity checked in the short-term continuous switching test, and does not guarantee the life for a long period of time.
Perform the maintenance and inspection according to the standard of the inspection manual to keep the service life.

Comparison of Scheduled Maintenance

Table 7 List of scheduled maintenance

Periodic Inspection	Retrofit VCB	GCB
General inspection (Every 3 years)	Man-hours: 2 Hr × 2 men	Man-hours: 4 Hr × 2 men
	• Visual check and cleaning • Check of insulation resistance • Lubrication of primary junctions	• Visual check and cleaning • Check of insulation resistance • Lubrication of mechanism, primary junctions • Operation Test
Detailed inspection (Every 6 years)	Man-hours: 5 Hr × 2 men	Man-hours: 10 Hr × 2 men
	• Check of vacuum pressure • Lubrication of mechanism • Operation test	• Inspection and adjustment of Breaking part • Operation test
Replacement of breaking part	When the number of operations exceeds the values below, the VI should be replaced. - Load current: 10,000 times (replacement of entire VCB) - Short-circuit current: 30 times	When the number of operations exceeds the values below, main contacts and arcing contacts should be replaced. - Load current: 1,000 times - Short-circuit current 10 times

Comparison of Structure

Table 8 List of structure

Unit or Part	Retrofit VCB	GCB
Control circuit	Same as GCB	Stored energy motor operation
Interlocking	Same as GCB	When moving CB inside panel, closing operation cannot be performed. When CB is closed, it cannot be moved inside panel.
Insulation	Epoxy-resin molding for main conductors and BMC (Bulk Mold Compound) for separation of VIs.	Epoxy-resin molding Insulation by SF_6
Drawout mechanism	Same as GCB	Withdrawn by pulling of handle.
Truck		Position switch, automatic safety shutters.
Primary junction		Tulip type connector, self-coupling.
Secondary junction		Manual-coupling
Ext. aux-switch		Mechanically linked operating mechanism.

GV Outline and Dimensions

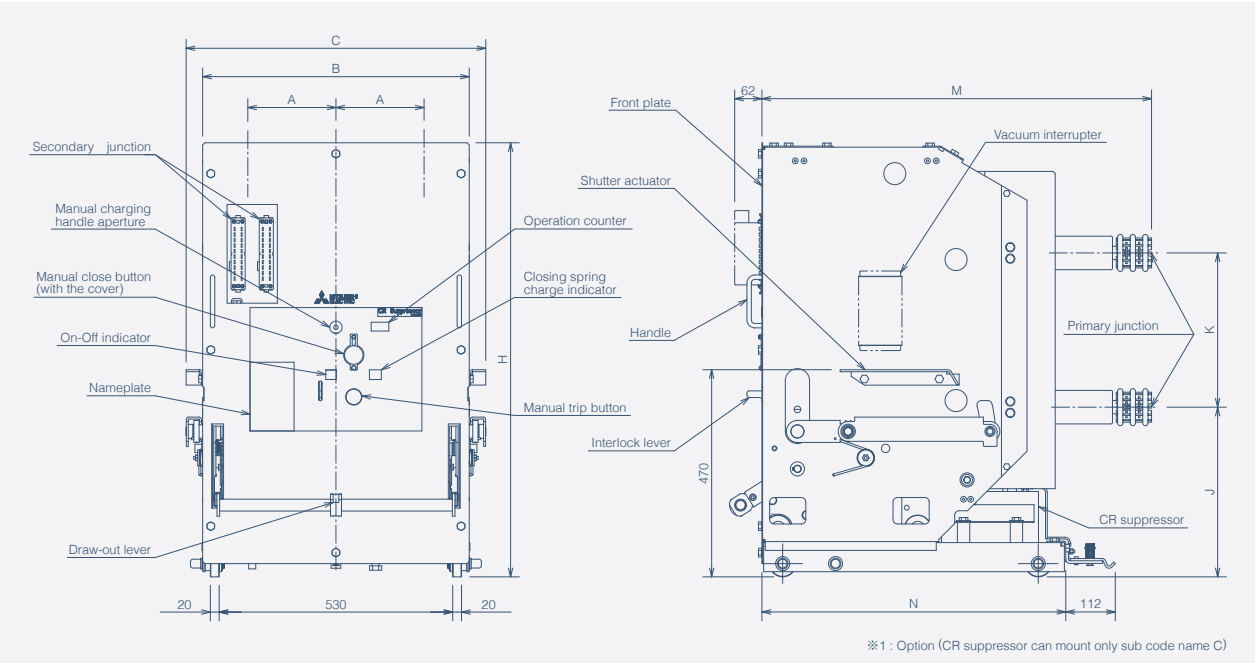
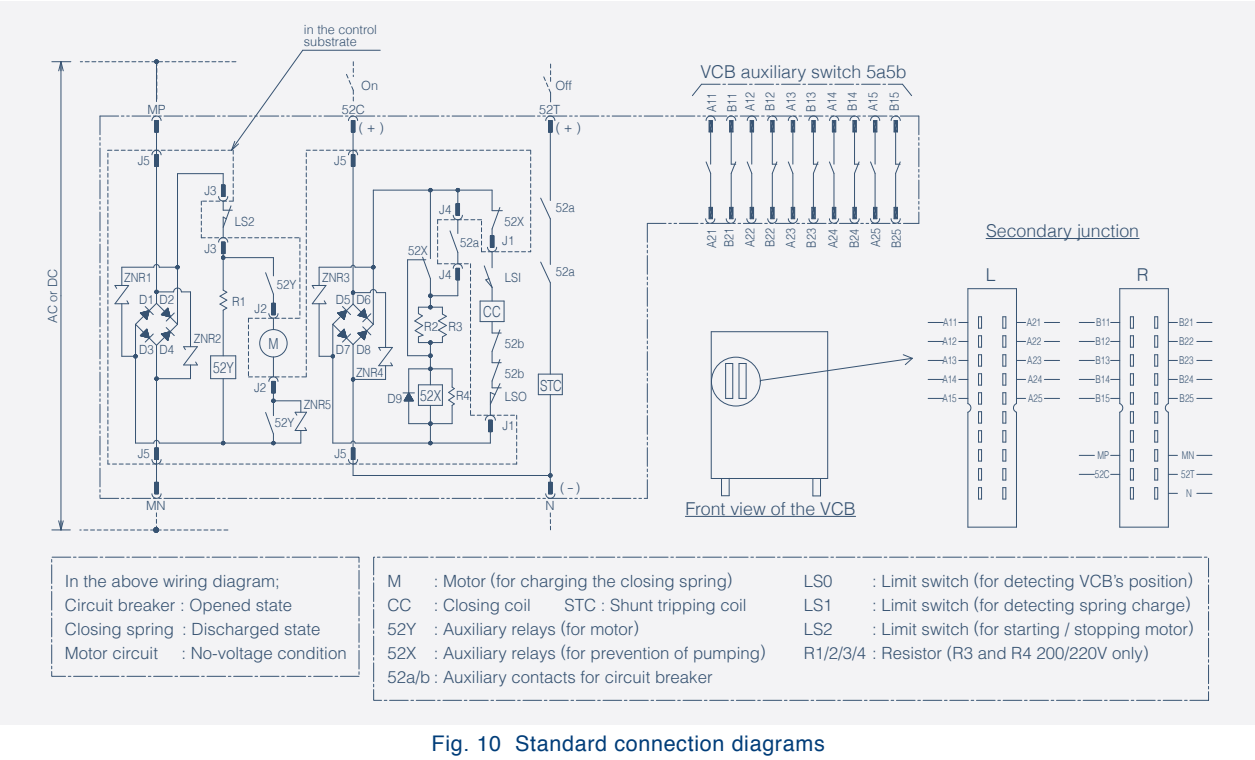


Fig. 9 Outline and dimensions

Table 9 Dimensions

Rated normal current (A)	Dimension (mm)									
	A	B	C	H	J	K	M		N	
	common						for sub code C,L	for sub code S	for sub code C,L	for sub code S
1,250 / 2,000	200	605	680	985	385	350	883	783	689	589
3,150	250	755	830	1040	400	400				

GV Connection Diagrams



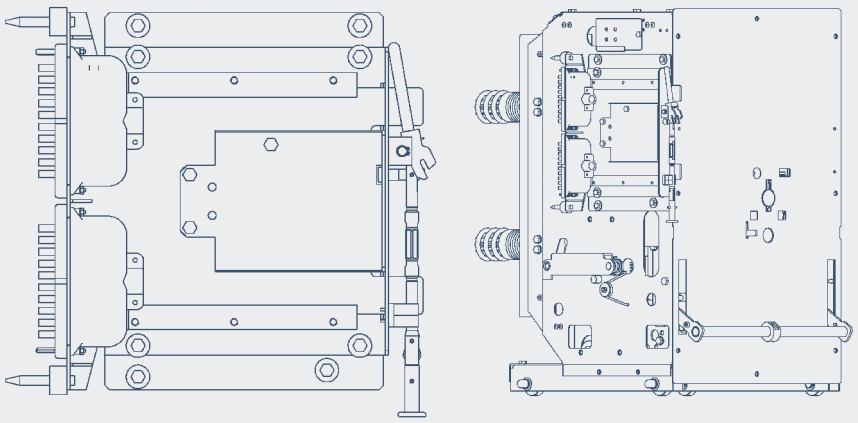
In the above wiring diagram;
Circuit breaker : Opened state
Closing spring : Discharged state
Motor circuit : No-voltage condition

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

Fig. 10 Standard connection diagrams

GV Optional Accessories

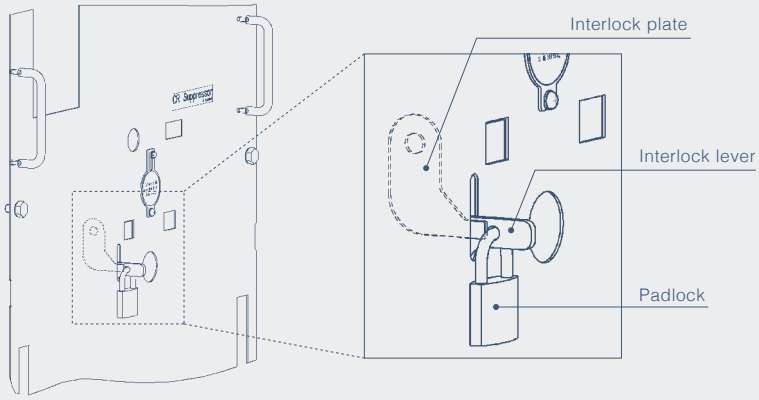
Self-coupling Connection for Secondary Junction



This option can be connected to secondary junction in the connected position or test position.

Fig. 11 Self-coupling connection for secondary

Insert/Draw-out Mechanism Padlock Device



When padlocked, the interlock lever cannot be lifted. Without lifting interlock lever, VCB cannot be inserted or drawn-out.
Note that users are responsible for preparing a padlock; a padlock will not be supplied by the manufacturer.
(Choose an appropriate padlock for ϕ7.5 hole .)

Fig. 12 Insert/Draw-out mechanism padlock device

Tripping Coil Disconnection Monitoring

This function monitors disconnection of the tripping coil and control connector based on output from the input terminal. The disconnection monitoring current is 30mA or blow.

Fig. 13 Tripping coil disconnection monitoring

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Eco Changes is the Mitsubishi Electric Group's environmental statement, and expresses the Group's stance on environmental management. Through a wide range of businesses, we are helping contribute to the realization of a sustainable society.

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⚠ 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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Specifications are subject to change without notice.