Changes for the Better

MITSUBISHI ELECTRIC

LOW-VOLTAGE SWITCHGEAR

MODEL

AL-P

The AL-P low-voltage switchgear conforms to the latest IEC 60439-1 standard and is designed and manufactured utilising Mitsubishi Electric state-of-the-art technology, fully taking into account present and future power system requirements.
Mitsubishi Electric has manufactured more than a hundred thousand low-voltage switchgear panels over more than 50 years. With this experience Mitsubishi Electric has gained a reputation of manufacturing up to date and reliable metal enclosed switchgear with a significant supply record to customers all of the world.

CONTENTS

1 FEATURES

HIGH RELIABILITY

- Heat stress analysis of the switchgear structure has led to a heat-resistant design in which circuit breakers up to 5000A are self-cooled (i.e. cooling fans not required).
- All components, such as current transformers, voltage transformers, relays and meters, are made of the highest quality materials.
- AL-P low-voltage switchgear are designed with the benefit of Mitsubishi's vast switchgear and circuit breaker production experience of in excess of one hundred thousand panels over the last 50 years.
- The reduced number of parts reduces the chance of failure.

SAFETY

- Partitions between compartments and an automatic shutter system completely isolate live parts.
- The pressure relief device which is installed optionally releases hot gas upwards in the event of an internal arc fault for operator's safety.

EASY HANDLING

- Control switches are installed at a height appropriate for easy viewing and operation.
- Installation and testing duration are considerably reduced as the switchgear is tested and adjusted in the factory and then delivered as a complete unit.

FLEXIBLE DESIGN

- Panels with main circuit and control cable entry from either top or bottom are available.
- The AL-P is readily combined with Mitsubishi Electric's Motor Control Center (MCC). The combined arrangement has many advantages such as compact size and a simplified overall structure. As the MCC utilizes a double-front design, a larger number of motor starter units can also be accommodated. The AL-P is the perfect complement for Mitsubishi's MCCs. (Further information regarding Mitsubishi's MCCs can be found in a separate publication.)

Figure 1-1 AL-P and Motor control center

2 APPLICATIONS

- AL-P low-voltage switchgear, with withdrawable circuit breakers, provide control and protection of the power supply to motors, transformers, capacitors and other feeder circuits.
- AL-P low-voltage switchgear is available at rated voltages up to 690V, with rated short-circuit breaking capacities up to 100kA.
- AL-P low-voltage switchgear is designed for indoor use and is particularly suitable for electric power utility systems, unit substations, industrial plants, commercial buildings, pumping stations, transportation systems and pipeline stations.

3 STANDARD RATINGS

1. LOW-VOLTAGE SWITCHGEAR

Standard	IEC 60439-1 Low-voltage switchgear and controlgear assemblies	
Rated insulation voltage	1000VAC	
Rated voltage	690VAC	
System	3ø3W / 3ø4W (4P ACB or 3P ACB with removable link) N Phase bus is half capacity.	
Rated busbar current (Horizontal)	630–5000A	
Rated frequency	50/60Hz	
Short-time withstand current (Horizontal bus)	50, 65, 75, 85, 100kA 1–3s	
Withstand voltage	Main circuit	3500V
	Control circuit	1500V

2. AIR CIRCUIT BREAKER

Standard	IEC 60947-2 Low-voltage switchgear and controlgear Part 2: Circuit breakers	
Rated insulation voltage	1000V AC	
Rated voltage	690V AC	
NOS pole	3P/4P	
Connection type	Main circuit	Automatic connection
	Control circuit	Automatic connection
Kinds of position	Connect-Test-Disconnect	

Figure 3-1 AL-P panel

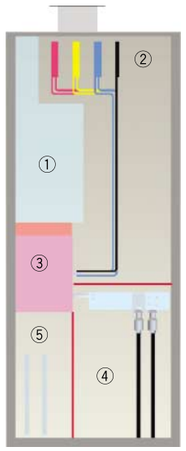
4 CONSTRUCTION

1. ENCLOSURE AND PARTITIONS

- The All metal enclosure is completely earthed. Each compartment (control, air circuit breaker, busbar and cable) is segregated from other compartments by earthed metal partitions (up to Form 4b).
- The front of AL-P low-voltage switchgear is divided into upper and lower compartments. The upper compartment is the control compartment, and the lower one is the circuit breaker compartment. (See Figure 4-1.)

  Meters, control switches, etc. are semi-flush mounted on the door of the control circuit compartment.

Figure 4-1 Front view of AL-P



① Control circuit compartment
② Busbar compartment
③ Air Circuit Breaker compartment
④ Cable compartment
⑤ Terminal Block compartment for control circuit

2. BUSBAR

- The main busbar is made of copper conductor.
- AL-P low-voltage switchgear has tin plated busbars as standard.

  However, when required, the busbar can be insulated with PVC. Also, the bus joints between adjacent panels can be shrouded with insulating covers, and the other connecting parts, such as those between busbars and circuit breaker bushings, or CB bushings and cable terminals, can be covered with insulating tape.

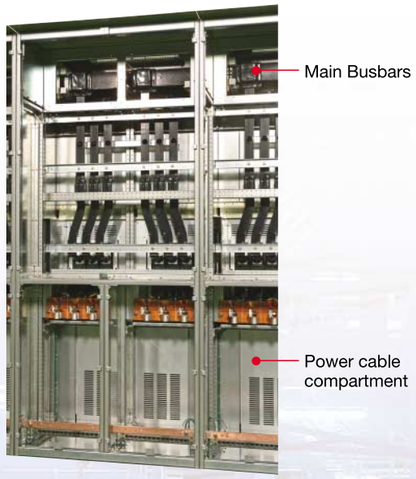


Figure 4-2 Main busbars with PVC insulation and power cable compartment (Rear view)

3. SAFETY AND SPACE SAVING LAYOUT

By adopting a duplex feeder arrangement, the following features are available with AL-P low-voltage switchgear.

Safety

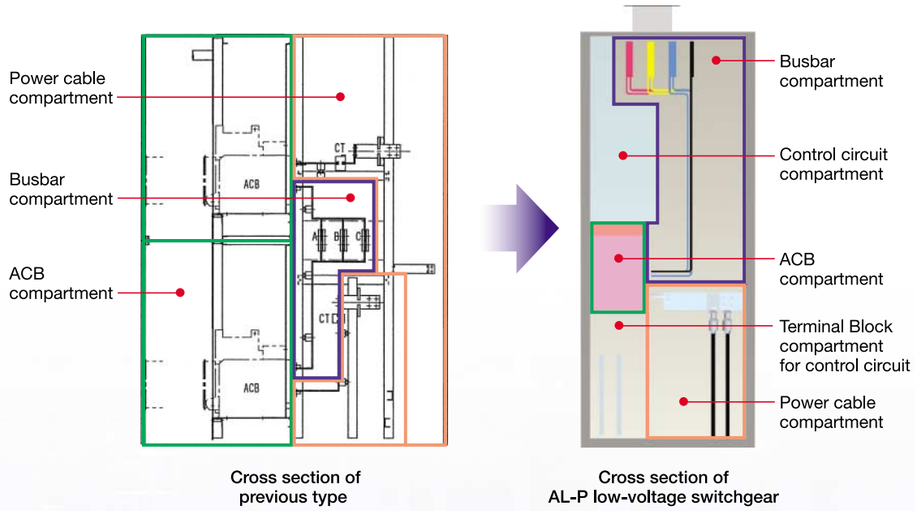
- The chances of electric shock are minimized due to earthed metal barrier partitioning between all compartments. (Internal partitioning up to Form 4b, as defined in IEC 60439-1, is possible.)
- Pressure relief devices may be optionally installed to prevent explosion in the event of an internal arc fault.

Space saving

- The panel depth is 1000 mm. (66% of its predecessor's 1500 mm depth.)
- A front-maintenance only version is also available for installation on or against a wall, and is particularly convenient in small installations such as pre-fabricated switching rooms.

4. INTERNAL SEPARATION

- The partition class is up to Form 4b according to IEC 60439-1 by the two feeder in duplex layout with simple metal partition.
- By adopting a duplex (side-by-side) feeder structure, partitioning has been improved, and the highest possible internal separation of Form 4b is possible.



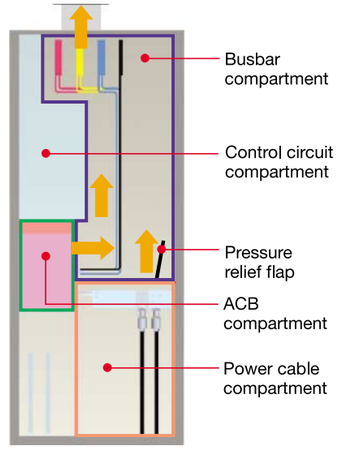
Cross section of previous type

Cross section of AL-P low-voltage switchgear

4 CONSTRUCTION

5. PRESSURE RELIEF DEVICE FOR THE INTERNAL ARC FAULT (IEC 61641)

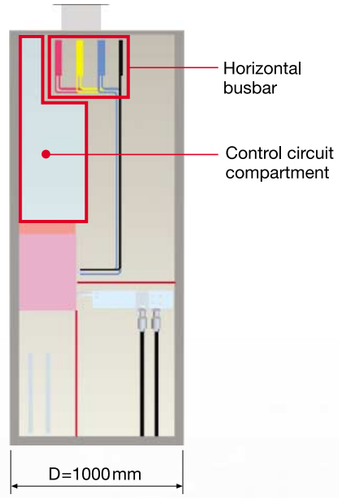
- A pressure relief device can be optionally installed for a further improvement of safety.
- In the event of an internal arc fault, the pressure relief device, which is installed on the top of the cubicle, is forcibly operated by the rising internal pressure and the hot gases released.



Cross section of
AL-P low-voltage switchgear

6. COMPACT DESIGN

- Depth is reduced by approximately 35% compared to the previous model.
- In the previous model, feeders ACBs were arranged vertically in tiers. As the horizontal busbars were situated in the centre of the panel, the load cable from the top-mounted ACB was required to pass over the horizontal busbars, as well as the bottom-mounted ACB's load cable whilst always maintaining adequate clearance. In the current model, by re-positioning the horizontal busbars to the top-center of the switchgear and arranging the ACBs horizontally, the large clearances are avoided.
- By applying a side-by-side arrangement of feeder ACBs, the depth of the switchgear is reduced and distinct control circuit compartments become possible.

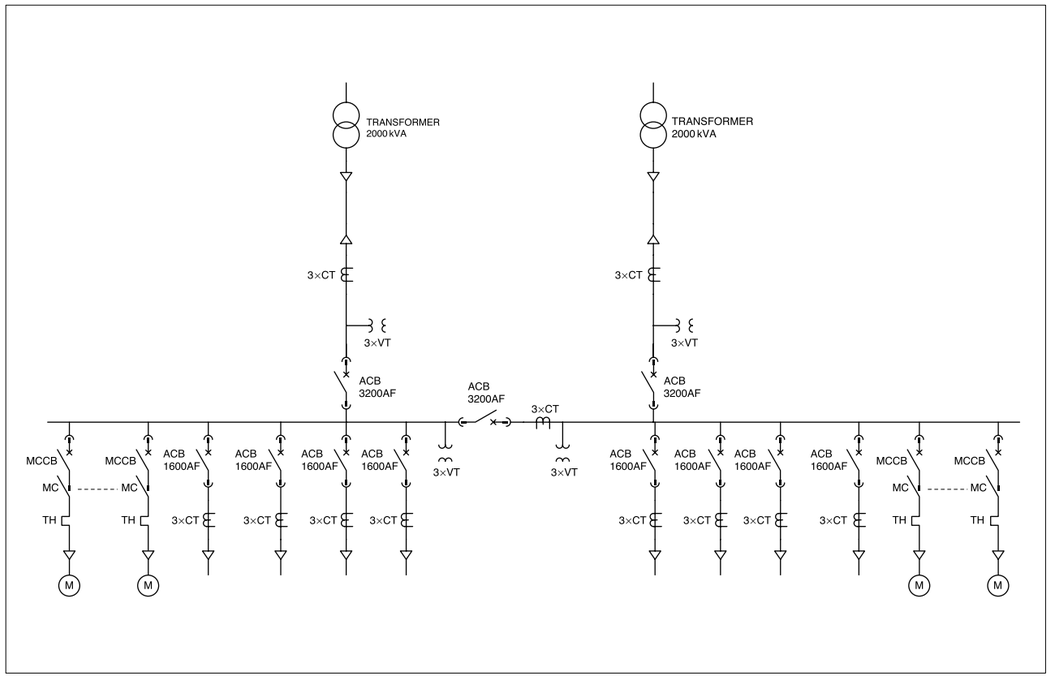


Cross section of
AL-P low-voltage switchgear

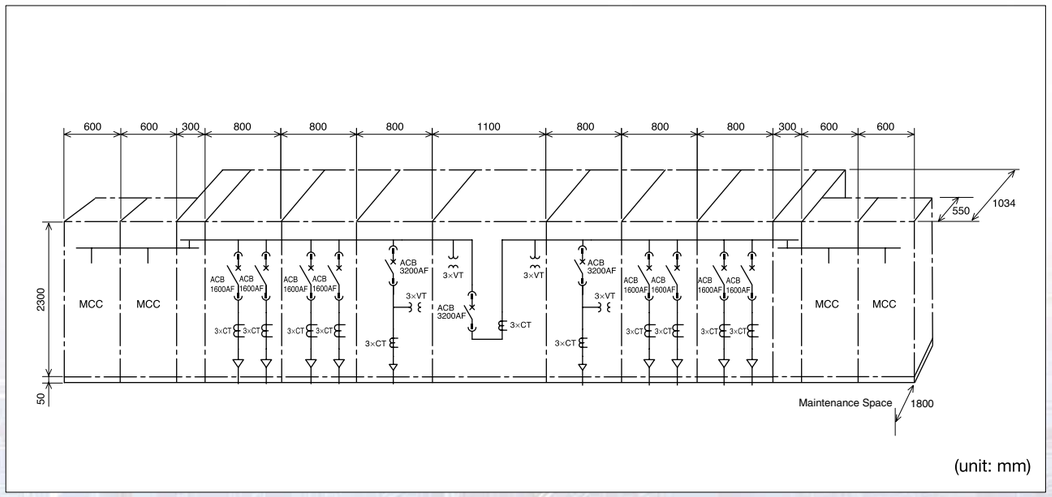
5 SWITCHGEAR ARRANGEMENT

1. EXAMPLE

A. SINGLE LINE DIAGRAM



B. PANEL LAYOUT



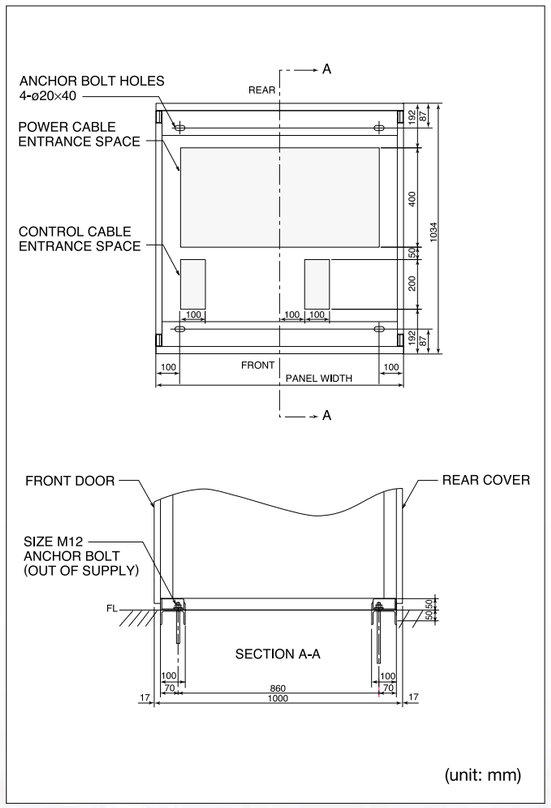
(unit: mm)

5 SWITCHGEAR ARRANGEMENT

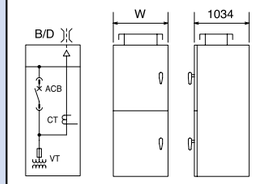
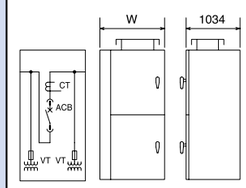
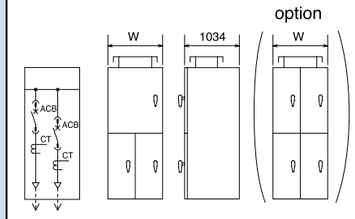
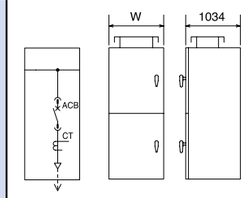
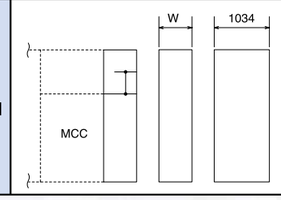
2. COMMON SPECIFICATION

- Standard: IEC 60439-1: Low-voltage switchgear and controlgear assemblies
- Specifications:
  - ① **Main busbar:** Max. 5000A, Short-time current: 100kA/85kA/75kA/65kA/50kA 1–3s
  - ② **Structure:** FR (Front operation, Rear and front maintenance) FF (Front operation, Front maintenance)
  - ③ **Internal separations:** Form 3a (up to Form 4b as option)
  - ④ **Channel base:** 50mm (It shall be add to the panel height.)

4. FOUNDATION



3. OUTLINE

ACB frame size				630AF	1000AF	1250AF	1600AF	2000AF (65kA)	2000AF (85kA)	2500AF	3200AF	4000AF	5000AF
Incomer		**3P**	Width (mm)	800					1000			1000	1200
			Height (mm)	2300					2300			2300	2300
			Depth (mm)	1034					1034			1034	1034
			Weight (kg)	750					950			1200	1600
		4P	Width (mm)	800					1000			1200	1200 1500 (1200+300) In case of arc-proof type
			Height (mm)	2300					2300			2300	2300
			Depth (mm)	1034					1034			1034	1034
			Weight (kg)	800					1050			1350	1750
Bus-tie		**3P**	Width (mm)	1100 (800+300)					1300 (1000+300)			1300 (1000+300)	1600 (1200+400)
			Height (mm)	2300					2300			2300	2300
			Depth (mm)	1034					1034			1034	1034
			Weight (kg)	850					1050			1250	1700
		4P	Width (mm)	1100 (800+300)					1300 (1000+300)			1500 (1200+300)	1600 (1200+400)
			Height (mm)	2300					2300			2300	2300
			Depth (mm)	1034					1034			1034	1034
			Weight (kg)	900					1150			1450	1850
Outgoing feeder (2 feeders in 1 panel)		**3P**	Width (mm)	800 1000 (IP4X and/or Arc-proof type)				——					
			Height (mm)	2300				——					
			Depth (mm)	1034				——					
			Weight (kg)	800				——					
		4P	Width (mm)	1000 1200 (Arc-proof type)				——					
			Height (mm)	2300				——					
			Depth (mm)	1034				——					
			Weight (kg)	900				——					
Outgoing feeder (1 feeder in 1 panel)		**3P**	Width (mm)	——				800	1000			——	
			Height (mm)	——				2300	2300			——	
			Depth (mm)	——				1034	1034			——	
			Weight (kg)	——				750	950			——	
		4P	Width (mm)	——				800	1000			——	
			Height (mm)	——				2300	2300			——	
			Depth (mm)	——				1034	1034			——	
			Weight (kg)	——				800	1050			——	
Bus transfer to connect Motor Control Center (MCC)		**3/4P**	Width (mm)	300									——
			Height (mm)	2300									——
			Depth (mm)	1034									——
			3P Weight (kg)	170									——
			4P Weight (kg)	180									——

Energizing current by ambient temperature

Structure: FR (Front operation, Rear and front maintenance)

		ACB frame size	630AF	1000AF	1250AF	1600AF	2000AF	2500AF	3200AF	4000AF	5000AF
Ambient temperature	**35°C**	Energizing current	630A	1000A	1250A	1600A	2000A	2500A	3200A	4000A	4750A
		Energizing rate	100%	100%	100%	100%	100%	100%	100%	100%	95%
	40°C	Energizing current	630A	1000A	1250A	1600A	2000A	2375A	3040A	3800A	4500A
		Energizing rate	100%	100%	100%	100%	100%	95%	95%	95%	90%
	50°C	Energizing current	550A	875A	1095A	1400A	1750A	2080A	2665A	3330A	3945A
		Energizing rate	87%	87%	87%	87%	87%	83%	83%	83%	78%

* Duplex feeder: Rated diversity factor = 0.9 * More than 2000A: The ventilating window is necessary for the rear cover.

Structure: FF (Front operation, Front maintenance)

		ACB frame size	630AF	1000AF	1250AF	1600AF	2000AF	2500AF	3200AF	4000AF	5000AF
Ambient temperature	**35°C**	Energizing current	630A	1000A	1250A	1600A	1945A	2160A	2770A	3460A	4050A
		Energizing rate	100%	100%	100%	100%	97%	86%	86%	86%	81%
	40°C	Energizing current	630A	1000A	1250A	1600A	1800A	2000A	2560A	3200A	3750A
		Energizing rate	100%	100%	100%	100%	90%	80%	80%	80%	75%
	50°C	Energizing current	550A	875A	1095A	1400A	1575A	1750A	2245A	2800A	3285A
		Energizing rate	87%	87%	87%	87%	78%	70%	70%	70%	65%

* Duplex feeder: Rated diversity factor = 0.9

6 STANDARD DESIGN

1. ENCLOSURE AND STRUCTURE

- Steel thickness is a minimum of 1.5mm
  - Side cover (both ends of arrangement): Min. 2.0mm
  - Frame: Min. 2.0mm
  - Door: Min. 2.0mm, painted
  - Ceiling plate: Min. 2.0mm
  - Bottom plate: Min. 2.0mm
  - Internal partitions: Min. 1.5mm
  - Mounting plates: Min. 2.0mm

- Standard front door/rear cover

Position	Structure	Hinge location	Handle location	Handle lock
Front	Three-hinged door	Left	Right	Optional
Rear	Bolted covers (×2)	—	—	—

- Degree of protection
  Enclosure: IP2X
  Internal partitions: IPXXB

2. BUSBAR AND CONNECTING CONDUCTOR

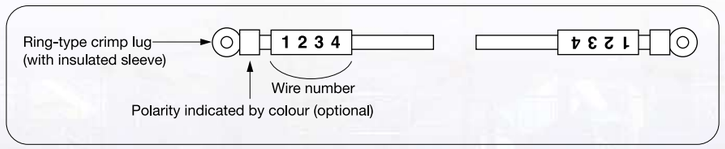
- Busbar material: copper
- Busbar joints: tin plating

3. EARTHING BUSBAR

- Material: copper
- Surface treatment: none (bare)

4. CONTROL CIRCUIT WIRING

- Wiring system: duct or bundled
- Insulation: heat-resistant plastic (PVC)
- Size: 1.25mm^2
- Colour: yellow, except for earth wire (green)
- Wire numbering: indicated by “tube” ferrule



5. PHASE/POLARITY ARRANGEMENT AND COLOUR CODING

- Main circuit and control circuit arrangements are as follows:

AC ····· 1st phase L1
2nd phase L2
3rd phase L3

(Viewed from front to back, top to bottom, or left to right from front.)

DC ····· 1st wire Positive
2nd wire Negative

(As viewed from front to back, top to bottom, or left to right from the front.)

- Main circuit colour identification is achieved with vinyl tape or coloured label at bus end where main cables are connected.

AC ····· 1st phase Red
2nd phase Yellow
3rd phase Blue

- Unless specially requested, the control circuit is not colour coded.
  (Identifying colour tube markers, with the standard colours shown below, can be optionally installed.)

AC 3-phase ····· 1st phase Red
2nd phase Yellow
3rd phase Blue
Neutral Black

AC 1-phase ····· 1st wire Red
2nd wire Blue
Neutral Black

DC ····· Positive Red
Negative Blue

6. WITHDRAWABLE EQUIPMENT

Apparatus	Main circuit	Control circuit	Earthing circuit (Carriage frame)
Air circuit breaker	Automatic connection (self-aligning)	Automatic connection (self-aligning)	Automatic connection (earthing shoe)

7. AIR CIRCUIT BREAKER POSITIONS

- Main circuit and control circuit arrangements are as follows:

Connected	Main and control circuit – Connected
Test	Main circuit – Disconnected Control circuit – Connected
Disconnected	Main and control – Disconnected

- The front door can be closed when the circuit breaker is in any position.

6 STANDARD DESIGN

8. CIRCUIT BREAKER INTERLOCKS

ACTION		CIRCUIT BREAKER INTERLOCK CONDITIONS					
		State		Position			
		On	Off	Connected	Midway position	Test position	Disconnected position
Insertion		×	○	—			
Withdrawal		×	○				
Electrical	Close	—		○	×	○	×
	Trip			○	— *	○	×
Mechanical	Close			○	×	○	○
	Trip			○	— *	○	○

○: possible ×: cannot be performed
*: ACB already open.

9. PAINTING AND COLOUR

- Panel front door
  The panel front door is cleaned and pretreated for rust, and then phosphate coated.
  Two coats of paint are then applied.
- Panel frame and covers
  The panel frame and internal covers are painted steel.
- Finish colour
  Enclosure: light grey (Munsell No. 5Y 7/1).
  Meter covers, control devices and protection relay cases: manufacturer's standard.

10. NAMEPLATES

- Nameplates are of plastic with black lettering on white background, fastened by plastic rivets, and are the following sizes:
  - Panel arrangement name: 63mm×315mm
  - Panel section name: 12mm×50mm

7 ACCESSORIES

ACCESSORIES

- ACB lifter
- OCR checker
- ACB draw-out handle
- Test plug set for secondary circuit of CT & VT

8 OPTIONS

CLASSIFICATION	ITEM	STANDARD DESIGN	SPECIAL SPECIFICATIONS AND/OR OPTIONS
Enclosure	• Degree of protection • Front door for control compartment of outgoing feeder	• IP2X • 1 door for 2 feeders	• IP43 • 2 doors for 2 feeders
Busbars	• Plating • Insulation • Short-time withstand current • Neutral busbar	• Tin • Bare • 50kA rms (1s) • Half size	• Silver • Epoxy coat • 100kA rms (1s) • Full size
Main circuit	• Cable entry • Cable lugs • Cable glands • Cable terminal treatment	• From bottom • Not supplied • Not supplied • Not supplied	• From top • Specify type, size • Specify type, size • Heat-shrinkable material (Specify size and type)
Control circuit	• Cable entry • Wire type • Wire size • Colour • Terminals • Terminal blocks	• From bottom • 600V, PVC • CT/PT secondary: 2.0mm² other: 1.25mm² • Yellow • Up to 5.5mm² • Screw type (MITSUBISHI: Type TE-K)	• From top • Please specify • 2.0mm² • Please specify • Please specify • Please specify (e.g. clip-on)
Apparatus	• Space heater • Transparent plastic covers (prevention of accidental contact with live parts) • Earthing truck • Key-interlock • Nameplates	— — — — • Acrylic plastic	• Please specify power source • Possible (behind door) • Available • Available • Laminated plastic or stainless steel
Painting	• Panel finish colour • Special painting specification	• Munsell 5Y 7/1 (light grey) —	• Please specify • For tropical or high humidity areas
Measurement and Protection	• Relay	• Overcurrent relay integrated into ACB	• MITSUBISHI *MP* Multiple Protection Relay • Specify instruments and protection relays

Safety Precautions

Please read the instruction manual before using the device.

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