MITSUBISHI

MOULDED CASE CIRCUIT BREAKERS

TECHNICAL NOTES

98 A

We have the pleasure of providing all our customers with the technical information for Mitsubishi moulded case circuit breakers. This indicates the fundamental data of our circuit breakers regarding the applicable standards, constructional principles, and operational performances. Please refer to the catalogue of our circuit breakers for details of specifications.
Also please stand in need of the handling and maintenance manual for maintaning the circuit breakers in service continuously.
We do hope they are available for all our customers to built more efficient systems.

CONTENTS

1. INTRODUCTION

Mitsubishi Advancing Technology

Mitsubishi, the leading manufacturer of circuit breakers, has been providing customers with a wide range of highly reliable and safe moulded case circuit breakers (MCCB) and earth-leakage circuit breakers (ELCB), corresponding to the needs of the age.

Since production began in 1933 many millions of Mitsubishi ACBs, MCCBs and MCBs have been sold throughout many countries.

In 1985 a new design concept for controlling arc energies within MCCBs – vapour jet control (VJC) – was introduced and significantly improved performance. It is provided the technological advance for a new 'super series' range of MCCBs and is used in all present ratings from 3 to 1600 amps.

In 1995 Mitsubishi offers the new PSS (Progressive Super Series) breakers having ratings from 3 to 250 amps that concentrate the most advanced technologies into a compact body. Their four major features are:

- New circuit-breaking technology ISTAC for a higher current-limiting performance, upgrading the circuit-breaking capability.
- Electronic circuit breakers with the Digital ETR protecting the circuit accurately.
- One-frame, one-size design allowing efficient panel design.
- Cassette-type internal accessories that allow installation by the user.

Progressive Super Series, an integration of technology and know-how from this comprehensive electronic product manufacturer, will create its own fields of application with its excellent performance.

A Brief Chronology

1933	Moulded case circuit breaker production begins.
1952	Miniature circuit breaker production begins.
1968	Manufacture commences of short-time-delayed breakers.
1969	Production and sale of first residual current circuit breakers.
1970	170kA breaking level 'permanent power fuse' integrated MCCBs is introduced.
1973	Introduction of first short-time delay and current-limiting selectable breakers go on sale.
1974	First MELNIC solid-state electronic trip unit MCCBs are introduced.
1975	ELCBs with solid-state integrated circuit sensing devices are introduced.
1977-1979	Four new ranges of MCCBs are introduced – economy, standard, current limiting, ultra current limiting and motor rated designs – a comprehensive coverage of most application requirements.
1982	Compact ACBs with solid-state trip devices and internally mounted accessories introduced.
1985-1989	Super series MCCBs with VJC and ETR are developed and launched – awarded the prestigious Japanese MInister of Construction Prize.
1990	New 200kA level U-series MCCBs super current limiting breakers are introduced.
1991	Super-NV ELCBs and Super-AE ACBs are introduced.
1995	Progressive Super Series 30~250 amps are introduced.
1997	Progressive Super Series 400~800 amps are introduced.

2. FEATURES – Advanced MCCB Design Technology & Performance

2.1 Arc-Extinguishing Device – ISTAC

Mitsubishi has developed an epoch-making ISTAC technology to realize an improved current-limiting and breaking performance within a smaller breaking space.
Introduction of ISTAC technology upgrades the current-limiting, selective-breaking, and cascade-breaking performance. The maximum peak let-through current I_p decreases to about 80% (compared with Mitsubishi's 100AF). The passing energy I_2t decreases to about 65% (compared with MItsubishi's 100AF). The smaller breaking space has led to an improved function, a smaller size, and a standardization of the breakers.

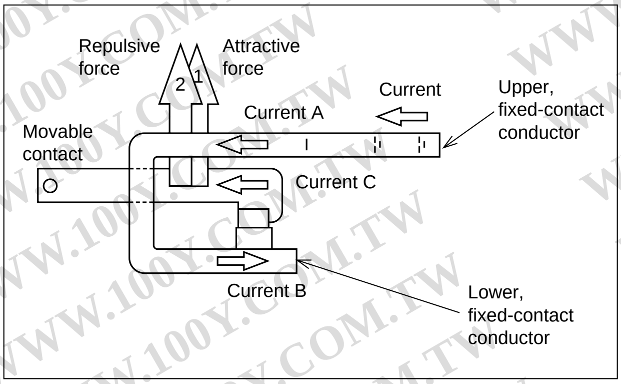
Triple forces accelerating

The triple forces generated by a newly designed current pass and the Vapor Jet Control (VJC) insulating materials which makes up a slot-type breaking construction accelerate the movable conductor, and separate the contacts faster than ever before in short-breaking.

Electromagnetic attractive force which works between a current of the movable conductor and a current of the fixed upper conductor.

Electromagnetic repulsive force which works between a current of the movable conductor and a current of the fixed lower conductor.

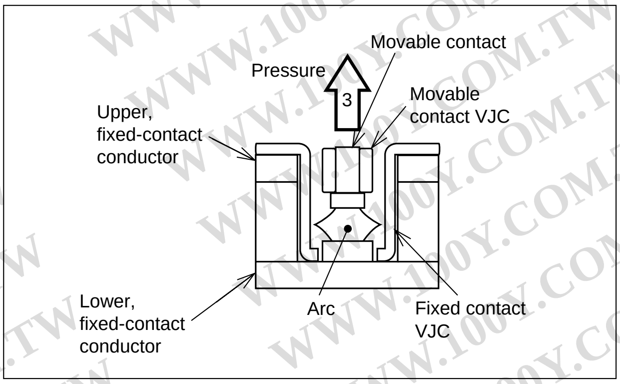
Pressure which works on the movable conductor by gas generated in the slot.



Arc control by slot-breaking

The VJC of the fixed contact incorporates newly developed insulation made of ceramic fiber and metal hydroxide. The substantially improves the VJC effect. The arc-extinguishing gas energies to improve the capability of extinguishing the arc.

The VJC suppresses the emergence of carbide products in breaking a current and contribute to the recovery of insulation immediately thereafter.
The VJCs on the fixed and movable contacts work together to forcefully reduce the arc spot and rapidly contract the total arc being extinguished.



Vapor jet control (VJC)

Vapor Jet Controllers made of insulating material are arranged around the contacts where they control the arc as follows:

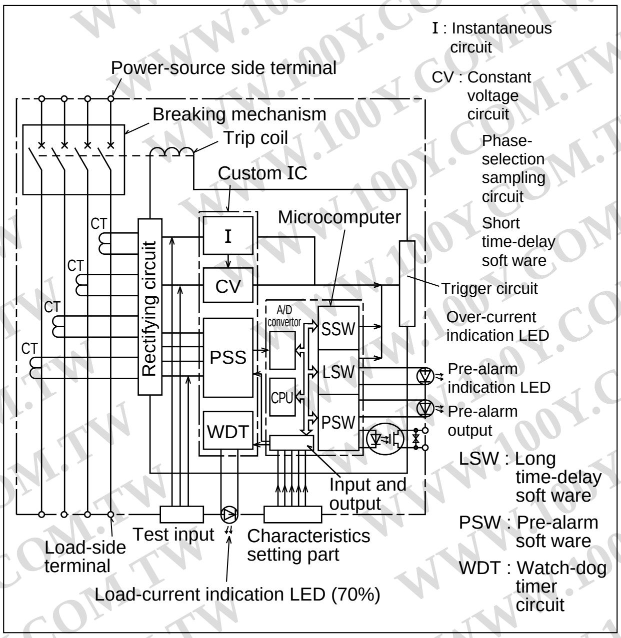
1. The arc spot is forcibly reduced by the arrangement of the insulating material.
2. The arc column is contracted.
3. Adiabatic expansion cools the arc.
4. The arc is transferred at the optimum moment to the arc-extinguishing chamber by the arrangement of the Vapor Jet Controllers.

2.2 Digital ETR (Electronic Trip Relay)

Mitsubishi's electronic MCCBs are equipped with a digital ETR to enable fine protection.
The digital ETR contains Mitsubishi's original double IC (8 bit microcomputer and custom-IC).

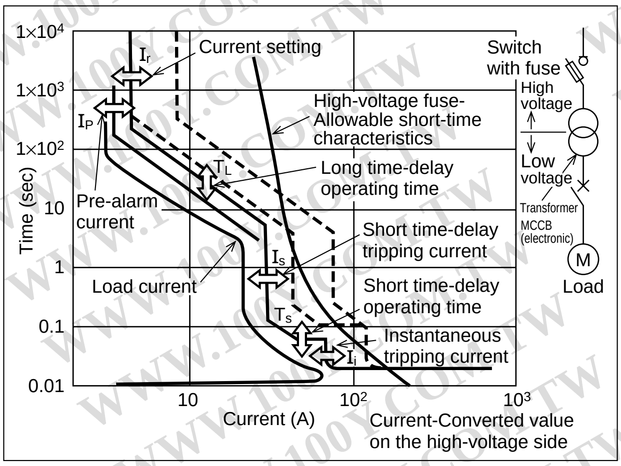
Digital detection of the effective value

Electronic devices such as an inverter distort the current waveform. Mitsubishi's PSS electronic breakers are designed to detect digitally the effective value of the current to minimize over-current tripping errors. This enables fine protection for the system.

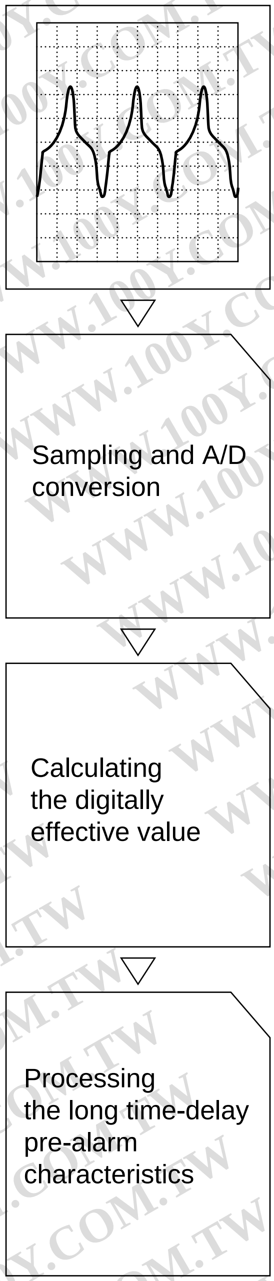


Standard equipped pre-alarm system

Mitsubishi's PSS electronic breakers have a pre-alarm system as a standard. When the load current exceeds the set pre-alarm current, the breaker lights up an LED and outputs a pre-alarm signal.



Processing of the digital ETR



2.3 Equipment of High Technology

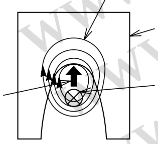
Series	Type	Advanced Technology			
		ISTAC	VJC	Digital-ETR	Analog-ETR
NF-S	NF30-SP				
	NF50-HP				
	NF50-HRP	●	●		
	NF60-HP				
	NF100-SP	●	●		
	NF100-HP	●	●		
	NF100-SEP	●	●	●	
	NF100-HEP	●	●	●	
	NF160-SP		●		
	NF160-HP	●	●		
	NF250-SP		●		
	NF250-HP	●	●		
	NF250-SEP	●	●	●	
	NF250-HEP	●	●	●	
	NF400-SP		●		
	NF400-SEP		●	●	
	NF400-HEP		●	●	
	NF400-REP		●	●	
	NF630-SP		●		
	NF630-SEP		●	●	
	NF630-HEP		●	●	
	NF630-REP		●	●	
	NF800-SEP		●	●	
	NF800-HEP		●	●	
	NF800-REP		●	●	
	NF1000-SS				●
	NF1250-SS				●
	NF1600-SS				●
NF-C	NF50-CP				
	NF60-CP				
	NF100-CP				
	NF250-CP				
	NF400-CP				
	NF630-CP				
	NF800-CEP		●	●	
NF-U	NF100-RP	●	●		
	NF100-UP	●	●		
	NF225-RP		●		
	NF225-UP	●	●		
	NF400-UEP		●	●	
	NF630-UEP		●	●	
	NF800-UEP		●	●	
	NF1250-UR				●

3. CONSTRUCTION AND OPERATION

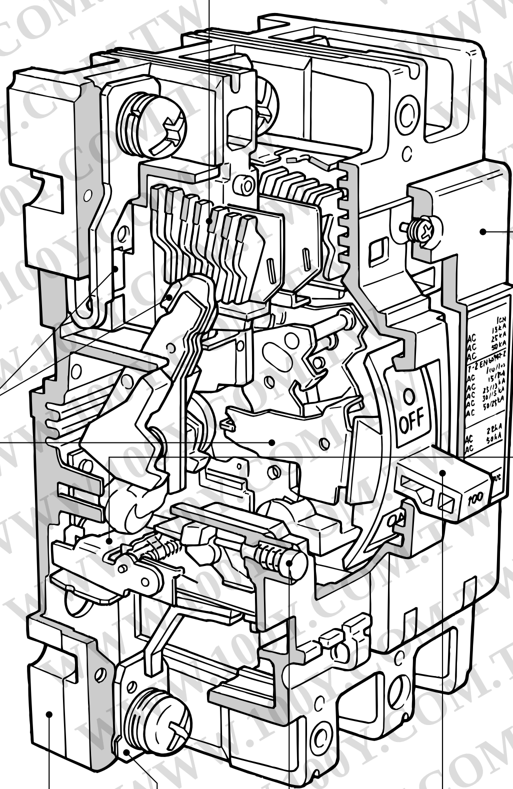
3.1 General

The primary components are: a switching mechanism, an automatic tripping device (and manual trip button), contacts, an arc-extinguishing device, terminals and a molded case.

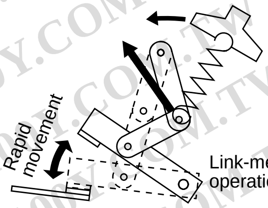
Arc-Extinguishing Device
Mitsubishi MCCBs feature excellent arc-extinguishing performance by virtue of the optimum combination of grid gap, shape, and material.



Arc extinction



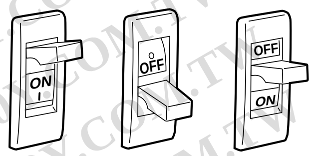
Switching Mechanism
The contacts open and close rapidly, regardless of the moving speed of the handle, minimizing contact wear and ensuring safety.



Trip Button (Push to Trip)
Enables tripping mechanically from outside, for confirming the operation of the accessory switches and the manual resetting function.

Handle

1. Trip indication
   The automatically tripped condition is indicated by the handle in the center position between ON and OFF, the yellow (or white) line cannot be seen in this position.
2. Resetting
   Resetting after tripping is performed by first moving the handle to the OFF position to engage the mechanism, then returning the handle to ON to reclose the circuit.
3. Trip-Free
   Even if the handle is held at ON, the breaker will trip if an overcurrent flows.



Handle indication

4. Contact On Mechanism
   Even in the worst case in which welding occurs owing to an overcurrent, the breaker will trip and the handle will maintain to ON, indicating the energizing state.

Fig. 3.1 Type NF100-SP Construction

3.2 Switching Mechanism

The ON, OFF and TRIPPED conditions are shown in Fig. 3.2. In passing from ON to OFF, the handle tension spring passes through alignment with the toggle link ("dead point" condition). In so doing, a positive, rapid contact-opening action is produced; the OFF to ON contact closing acts in a similar way ("quick make" and "quick break" actions). In both cases the action of the contacts is always rapid and positive, and independent of the human element – i.e., the force or speed of the handle.

In auto tripping a rotation of the bracket releases the cradle and operates the toggle link to produce the contact-opening action described above. In the tripped condition the handle assumes the center position between on and off, providing a visual indication of the tripped condition. Also, auto trip is "trip free," so that the handle cannot be used to hold the breaker in the ON condition. The protective contact-opening function cannot be defeated.

In multipole breakers the poles are separated by integral barriers in the molded case. The moving contacts of the poles are attached to the central toggle link by a common-trip bar, however, so that tripping, opening and closing of all poles is always simultaneous. This is the "common trip" feature, by which single phasing and similar unbalance malfunctions are effectively prevented.

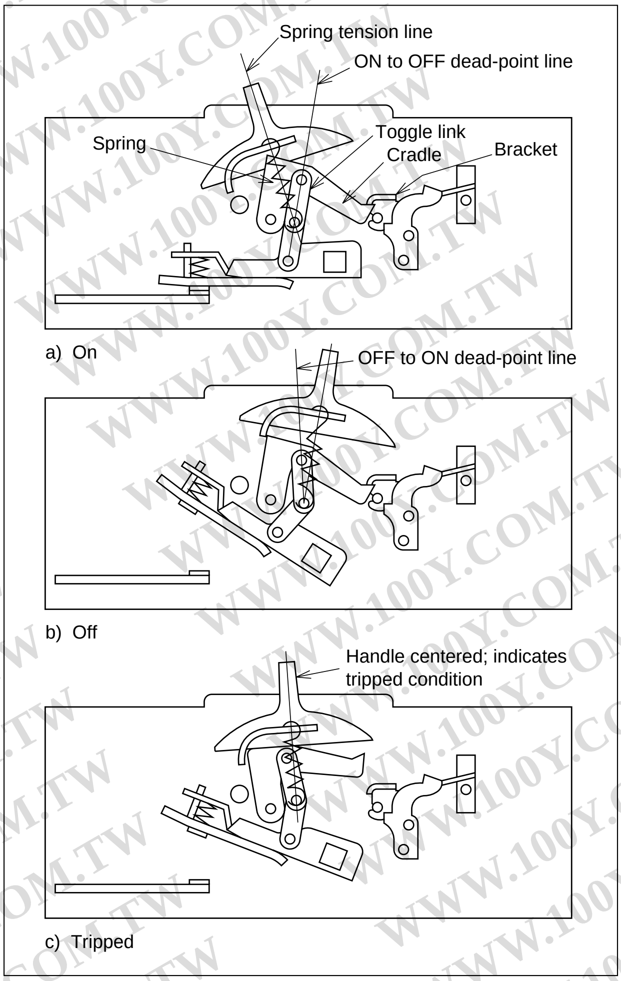


Fig. 3.2 Switching Mechanism Action

3.3 Automatic Tripping Device

There are three types of device, the thermal-magnetic type, the hydraulic-magnetic type and the electronic trip relay type.

■Automatic Tripping Devices

●Thermal-Magnetic Type (100~800A Frame)

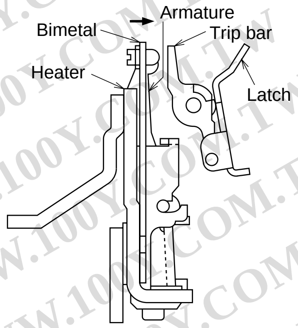


Fig. 3.3

1. Time-Delay Operation
   An overcurrent heats and warps the bi-metal to actuate the trip bar.
2. Instantaneous Operation
   If the overcurrent is excessive, the amature is attracted and the trip bar actuated.

●Thermal-Magnetic Type (1000~4000A Frame)

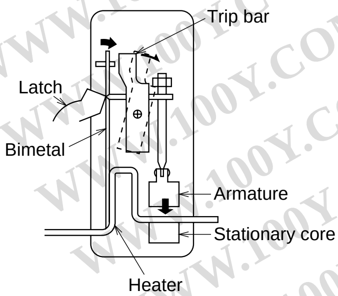


Fig. 3.4

1. Time-Delay Operation
   An overcurrent heats and warps the bi-metal to actuate the trip bar.
2. Instantaneous Operation
   If the overcurrent is excessive, magnetization of the stationary core is strong enough to attract the armature and actuate the trip bar.

●Hydraulic-Magnetic Type (30~60A Frame)

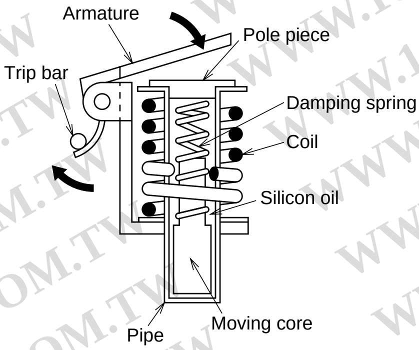


Fig. 3.5

1. Time-Delay Operation
   At an overcurrent flow, the magnetic force of the coil overcomes the spring, the core closes to the pole piece, attracts the armature, and actuates the trip bar. The delay is obtained by the viscosity of silicon oil.
2. Instantaneous Operation
   If the overcurrent is excessive, the armature is instantly attracted, without the influence of the moving core.

●Principle of Electronic Trip Relay (ETR) Operation

(100~800A Frame) **(1000~1600A Frame)**

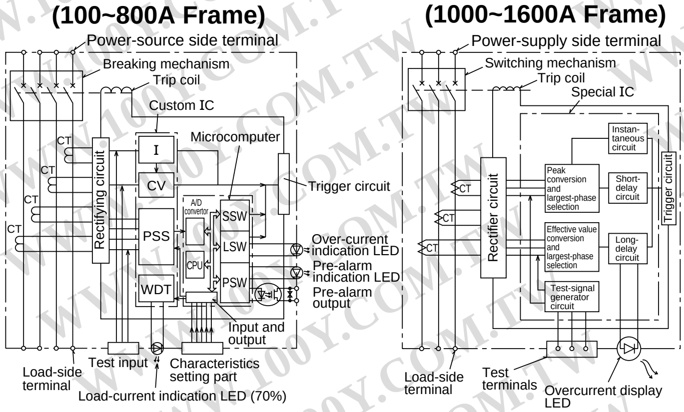
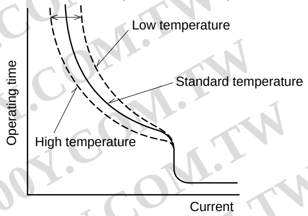
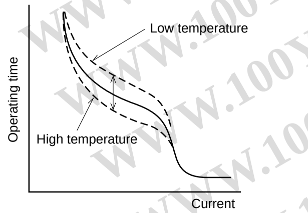
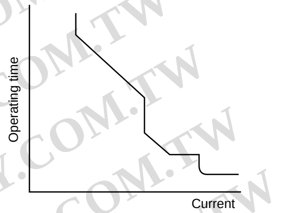
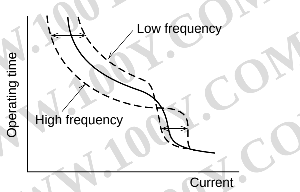
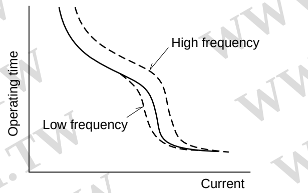
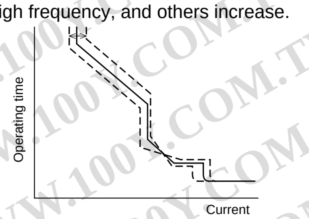
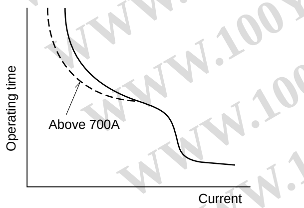
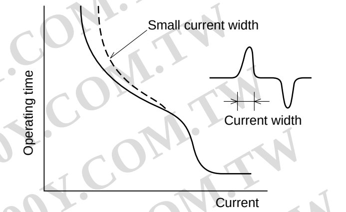
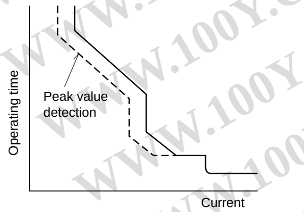
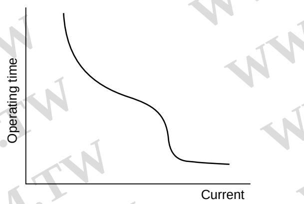
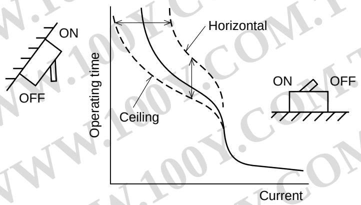
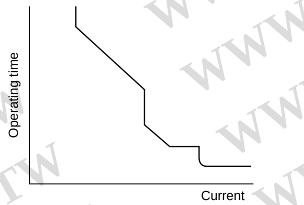
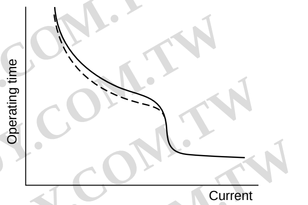
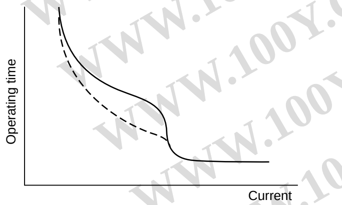
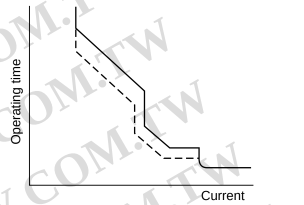


Fig. 3.6

1. The current flowing in each phase is monitored by a current transformer (CT).
2. Each phase of the transformed current undergoes full-phase rectification in the rectifier circuit.
3. After rectification, each of the currents are converted by a peak-conversion and an effective-value conversion circuit.
4. The largest phase is selected from the converted currents.
5. Each time-delay circuit generates a time delay corresponding to the largest phase.
6. The trigger circuit outputs a trigger signal.
7. The trip coil is excited, operating the switching mechanism.

Table 3.1 Comparison of Thermal-Magnetic, Hydraulic-Magnetic and Electronic Types

Item	Thermal-magnetic type	Hydraulic-magnetic type	Electronic type
Ambient temperature	Operating current is affected by ambient temperature (bimetal responds to absolute temperature not temperature rise). 	Affected only to the extent that the damping-oil viscosity is affected. 	Negligible effect 
Frequency	Negligible effect up to several hundred Hz; above that the instantaneous trip is affected due to increased iron losses. 	Trip current increases with frequency, due to increased iron losses. 	Tripping current of some types decrease due to CT or condition of operating circuit with high frequency, and others increase. 
Distorted wave	Negligible effect up to 600A; Above that operating current decreases due to increase of a fever. 	IF distortion is big, minimum operating current increases. 	For peak value detection, operating current drops. 
Mounting attitude	Negligible effect. 	Mounting attitude changes the effective weight of the magnetic core. 	Negligible effect 
Flexibility of operating characteristics	Bimetal must provide adequate deflection force and desired temperature characteristic. Operating time range is limited. 	Oil viscosity, cylinder, core and spring design, etc., allow a wide choice of operating times. 	Operating time can be easily shortened. To lengthen operating time is not. 
Flexibility of rated current	Units for small rated currents are physically impractical.	Coil winding can easily be designed to suit any ampere rating.	Within the range of 50(60)~100% of rated current, any ampere rating are practical. Also, to lower the value of short-time delay or instantaneous trip can be easily done comparatively.

3.4 Contacts

A pair of contacts comprises a moving contact and a fixed contact. The instants of opening and closing impose the most severe duty. Contact materials must be selected with consideration to three major criteria:

1. Minimum contact resistance
2. Maximum resistance to wear
3. Maximum resistance to welding

Silver or silver-alloy contacts are low in resistance, but wear rather easily. Tungsten, or majority-tungsten alloys are strong against wear due to arcing, but rather high in contact resistance. Where feasible, 60%+ silver alloy (with tungsten carbide) is used for contacts primarily intended for current carrying, and 60%+ tungsten alloy (with silver) is used for contacts primarily intended for arc interruption. Large-capacity MCCBs employ this arrangement, having multicontact pairs, with the current-carrying and arc-interruption duties separated.

3.5 Arc-Extinguishing Device

Arcing, an inevitable aspect of current interruption, must be extinguished rapidly and effectively, in normal switching as well as protective tripping, to minimize deterioration of contacts and adjacent insulating materials. In Mitsubishi MCCBs a simple, reliable, and highly effective “de-ion arc extinguisher,” consisting of shaped magnetic plates (grids) spaced apart in an insulating supporting frame, is used (Fig. 3.7). The arc (ionized-path current) induces a flux in the grids that attracts the arc, which tends to “lie down” on the grids, breaking up into a series of smaller arcs, and also being cooled by the grid heat conduction. The arc (being effectively longer) thus requires far more voltage to sustain it, and (being cooler) tends to lose ionization and extinguish. If these two effects do not extinguish the arc, as in a very large fault, the elevated temperature of the insulating frame will cause gassing-out of the frame material, to de-ionize the arc. Ac arcs are generally faster extinguishing due to the zero-voltage point at each half cycle.

3.6 Molded Case

The integral molded cases used in Mitsubishi MCCBs are constructed of the polyester resin containing glass fibers, the phenolic resin or glass reinforced nylon. They are designed to be suitably arc-, heat- and gas-resistant, and to provide the necessary insulating spacings and barriers, as well as the physical strength required for the purpose.

3.7 Terminals

These are constructed to assure electrical efficiency and reliability, with minimized possibility of localized heating. A wide variety of types are available for ease of mounting and connection. Compression-bonded types and bar types are most commonly used.

3.8 Trip Button

This is a pushbutton for external, mechanical tripping of the MCCB locally, without operating the external-accessory shunt trip or undervoltage trip, etc. It enables easy checking of breaker resetting, control-circuit devices associated with alarm contacts, etc., and resetting by external handle.

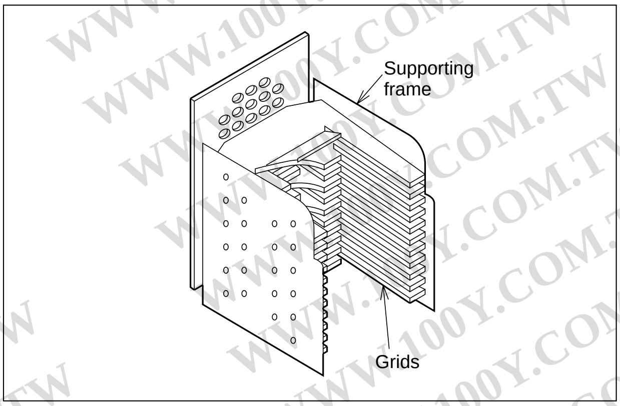


Fig. 3.7 The De-Ion Arc Extinguisher

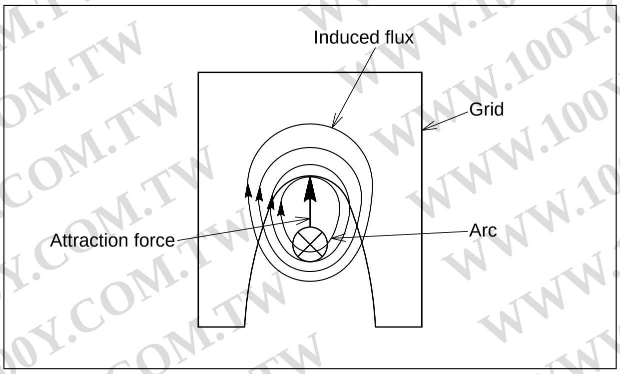


Fig. 3.8 The Induced-Flux Effect

4. CHARACTERISTICS AND PERFORMANCE

4.1 Overcurrent-Trip Characteristics (Delay Tripping)

Tripping times for overcurrents of 130 and 200% of rated current are given in Table 4.1, assuming ambient temperatures of 40°C, a typical condition inside of panelboards. The figures reflect all poles tested together for 130% tripping, and 105% non-tripping. Within the range of the long-delay-element (thermal or hydraulic) operation, tripping times are substantially linear, in inverse relationship to overcurrent magnitude.

The tripping times are established to prevent excessive conductor-temperature rise; although times may vary among MCCBs of different makers, the lower limit is restricted by the demands of typical loads: tungsten-lamp inrush, starting motor, mercury-arc lamps, etc. The tripping characteristics of Mitsubishi MCCBs are established to best ensure protection against abnormal currents, while avoiding nuisance tripping.

4.1.1 Ambient Temperature and Thermal Tripping

Fig. 4.1 is a typical ambient compensation curve (curves differ according to types and ratings), showing that an MCCB rated for 40°C ambient use must be derated to 90% if used in a 50°C environment. In an overcurrent condition, for the specified tripping time, tripping would occur at 180% rated current, not 200%. At 25°C, for the same tripping time, tripping would occur at 216%, not 200%.

4.1.2 Hot-State Tripping

The tripping characteristics described above reflect "cold-state tripping" – i.e., overloads increased from zero – and the MCCB stabilized at rated ambient. This is a practical parameter for most uses, but in intermittent operations, such as resistance welding, motor pulsing, etc., the "hot state" tripping characteristic must be specified, since over-loads are most likely to occur with the MCCB in a heated state, while a certain load current is already flowing.

Where the MCCB is assumed to be at 50% of rating when the overload occurs, the parameter is called the 50% hot-state characteristic; if no percentage is specified, 100% is assumed. Hot-state ratings of 50% and 75% are common.

4.2 Short-Circuit Trip Characteristics (Instantaneous Tripping)

For Mitsubishi MCCBs with thermal-magnetic trip units the instantaneous-trip current can be specified independently of the delay characteristic, and in many cases this parameter is adjustable offering considerable advantage in coordination with other protection and control devices. For example, in coordination with motor starters, it is important to set the MCCB instantaneous-trip element at a lower value than the fusing (destruction) current of the thermal overload relay (OLR) of the starter.

For selective tripping, it must be remembered that even though the branch-MCCB tripping time may be shorter than the total tripping time of the main MCCB, in a fault condition the latter may also be tripped because its latching curve overlaps the tripping curve of the former. The necessary data for establishing the required compatibility is provided in the Mitsubishi MCCB sales catalogues.

The total clearing time for the "instantaneous" tripping feature is shown in Fig. 4.3; actual values differ for each MCCB type.

Table 4.1 Overcurrent Tripping Times

Rated current (A)	Tripping time (minutes, max.)		Non-Tripping time (minutes, max.)
	200%	130%	105%
30 or less	8.5	60	60
31~63	4	60	60
64~100	8.5	120	120
101~250	8	120	120
251~400	10	120	120
401~630	12	120	120
631~800	14	120	120
801~1000	16	120	120
1001~1250	18	120	120
1251~1600	20	120	120
1601~2000	22	120	120
2001~4000	24	120	120

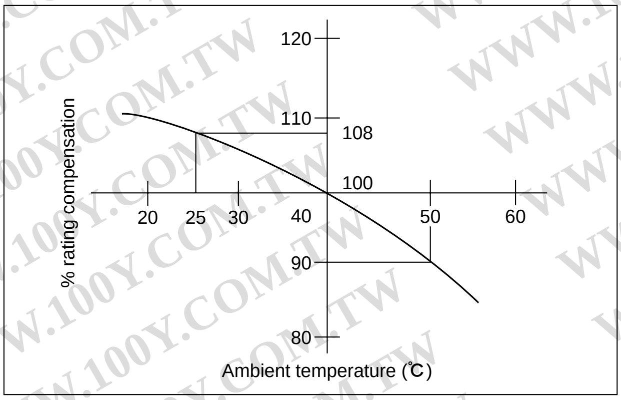


Fig. 4.1 Typical Temperature-Compensation Curve

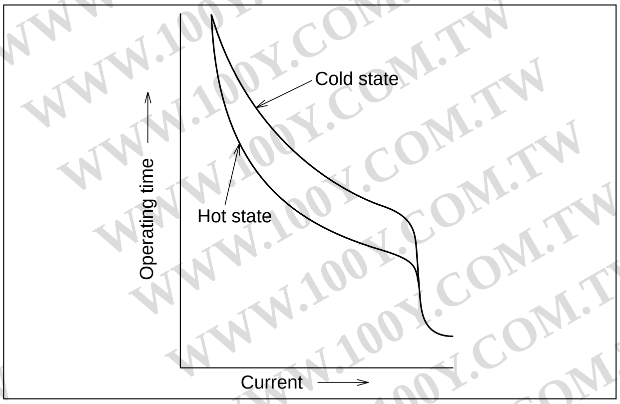


Fig. 4.2 Hot-State-Tripping Curve

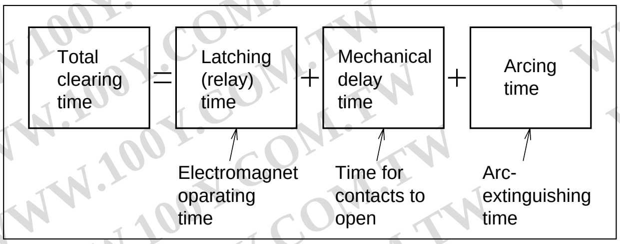


Fig. 4.3 Instantaneous Tripping Sequence

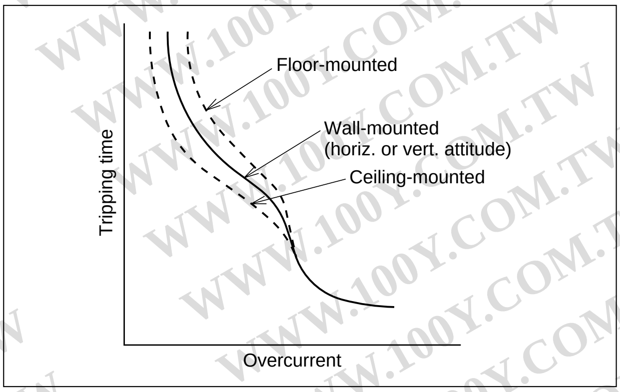


Fig. 4.4 Effect of Mounting Attitude on the Hydraulic-Magnetic MCCB Tripping Curves

4.3 Effects of Mounting Attitudes

Instantaneous tripping is negligibly affected by mounting attitude, for all types of MCCB. Delay tripping is also negligibly affected in the thermal types, but in the hydraulic-magnetic types the core-weight effect becomes a factor. Fig. 4.4 shows the effect, for vertical-surface mounting and for two styles of horizontal-surface mounting.

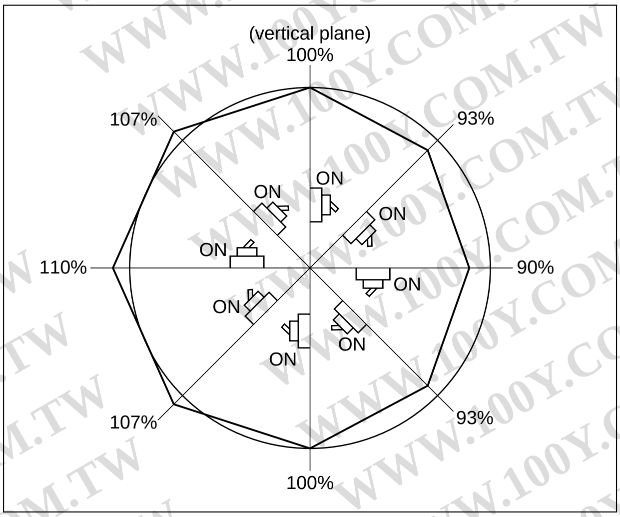
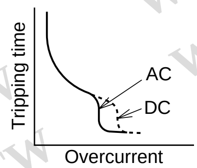
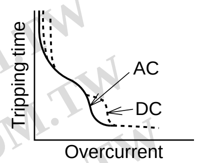


Fig. 4.5 Effects of Nonvertical-Plane Mounting on Current Rating

4.4 DC Tripping Characteristics of AC-Rated MCCBs

Table 4.2 DC Tripping Characteristics

Trip unit	Long delay	Instantaneous	Tripping curve
Thermal magnetic	No effect below 630A frame. Above this, AC types cannot be used for DC.	DC inst.-trip current is approx. 130% of AC value.	
Hydraulic magnetic	DC minimum-trip values are 110~140% of AC values.		

4.5 Frequency Characteristics

At commercial frequencies the characteristics of Mitsubishi MCCBs of below 630A frame size are virtually constant at both 50Hz and 60Hz (except for the E Line models, the characteristics of MCCBs of 800A frame and above vary due to the CT used with the delay element).

At high frequencies (e.g., 400Hz), both the current capacity and delay tripping curves will be reduced by skin effect and increased iron losses.

Performance reduction will differ for different types; at 400Hz it will become 80% of the rating in breakers of maximum rated current for the frame size, and 90% of the rating in breakers of half of the maximum rating for the frame size.

The instantaneous trip current will gradually increase with frequency, due to reverse excitation by eddy currents. The rise rate is not consistent, but around 400Hz it becomes about twice the value at 60Hz. Mitsubishi makes available MCCBs especially designed for 400Hz use. Apart from operating characteristics they are identical to standard MCCBs (S Line).

4.6 Switching Characteristics

The MCCB, specifically designed for protective interruption rather than switching, and requiring high-contact pressure and efficient arc-extinguishing capability, is expected to demonstrate inferior capability to that of a magnetic switch in terms of the number of operations per minute and operation life span. The specifications given in Table 4.3 are applicable where the MCCB is used as a switch for making and breaking rated current.

Electrical tripping endurance in MCCBs with shunt or undervoltage tripping devices is specified as 10% of the mechanical-endurance number of operations quoted in IEC standards.

Shunt tripping or undervoltage tripping devices are intended as an emergency trip provision and should not be used for normal circuit-interruption purposes.

Table 4.3 MCCB Switching Endurance

Frame size	Operations per hour	Number of operations		
		Without current	With current	Total
100 or less	120	8500	1500	10000
225	120	7000	1000	8000
400, 630	60	4000	1000	5000
800	20	2500	500	3000
1000~2000	20	2500	500	3000
2500, 3000	10	1500	500	2000
3200, 4000	10	1500	500	2000

4.7 Dielectric Strength

In addition to the requirements of the various international standards, Mitsubishi MCCBs also have the impulse-voltage withstand capabilities given below (Table 4.4). The impulse voltage is defined as substantially square-wave, with a crest length of 0.5~1.5µsec and a tail-length of 32~48µsec. The voltage is applied between line and load terminals (MCCB off), and between live parts and ground (MCCB on).

Table 4.4 MCCB Impulse Withstand Voltage (Uimp)

Line		Type	Impulse-voltage (kA)
MB		MB30-CS	4
		MB30-SP MB50-CP MB-50-SP MB100-SP MB225-SP	6
NF	S	NF30-SP NF50-HP NF60-HP NF50-HRP NF100-SP NF100-HP NF100-SEP NF100-HEP NF160-SP NF160-HP NF250-SP NF250-HP NF250-SEP NF250-HEP	6
		NF400-SP NF400-SEP NF400-HEP NF400-REP NF630-SP NF630-SEP NF630-HEP NF630-REP NF800-SEP NF800-HEP NF800-REP NF800-REP NF1000-SS NF1250-SS NF1600-SS	8
	C	NF30-CS	4
		NF50-CP NF60-CP NF100-CP NF250-CP	6
		NF400-CP NF630-CP NF800-CEP	8
	U	NF100-RP NF100-UP NF225-RP NF225-UP	6
		NF400-UEP NF630-UEP NF800-UEP	8

5. CIRCUIT BREAKER SELECTION

5.1 Circuit Breaker Selection Table

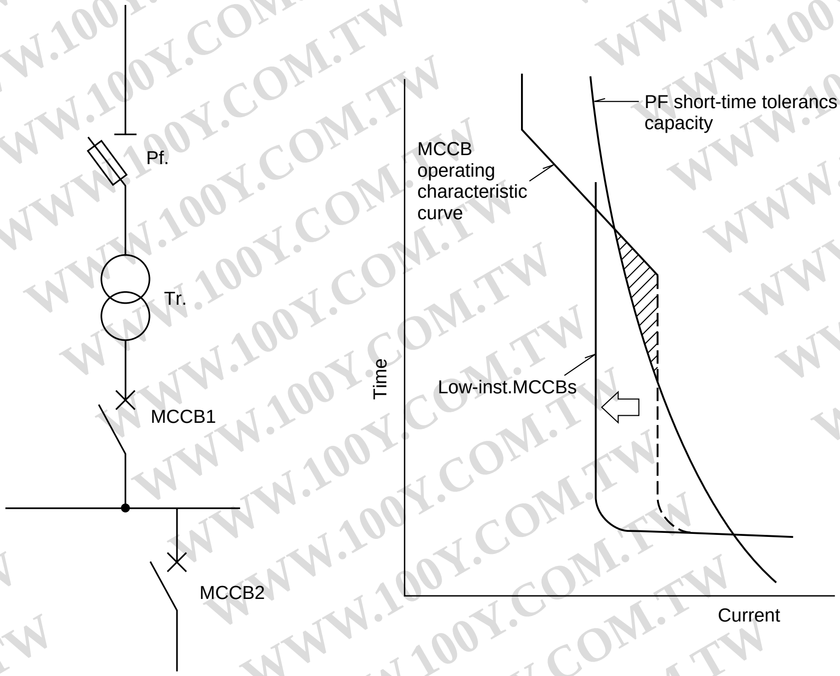
Following Table shows various characteristics of each breaker to consider selection and coordination with upstream devices or loads.

Characteristics

Standard : Standard charactristics MCCBs

Low-inst : Low-inst. MCCBs for Discrimination

When a power fuse (PF) is used as a high-voltage protector, it must be coordinated with an MCCBs on the secondary side.



Generator : Generator-Protection MCCBs

These MCCBs have long-time-delay operation shorter than standard type and low instantaneous operation.

Mag-Only : Magnetic trip only MCCBs

These are standard MCCBs minus the thermal tripping device. They have no time-delay tripping characteristic, providing protection only against large-magnitude short-circuit faults.

CIRCUIT BREAKER SELECTION TABLE

Frame (A)			30		50
Type			NF30-CS	NF30-SP	NF50-CP
Rated current In (A)			3, 5, 10, 15, 20, 30	3, 5, 10, 15, 20, 30	10, 15, 20, 30, 40, 50
Rated insulation voltage Ui (V) AC			500	600	600
AC Breaking capacity (kA rms) IEC60947-2 Icu/Ics		690V	–	–	–
		500V	–	2.5/1	2.5/1
		440V	1.5/1.5 (415V)	2.5/1	2.5/1
		400V	1.5/1.5 (380V)	5/2	5/2
		230V	2.5/2 (240V)	5/2	5/2
Standard	Number of poles		2 3	2 3	2 3
	Automatic tripping device		Hydraulic-magnetic Fixed ampere rating and instantaneous	Hydraulic-magnetic Fixed ampere rating and instantaneous	Hydraulic-magnetic Fixed ampere rating and instantaneous
	Rating (A) and Inst. (A)		3 39 ± 17 5 66 ± 28 10 132 ± 57 15 198 ± 86 20 265 ± 115 30 397 ± 172	3 33 ± 10 5 55 ± 17 10 110 ± 35 15 165 ± 52 20 220 ± 70 30 330 ± 105	10 110 ± 35 15 165 ± 52 20 220 ± 70 30 330 ± 105 40 440 ± 140 50 550 ± 175
Low-inst	Number of poles		–	–	–
	Automatic tripping device		–	–	–
	Rating (A) and Inst. (A)		–	–	–
Generator	Number of poles		–	–	–
	Automatic tripping device		–	–	–
	Rating (A) and Inst. (A)		–	–	–
Mag-Only	Number of poles		–	2 3	2 3
	Automatic tripping device		–	Magnetic Fixed ampere rating instantaneous	Magnetic Fixed ampere rating instantaneous
	Rating (A) and Inst. (A)		–	3 30 ± 6 5 50 ± 10 10 100 ± 20 15 150 ± 30 20 200 ± 40 30 300 ± 60	10 100 ± 20 15 150 ± 30 20 200 ± 40 30 300 ± 60 40 400 ± 80 50 500 ± 100