5. Troubleshooting

5.1 Troubleshooting for circuit-breaker proper (MCCB/ELCB)

Trouble		Cause		Countermeasure
Abnormal operation	Closing impossible	Foreign matter in switching mechanism		Foreign matters to be removed
		No resetting		To be reset once again
		Resetting impossible	See below (*)	See below
	(*) Resetting impossible Tripping impossible OFF impossible	Wear due to trip endurance	Incessant use of voltage trip operation	To be replaced with new one, Voltage trip to be replaced by electric operation
			End of service life	To be replaced with new one
		Poor reset mechanism	Poor adjustment	To be returned for repairing
		Non-excitation of undervoltage coil	Carelessness	To be excited
		Resetting time has not elapsed		Wait until the bimetal is cooled down
		Breakage and/or fatigue of the switching spring	Breakage by initial trouble	To be returned for repairing
			End of service life	To be replaced by new one
		Fusion of contact due to excessive interruptive current		To be replaced by circuit-breaker with large breaking capacity
Broken handle		Excessive operation power		Handle to be replaced
		Poor positional relationship between the external handle and the circuit-breaker		Handle to be replaced Revision of positional relationship
		Excessive shock from exterior		To be replaced with new one
Poor electrification		Insulating material mingled between contacts		Foreign matter to be removed (with removable cover) To be returned for repairing (with unremovable cover)
		Corrosion by infiltrating rain water, etc.		To be replaced with new one
		Fused conductive portion	Excessive interrupting current	To be replaced by new one with larger breaking capacity
		Large consumption of contact	Short-circuit current cut off. End of service life	To be replaced with new one
			Application of overcurrent	
Breakage of rated changeover screw		Excessive tightening torque (tighten with 3 to 4.5 kg-cm of torque)		To be returned for repairing
Troublesome operation	Troublesome operation under normal load	Too high an ambient temperature	Erroneous selection (temperature correction)	Rating selection to be changed
			Board hermetically closed	Ventilation
		Too high a temperature rise	Loosened connection to terminal	Retighten
		Deviation of applied frequency (thermal-adjustable electromagnetic type 800AF or higher)	Erroneous selection (frequency)	To be replaced with circuit-breaker of suitable frequency
		Load current strained with much high component		Distortion factor to be decreased by reactor Selection of rating to be changed
		Rather small measurements by error of measuring instrument due to distorted current		To be measured correctly by a meter with true effective value, and correct selection of rating
	Electronic type MCCB Overcurrent display LED is on	Too small a setting of rated current		Correct the setting of rated current
		Tightening forgotten of the changeover screw of rated current		Correct retightening of the rated current changeover screw with tightening torque: 3 to 4.5 kg-cm
		Failure of rated current changeover portion		To be returned for repairing
	Erroneous action while starting	Exothermic reaction due to repeated starting current	Erroneous selection	To be replaced by a unit with higher rating
		Too long a starting time	Erroneous selection	To be replaced by a unit with higher rating
	Instantaneous action during starting	Too high a starting current		Electromagnetic setting to be change or the unit to be replaced by one with higher rating
		Too high a starting rush current		Electromagnetic setting to be change or the unit to be replaced by one with higher rating
		Transient current when changing delta connection to star one. Transient current due to reversible operation		Electromagnetic setting to be change or the unit to be replaced by one with higher rating
		Rush current at the time of instantaneous restart		Electromagnetic setting to be change or the unit to be replaced by one with higher rating
		Rare short-circuit of motor		Motor to be repaired
		Bimetal reset incomplete after instantaneous tripping		To be fully restored
		Abnormal current running simultaneously with closing (short-circuit closing)		Circuit to be checked to remove the cause
	Operating while in use	Transmission was made with antenna of transceiver (5W or higher) closely mounted on the electronic MCCB and earth leakage breaker		Transceiver to be used at a distance at least 1 m from the electronic MCCB
Short-circuit on line side		Shift from the short-circuit of another conductor		Cause to be removed To be replaced with new one
		Accumulated dust		Cause to be removed To be replaced with new one
		Fall of conductor on line side		Cause to be removed To be replaced with new one
Temperature rise	Too high a temperature on the terminal side	Poor tightening	Poor maintenance	Retighten
		Contact heavily consumed	End of service life	To be replaced by new one
		Increased contact resistance	Intrusion of rust and dust	Foreign matters to be removed
	Too high a temperature on the lateral side of the mould	Complete electromagnetic type used in high frequency (400 Hz, for instance)		Suitable frequency to be selected To be changed into thermal type.
		Load current distorted containing much high frequency component		Distortion factor to be decreased by reactor Selection of rating to be changed
		Erroneous measurement dependent on feeling		To be measured with a measuring instrument
	Exothermic reaction of the tightened portion of stud	Loosened stud		Retighten
		Poor contact between the conductive portion of stud and the body terminal		Reassemble the stud
		Groove machining forgotten for reduction of eddy-current exothermic reaction of rear-connected type iron mount plate (400AF or higher)		Groove to be provided
No operation	No tripping with over current	Too high a rated current selected		To be replaced by a unit with lower rating
		Wrong frequency applied		Suitable frequency to be selected
		Tripping of backup circuit-breaker	Too low a current for instantaneous tripping of backup breaker	Instantaneous electromagnetic switch to be lowered Raise the electromagnetic setting of backup breaker or change the rating
No operation with tester (electronic MCCB)	Overcurrent display LED does not come on. Or, though it comes on, it goes off sonner than normal.	The battery of breaker tester has come at the end of its service life.		Battery to be replaced.
	Overcurrent display LED comes on and goes off after prescribed time. But, no tripping.	Poor tripping mechanism		To be returned for repairing.

5.2 Troubleshooting for leakage operation portion

Trouble		Cause	Countermeasure
Trouble-some action	Operates simultaneously with closing (such operation of leakage mechanism as popping-out of the leakage display button)	Too long a wire and too large a ground electrostatic capacity causes the leak current to flow	Rated sensitivity current to be changed, or ELCB to be installed near load
		Normal operation due to leak current	Leak point to be repaired
	Operates during use	Refer to 5.4	
Abnormal operation	Leakage operation and the like by test button, but no display	Poor lamp or its end of service life	To be replaced by new one
		Display button does not come out due to poor adjustment	To be returned for repairing
No operation	Depressing the test button does not lead to operation	Trouble in electronic circuit	To be replaced by new one
		No voltage applied	Apply specified voltage
		Poor continuity of contact	Remove foreign matter on the contact

5.3 Troubleshooting of accessories

Trouble		Cause		Countermeasure
NFM/NVM (electric operation device)	Operation disabled	Voltage drop of operational power supply	Too low a capacity of the wire of operational circuit	Increase the diameter of the wire
			Too low a capacity of the operational power supply	Improve the operational power supply
		Burnt resistor/motor	Excessive continuous operation	To be returned for repairing (replacement of resister/motor)
		Erroneous wiring		Regularize the wiring
		Erroneous voltage applied		Regular operational voltage to be applied
	Continuous idling	Operation of ON and OFF circuits at the same time or erroneous manipulation		Push button to be provided with interlock
		Self-sustaining auxiliary switch contact to be used for automatic resetting		The contact for automatic resetting to be used as that for alarm switch
	One turn of idling when closing	Voltage tripping in OFF state or tripping by undervoltage		OFF operation once to reset and ON operation again
		The circuit-breaker proper has automatically cut off and tripped		
UVT (undervoltage tripping device)	Closing disabled	Erroneous frequency or voltage applied		Power supply to be improved
		No pulling	Too large a voltage drop	Voltage to be improved
	No tripping even with no voltage	Trouble in circuit-breaker tripping mechanism		To be returned for repairing
SHT (voltage tripping device)	No tripping action	Insufficient voltage	Operational voltage drop	Power supply to be improved
			Erroneous voltage applied	Power supply to be improved
		Coil burnt out	Continous excitation of coil	To be returned for repairing (replacement of coil, auxiliary contact to be provided for protection from burning)
			Continuous excitation under a voltage inferior to the operating voltage	To be returned for repairing (replacement of coil), power supply to be improved
			Poor auxiliary contact for prevention of burning	To be returned for repairing (replacement of coil, contact to be repaired)
			Abnormal voltage applied	To be returned for repairing (replacement of coil)
AL (alarm switch), AX (auxiliary switch), EAL (earth-leakage alarm, switch), MG (Insulation switch) PAL (pre-alarm)	Malfunction	Poor contact due to overcurrent		To be returned for repairing
		Erroneous wiring	Erroneous wiring when installing	Regular wiring to be made referring to the name plate
		Microload	Erroneous selection	To be returned for repairing (to be replaced with that for microload)
		Loosened attaching screws	Insufficient tightening Vibration during transportation	To be returned for repairing (re-adjustment)

5.4 Analysis of unnecessary operation

Operation of ELCB by the causes on purpose, leak current, electrification, ground fault etc., is normal, while operation by other causes such as surge and induction is unnecessary (called stray operation or nuisance trip). It seems that quite a number of users have the preconception that earth leakage circuit breakers are troublesome as they operate unreasonably. Therefore, unnecessary operation is analyzed and selection of correct ELCB is stated in the following text.

5.4.1 Classification of ELCB operation

ELCB operation is classified as follows;

- Operation
  - Normal operation
    - (1) Operation by leak current, electrification, ground fault etc.
  - Unnecessary operation
    - Those attributable to ELCB
      - (2) Fault of earth leakage circuit breaker
      - (3) Inadequate sensitivity current (too sensitive)
    - Those attributable to circuit and others
      - (4) Operation by surge
      - (5) Operation by circulation current
      - (6) Operation by induction
      - (7) Operation by wrong wire connection
      - (8) Operation by inadequate earth
      - (9) Operation by influence of at ground fault of shunt circuit
      - (10) Operation by overload or short-circuit
      - (11) Operation by environment (vibration, impact etc.)
      - (12) Operation by carrier phone unit
      - (13) Operation by electromagnetic wave
      - (14) Operation by inverters
      - (15) Others (Operation of surge absorber etc.)

5.4.2 Detail of operation

(1) Normal operation

Operation of ELCB according to each purpose. Primary examples are shown below.

① Deterioration of equipment insulation ..... This is often the case with water handling devices such as washing machine and those subjected to high impact such as press machine.

② Deterioration of wire insulation ..... This is often the case with joints and terminals of temporarily installed electric lines.

③ Faulty work ..... Ground fault by damage or disconnection of cables during work.

④ Careless handling ..... Electrification by wetting and ground fault by surge or dropped foreign matter.

(2) Fault of ELCB

Failure caused by deterioration and corrosion of parts but fault of the leak detecting unit is rare. In some cases, closing becomes unstable because of wear of the magnet or the switching mechanism. Besides such fault, ELCB of low balancing characteristic tends to operation when the motor starts. It is, therefore, necessary, to use ELCB made by reliable manufacturers.

(3) Inadequate sensitivity current

ELCB operates if the sensitivity current is too sensitive compared with normal leak current of the circuit. This is a matter of selection.

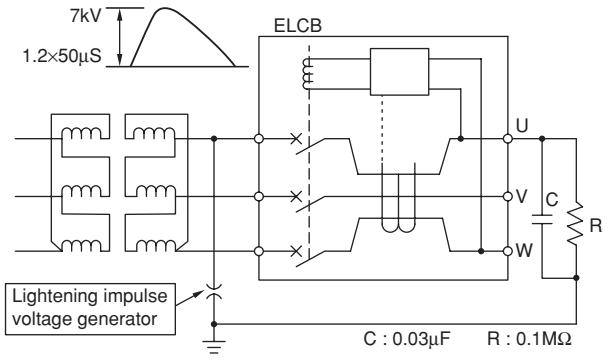
In most cases, leak current from circuits is attributable to static capacity to ground of the wire. Of some electric furnaces and sheath heaters, the insulation resistance comes down when cooled even if the insulation resistance is enough at high temperature, and it takes time to find out the cause of ELCB operation.

As to leak current from circuits, it must also be noted that ELCB is operated not only by leak current under normal condition but also by transient leak current to ground at switching or at start-up. Transient leakage at start-up is generated through static capacity to the frame of winding as potential distribution of winding at start-up differs from that during operation.

(4) Operation by surge

To surge by secondary transfer of inductive lightening of wires, non-operation test by lightening impulse is set forth in JIS C-8371, and surge resistivity is ensured. Circuit of the lightening impulse non-operation test is shown at right.

Almost all NVs of Mitsubishi are provided with a DPDC surge discrimination circuit for judging leak current to ground by ground fault current and surge so as to improve unnecessary operation preventing function.

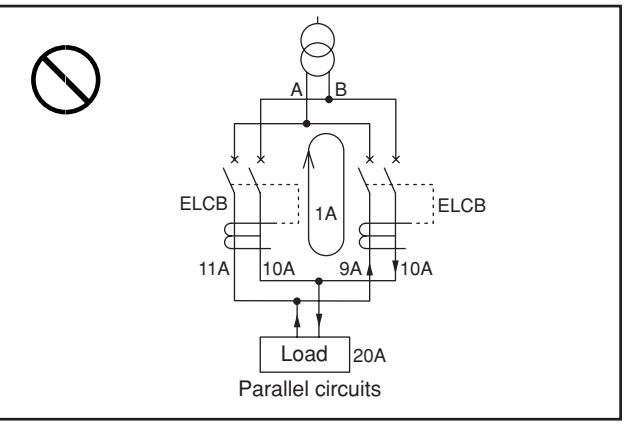


Test circuit of lightening impulse non-operation

(5) Operation by loop circuit (circulation current)

In the parallel circuits connected at load side, diverted current of each phase isn't necessarily equal between the right and the left branches. If A phase is diverted into 11A and 9A, for example, the difference of 1A is to be circulating in the loop.

Parallel use of two ELCBs is therefore prohibitive as the circulation current causes operation of the earth leakage circuit breaker.



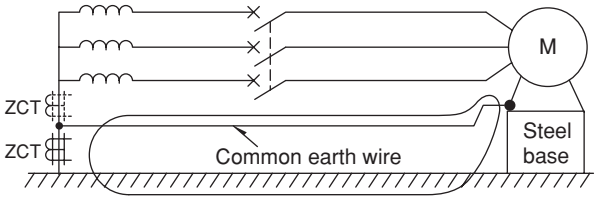
Parallel circuits

(5) Operation by induction

Those with loop circuits are susceptible to induction. Taking a loop as a loop antenna, the primary winding of ZCT is to be connected with the antenna, and induction is easily generated.

When a common earth wire is used, place the ZCT at the position of the continuous line in the drawing, then the primary conductor of the ZCT forms a loop. To avoid this, the ZCT must be placed at the position shown by the dotted line in the drawing.

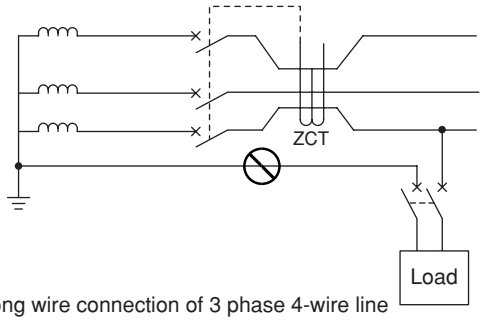
Induction can also be generated in the input circuit of the earth leakage relay, and it is necessary to braid the lead wires between the earth leakage relay, and the ZCT.



Ground fault detection by earth wire

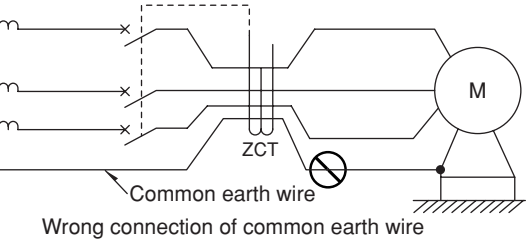
(7) Operation by wrong wire connection

Failure in passing the neutral wire through the ZCT for the lines of single phase 3-wire or 3 phase 4-wire is a simple mistake. In this case, the ELCB is operated by single phase load current.



Wrong wire connection of 3 phase 4-wire line

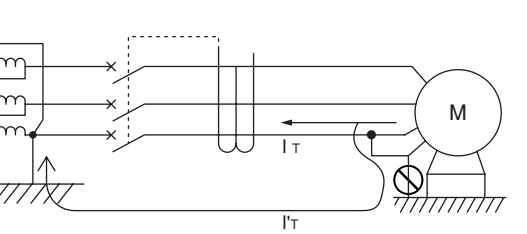
On the other hand, the common earth wire shall not go through the ZCT as it can be cause malfunction at leakage.



Wrong connection of common earth wire

(8) Operation by inadequate earth

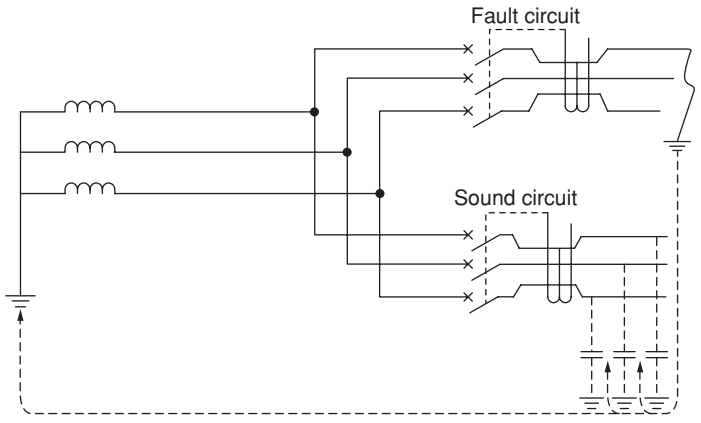
Though the wire is grounded at the earth side, the wire shall not be earthed at the load side. By the voltage of voltage drop in the line at the earth side, a part of the load current is diverted as shown by I'T, and the ELCB is operated.



Inadequate double ground

(9) Operation of sound circuit at ground fault of shunt circuit

Not only the ELCB in the ground fault circuit but also the one in the sound circuit is operated in some cases through the circuit as illustrated below. This can be avoided by keeping sensitive current suitably for the leak current by static capacity to ground.



Operation of sound circuit by static capacity to ground

(10) Operation by overload and short-circuit

It is natural that the devices having overload or short-circuit operation elements operate at short-circuit. However, ELCB is commonly used for many other purposes, and it tends to be overlooked that ELCB operate even at an overload and a short-circuit failure. Moreover, even the one dedicated to ground fault is sometimes operated by an excessive overload and short-circuit because balance performance of ELCB is limited. In these cases, however, overload and short-circuit can be noticed if they are significant.

(11) Environment of vibration, impact, high temperature etc.

These factors may be taken almost equal to those of Mitsubishi's MCCB. Heat resistivity of electronic circuits tends to be fell unreliable. To Mitsubishi's ELCB, enough allowance is given to ratings of the parts, the parts which can withstand high temperature operation are used, and the ICs incorporating tempereture compensation circuits are used to ensure stable operation even in varying temperature environment.

(12) Operation by carrier phone unit

Malfunctions of the ELCB can result in some cases when attached to a line provided with a carrier phone, which enables calls through the power line.

Since the carrier phone forcefully gives high frequency signals (normally 50kHz to 400kHz) between the line and the ground, the ELCB detects the high frequency signals as if they are leak current and leads to malfunction. Malfunction or not depends largely on magnitude of the high frequency signals, high frequency characteristic of the ELCB, and degree of rated sensitive current.

(13) Operation by electromagnetic wave

When a portable type transceiver is placed near the ELCB at transmission, particularly intense magnetic field is generated easily resulting in malfunction. Generally speaking, frequency bands of portable type transceivers are 27/28MHz, 50/50MHz, 150MHz, 400MHz, and 900MHz, and the output is about 0.5 to 5W. It is confirmed that the ELCB is free from any malfunction when different kinds of transceivers of 5W output are used for transmission being placed at 1m from the ELCB.

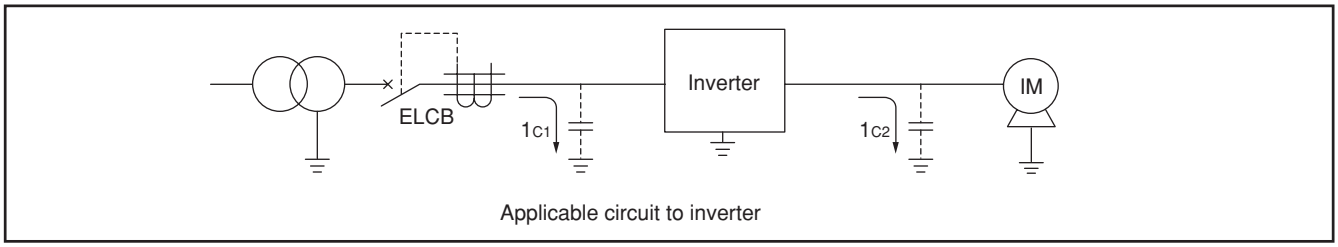
(14) Operation by inverters

Inverters operate many high-frequency components as they turn A.C. power supply to D.C. through rectification, then turn to A.C. again by switching through transistors.

Increased static capacity to ground sometimes causes malfunctions as the high frequency components are kept flowing by the static capacity to ground. To use ELCB in general in an inverter circuit, it is necessary to select those of lower sensitive current than usual in order avoid unnecessary operation.

For ground fault detection of high sensitivity in inverter circuit and yet for stable ground fault detection at both the primary and the secondary sides of the inverters, it is necessary to use an ELCB designed for higher harmonic earth-leakages and surges, which is hardly affected by high frequency components, as the measure against the inverter.

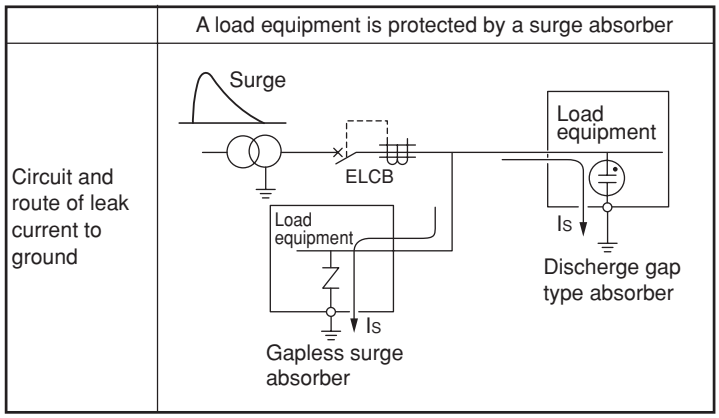
It is also essential to install the ELCB at the primary side of the inverter, and never at the secondary side.



Applicable circuit to inverter

(15) Others

As electronic arrangement of load equipment advances, surge absorbers are installed in the equipment more and more to protect them against surge. As the surge absorbers connected to the ground discharge the surge to the ground, a high leak current is generated to the ground, for a short time though, and unnecessary operation of the ELCB is resulted in some cases.



Leak current to ground through surge absorber

Most Mitsubishi's ELCB are provided with a DPDC surge discriminating circuit for judging ground fault current by failure such as faulty insulation from leak current to ground by surge, and improvement in the performance of preventing unnecessary operation is realized even when the surge absorber is installed between the line and the ground.