

Specification for Moulded Case Circuit Breakers from 100 to 630 A

Protective device for low voltage electrical installation

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1 General

The present specification applies to moulded-case circuit breakers (MCCB) from 100A to 630A for AC (50/60Hz) low voltage electrical installation from 220V to 690V. MCCB shall be equipped with a trip unit that offers the appropriate level of performance to fit to the application. Electronic versions will provide highly accurate protection with measurement, metering, operating assistance and communication functions.

- MCCB shall be available in fixed or plug-in/withdrawable versions as well as in 3-pole and 4-pole versions. For plug-in/withdrawable versions, a safety trip shall provide advanced opening to prevent connection and disconnection of a closed circuit breaker
- MCCBs shall be designed for both vertical and horizontal mounting, without any adverse effect on electrical performance. It shall be possible to supply power either from the upstream or downstream side.
- For a MCCB rating frame given , MCCBs dimensions shall be the same whatever the ultimate breaking capacity.
- MCCCB shall have a rated operational voltage of 800 V and a rated insulation voltage of 800 V (AC 50/60 Hz),

2 Compliance with Standards

Numéro	Titre	Usage
EN /IEC 60947-1 & 2	Low-voltage Switchgear and controlgear Part 2 : Circuit Breaker	Characteristics of circuit-breakers; - operation and behaviour in normal service; - operation and behaviour in case of overload and operation and behaviour in case of short-circuit, including co-ordination in service (discrimination and back-up protection); - dielectric properties;.
IEC 60947-2, annex B	Circuit Breaker incorporating residual current protection	
IEC 60947-2, annex F	Additional tests for circuit-breakers with electronic over-current protection	Electronic trip unit (rms current measurement, EMC)
IEC 60664-1	Insulation coordination for equipment within low-voltage systems - Part 1: Principles, requirements and tests	Category IV for a rated insulation voltage up to 690 V, class II insulation between the front and internal power circuits
IEC 61000-4-1	Electromagnetic compatibility (EMC) Testing and measurement techniques	EMC Immunity
IEC 61557-12	Combined performance measuring and monitoring devices for electrical parameters	Accuracy class
IEC 60068-2	Environmental testing	Climatic withstand
IEC 755	General requirements for residual current operated protective devices	Class A RCD

3 Circuit breaker design

3.1 Safety

For maximum safety,

- the power contacts shall be insulated in an enclosure made of a thermosetting material from other functions such as the operating mechanism, the case, the trip unit and auxiliaries
- All poles shall operate simultaneously for circuit breaker opening, closing and tripping.
- MCCBs shall be actuated by a toggle or handle that clearly indicates the three positions: ON, OFF and TRIPPED.
- In order to ensure suitability for isolation complying with IEC 60947-2 § 7-27:
- The operating mechanism shall be designed such that the toggle or handle can only be in OFF position (O) if the power contacts are all actually separated, in OFF position, the toggle or handle shall indicate the isolation position.
- Isolation shall be provided by a double break on the main circuit.
- MCCBs shall be able to receive a device for locking in the “isolated” position, with up to 3 padlocks, Ø8 maximum.
- MCCBs shall be designed to prevent access to live parts when the cover is removed
- MCCBs shall be equipped with a “push to trip” button in front to test operation and the opening of the poles.
- MCCB rating, “push to trip” button, performances and contact position indication must be clearly visible and accessible from the front, through the front panel or the door of the switchboard.
- For rating frame higher than 250 A MCCBs shall be fitted with metallic filters to reduce effects perceptible from the outside during current interruption

3.2 Current limitation, discrimination, durability

- From 100 A to 630 A rating frame, MCCBs breaking unit shall be made with a double rotary contact to greatly limit let through energy on the installation. For short-circuits, the maximum thermal stress I^2t shall be limited to: $10^6 A^2s$ for ratings up to 250 A, $5 \times 10^6 A^2s$ for ratings between 400 A and 630 A.
- MCCBs, the current ratings of which are identical with the ratings of their trip units, shall ensure discrimination for any fault current up to at least 35 kA rms, with any downstream circuit-breaker having a current rating less or equal to 0.4 times that of the upstream circuit-breaker.
- MCCB from 100A with electronic trip unit shall ensure total discrimination with Miniature Circuit breaker up to 40A.
- The electrical durability of MCCBs, as defined by IEC 60947-2 standard, shall be at least equal to 3 times the minimum required by the standard.

3.3 Auxiliaries and accessories

- It shall be possible to equip MCCBs with a motor mechanism for electrically controlled operation. An “auto/manual” switch in front shall, when set to the “manual” position, lock out electrical control; when set to “auto”, lock out the manual control; remote indication of “manual” or “auto” mode shall be possible. It shall also be possible to seal the access to the “auto” control. Closing shall take place in less than 80 ms.
- Following tripping due to electrical faults (overload, short-circuit, earth fault), remote reset shall be inhibited. It shall however be possible if opening was initiated by a voltage release.
- The operating mechanism shall be of the stored-energy type only
- The addition of a motor mechanism or a rotary handle shall in no way affect circuit breaker characteristics:
 - o Only three stable tripping mechanism positions (ON, OFF and TRIPPED) shall be possible with the motor mechanism,
 - o Suitability for isolation shall be provided by positive contact indication (ON and OFF) in front of the motor mechanism module
- MCCBs shall be designed to enable safe on-site installation of auxiliaries such as voltage releases (shunt and undervoltage releases) and indication switches as follows:
 - o same field installable auxiliary contacts for signalling different functions, as: open/ closed position, fault signal, electrical fault (including electrical leakage) signal, all auxiliaries shall be common for the entire range,
 - o they shall be separated from power circuits,
 - o all electrical auxiliaries shall be of the snap-in type and fitted with terminal blocks,
 - o Auxiliary function and terminals shall be permanently engraved on the case of the circuit breaker and the auxiliary itself,
- The addition of auxiliaries shall not increase the volume of the circuit breaker.
- The addition of a motor mechanism module or a rotary handle, etc., shall not mask or block device settings

4 Protections requirements

4.1 General

- MCCBs shall comprise a device, designed to trip the circuit-breaker in the event of high-value short-circuit currents. This device shall be independent of the thermal-magnetic or electronic trip unit. The breaking will be carried out in less than 10ms for short-circuit currents above $25I_n$.
- MCCBs with ratings up to 250 A shall be equipped with fully interchangeable trip units in order to ensure the protection against overcharge and short-circuit. The trip units shall be either of:
 - o thermal-magnetic
 - o electronic
- MCCBs with ratings over 250 A shall be equipped with electronic trip units.
- The trip units shall not augment overall circuit breaker volume
- Trip unit shall be easily interchangeable and easily secured to the MCCB without removing the breaker from the panel
- All electronic components shall withstand temperatures up to 105 °C.
- Electronic and thermal-magnetic trip units shall be adjustable and it shall be possible to fit lead seals to prevent unauthorised access to the settings
- Protection settings shall apply to all circuit breaker poles
- It shall be possible to equip MCCBs with an auxiliary contact signaling an electrical fault operated by the trip unit

4.2 Thermo-magnetic trip unit from 16 to 250 A

These trip units shall offer:

- Adjustable thermal protection from 0.7 to 1.0 times the current rating
- Fixed magnetic protection for current ratings up to 200 A
- Adjustable (from 5 to 10 times the current rating) for current ratings greater than 200 A.
- Adjustable (from 9 (or less) to 14 times the current rating for magnetic only motor protection
- It shall be possible to ensure neutral protection. The tripping threshold shall be equal to that of the phases

4.3 Electronic trip units from 16A to 630A

4.3.1 Generals

MCCB shall be equipped with a trip unit that offers the appropriate level of performance to fit to the application.

- It shall be possible to adjust basic protections with a knob without any power supply or when the main is off
- Electronic trip unit shall be fitted with thermal memory
- The following monitoring functions shall be integral parts of electronic trip units:
 - o 2 LED for load indication, one lighted above 90 % of I_r , and one lighted above 105 % of I_r
 - o a test connector shall be installed for checks on electronic and tripping mechanism operation using an external device
- MCCBs shall be equipped with a self-test of the connection between the electronic trip unit, the current transformers and the actuator. The self-test will be of positive logic and visible through the flashing of a green LED in case the self-test occurred correctly and the extinction of the LED in case the self-test failed.
- It shall be possible to equip MCCBs with auxiliary contact to indicate the cause of tripping (long time, short time, instantaneous, earth fault if requested),

4.3.2 Electronic trip units for standard application or without measurement and communication

These trip units shall offer

- Long time protection (LT)
 - Selectable I_r threshold settings from 36% to 100 % of the trip unit rating (by knobs)
- Short time protection (ST)
 - Selectable I_{sd} threshold settings from $1.5xI_r$ and $10xI_r$ (by knob)
 - Fixed short time delay 40 ms,
- Instantaneous protection: fixed threshold between 11 and $15xI_n$, depending on the rating

4.3.3 Electronic trip units for advanced protection or measurement and communication

4.3.3.1 Protections

- Long time protection (LT):
 - Selectable Ir threshold settings from 36% to 100 % of the trip unit rating (by knob)
 - Selectable temporisation from 0,5s@6Ir to 16s@6Ir
- Short time protection (ST)
 - Selectable Isd threshold settings from 1.5xIr and 10xIr (by knob)
 - Selectable temporisation from 0 to 0,4s with option I²t ON or OFF
- Instantaneous protection
 - Selectable Ii threshold settings from 1,5In to 11 or 15xIn, depending on the rating
- Fine adjustment shall be possible by keypad.
- Four-pole devices shall be equipped for neutral protection with
 - as standard with a 3-position setting : - neutral not protected - neutral tripping threshold equal to half the phase value - neutral threshold equal to the phase value
 - or LT protection for Neutral could be set separately up to 1,6xIr_phase
- The following additional protections could be offer according to the MCCB application:
- Ground fault protection
 - It shall be possible to deactivate the ground fault protection.
 - It shall be possible to adjust the ground fault protection down to 16A.
- Motor protection (unbalance, locked rotor, long start, under load)
- Generator protection

4.3.3.2 Measurement

These trip units shall offer measurement without additional module. Measures shall be either:

- Currents, (Phases, Neutral, average, max)

Or

- Currents, voltage, power, Energy, Total Voltage Harmonic distortion, Total current harmonic distortion.
- Accuracies of the entire measurement system, including the sensors: shall be
 - Current: Class 1 as per IEC 61557-12
 - Voltage: 0.5 %
 - Power and energy: Class 2 as per IEC 61557-12
- Rogowski current transformers shall be used to ensure accurate measurements from low current up to high currents
- Measurement chain shall be independent from the protection chain
- The measurements shall be displayed on the breaker itself and/or on a remote display and/or on a remote system via Modbus communication.

4.3.4 Additional earth leakage protection

- It shall be possible to assemble earth fault protection moulded-case circuit breakers by adding a residual current device (RCD) directly to the circuit breaker case. The resulting device shall:
 - o comply with appendix B of IEC 60947-2 standard,
 - o be immunised against nuisance tripping as per IEC 60255 and IEC 61000-4 standards,
 - o be capable of working normally down to -25 °C ambient temperature,
 - o operate without an auxiliary power supply, i.e. it shall be capable of operating normally on any 2-phase or 3-phase power network with a voltage between 200 V and 440 V, and of tripping the circuit-breaker even in the event of voltage dips down to 80 V
- An option shall allow to use RCD for alarming only.
- RCD module shall not exclude some other module or accessories.

5 Operating & Maintenance (Electronic trip units)

5.1 Operating assistance function

- Electronic trip units with measurement and communication capability shall offer operating assistance function:
 - o Indication of fault types (LT, ST, instantaneous, ground fault) faulty phases, Interrupted current.
 - o trips history
 - o alarms history
 - o events history (setting changes, test...)
- Theses functions and indicators shall be available by remote display, communication or setting PC tool.

5.2 Alarms

- User shall be able to activate alarms based on measurement (I, U, F, P, Q, S, THD, CosPhi, FP, Idemand, Pdemand,) or counters
- Alarms shall be time stamped
- Alarms could activate a digital output
- These functions and indicators shall be available by remote display, communication or setting PC tool.

5.3 Maintenance indicators

Electronic trip units with measurement and communication capability shall offer maintenance indicators:

- Operation, trip and alarm counters,
- Operating hours counter,
- Contact wear,
- Load profile
- These functions and indicators shall be available by remote display, communication or setting PC tool.

5.4 Auto-test – Led « Ready »

- MCCB's electronic trip unit shall be equipped with a self-test of the connection between the electronic trip unit, the current transformers and the actuator, that will not cause the circuit-breaker to trip.
- The self-test will be of positive logic and visible through the flashing of a green LED in case the self-test occurred correctly and the extinction of the LED in case the self-test failed.

5.5 Commissioning and operating tool

- A test connector shall be installed for checks on electronic and tripping mechanism operation using an external device
- A software tool available for all electronic trip unit shall be provided:
 - To visualize and configure trip unit parameters
 - To create and save setting files
 - To display tripping curve
 - To set time and date
 - To display tripping and alarms histories

6 Communication

MCCB shall be equipped easily with MODBUS communication.

- Whatever the trip unit is:
 - the following information shall be accessible:
 - ON/OFF position (O/F) / trip indication (SD) / fault-trip indication (SDE).
 - the following commands shall be possible
 - open / close / reset.
- When advanced trip units are used the following information shall be accessible:
 - instantaneous and demand values, maximeters/minimeters, energy metering, demand current and power, power quality.
 - protection and alarm settings
 - time-stamped trip and alarm histories and event tables
- Maintenance indicators.

7 Environment

- Production site organisation shall be non polluting and certified to comply with ISO 9002 and ISO 14001 standards.
- MCCBs shall be designed according to Eco-design complying with ISO 14062 Especially MCCB's materials shall be of halogen free type
- MCCB shall be designed for easy disassembly and recycling at end of life, and complies with environmental directives RoHS and WEEE.