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ISO 10924-1

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Road vehicles — Circuit breakers —

Part 1: Definitions and general test requirements

Véhicules routiers — Coupe-circuits —

Partie 1: Définitions et exigences générales d'essai

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 10924-1 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

ISO 10924 consists of the following parts, under the general title *Road vehicles — Circuit breakers*:

— *Part 1: Definitions and general test requirements*

— *Part 4: Medium circuit breakers with tabs (Blade type), Form CB15*

The following part is under preparation:

— *Part 2: User's guide*

The following parts are planned:

— *Part 3: Miniature circuit breakers with tabs (Blade type), Form CB11*

— *Part 5: High current circuit breakers with tabs (Blade type), Form CB29*

— *Part 6: Circuit breakers with bolt-in contacts*

Road vehicles — Circuit breakers —

Part 1:
Definitions and general test requirements

1 Scope

This part of ISO 10924 defines terms and specifies general test requirements for circuit breakers for use in road vehicles with a nominal voltage of 12 V or 24 V.

This part of ISO 10924 is intended to be used in conjunction with other parts of ISO 10924.

This part of ISO 10924 is not applicable to circuit breaker holders (electrical centres or fuse-holders) used in vehicles.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6722, *Road vehicles — 60 V and 600 V single-core cables — Dimensions, test methods and requirements*

ISO 8820-1, *Road vehicles — Fuse-links — Part 1: Definitions and general test requirements*

ISO 8820-3, *Road vehicles — Fuse-links — Part 3: Fuse-links with tabs (blade type) Type C (medium), Type E (high current) and Type F (miniature)*

ISO 16750-1, *Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 1: General*

ISO 16750-3, *Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 3: Mechanical loads*

ISO 16750-4, *Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 4: Climatic loads*

ISO 16750-5, *Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 5: Chemical loads*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 16750-1, ISO 8820-1 and the following apply.

3.1
circuit breaker
overcurrent protection device that interrupts mechanically the circuit reversibly, responsive to electric current

NOTE The test fixture for the circuit breaker might be identical to the test fixture as described in the appropriate part of ISO 8820, however, some circuit breaker designs do not require a separate test fixture, as the cables are directly connected to the circuit breaker terminals.

3.2 Circuit breaker types

3.2.1
type I – automatic reset
mechanism that provides the reversal of an over-load condition after a cool-down period without any manual activity required by a user

3.2.2
type II – electrically reset
mechanism having a secondary heating circuit which, after an over-load condition occurs, creates heat internally upon the thermal element of the circuit breaker to keep it from reversing, as long as electrical system voltage and a small current flow (< 1,0 A) are available

NOTE The reset function is accomplished by removing all electrical power supplied to the circuit breaker until the internal thermal element cools down and returns to its conductive position.

3.2.3
type III – manual reset
reset mechanism to enable the user by manual operation to reverse of a circuit interruption

3.2.4
type IV – switchable
mechanism for manual switch off for testing or maintenance

3.3 Circuit breaker components

3.3.1
housing
electrically non-conductive mechanical support for conductive and non-conductive parts of the circuit breaker

3.3.2
terminal
part of the circuit breaker that makes the electrical connection in the electrical circuit

3.3.3
thermal element
active part that monitors the current and causes the reversible interruption of the circuit in the case of an overcurrent

3.4 Circuit breaker features

3.4.1
snap-action mechanism
mechanism that ensures that the contact closing speed by mechanical reset is independent of the speed of operation of the reset mechanism

3.4.2
reset mechanism
mechanism that provides a user interface in a manual reset circuit breaker for resetting the device after an overcurrent condition

3.4.3
trip mechanism
mechanism that comprises a thermal actuator and mechanical components

3.4.4
switching mechanism
mechanism that provides the ability to switch off the circuit breaker by mechanical means

3.4.5
trip free mechanism
mechanism that prevents the switching mechanism from being defeated by forcibly holding the actuator in the "ON" position

NOTE In other words, it cannot be held closed against an overload.

3.4.5.1
cycling trip free mechanism
mechanism that cycles to open and close the contact(s) repeatedly if the actuator is maintained in the "ON" position in case of overcurrent

3.4.5.2
fully trip free mechanism
mechanism that enables the moving contact(s) to open and remain open, even if the actuator is maintained in the "ON" position in case of overcurrent

3.5
rated current
I_R
current used for identifying the circuit breaker, according to specified tests

NOTE 1 The continuous current is lower than the rated current.

NOTE 2 Adapted from ISO 8820-1:2008, definition 3.2.

3.6
prospective current
I_P
current that would flow in a circuit if the circuit breaker were replaced by a conductor with negligible impedance

NOTE See Figure 2.

3.7
nominal voltage
U_N
voltage value used to describe the electrical system of a vehicle

[ISO 16750-1:2006, definition 3.1]

3.8
supply voltage maximum
U_{Smax}
highest supply voltage in the specified supply voltage range of the DUT performing class A

[ISO 16750-1:2006, definition 3.4]

NOTE DUT: device under test.

3.9
voltage drop
U_D
voltage measured between specified measuring points at a specified current

[ISO 8820-1:2008, definition 3.4]

3.10
absolute breaking capacity
value of prospective breaking current a circuit breaker is capable of breaking at supply voltage maximum under prescribed conditions of use and behaviour

3.11
breaking capacity
value of prospective breaking current a circuit breaker is capable of breaking at rated voltage under prescribed conditions of use and behaviour

NOTE Adapted from ISO 8820-1:2008, definition 3.5.

3.12
time constant
time required for a physical quantity to rise from 0 to 1 – 1/e (i.e. 63,2 %) of its final steady value when it varies with time, t, as $1 - 1^{-kt}$

[ISO 8820-1:2008, definition 3.6]

3.13
operating time
time between the application of an over current and the moment when the current drops below a value, as specified in the appropriate part of ISO 8820

[ISO 8820-1:2008, definition 3.7]

3.14
resetting time
time elapsed between a circuit breaker tripping due to an overcurrent and subsequently reaching the ability of the circuit breaker to be reset

3.15
dielectric strength
strength measured between specified measuring points, as described in the appropriate parts of ISO 10924, at a specified voltage without flash-over

4 Marking, labelling and colour coding

The circuit breakers shall be permanently marked to be externally visible:

— rated current, I_R, expressed in amperes,

— supply voltage maximum, U_{Smax}, expressed in volts,

— colour coding,

— manufacturer's name, trademark or symbol.

The value of the nominal current without unit is accepted.

5 Tests and requirements

5.1 General

5.1.1 General test conditions

If not otherwise specified, all tests shall be performed at room temperature (RT) (23 ± 5) °C at a relative humidity (RH) of between 45 % and 75 % (standard condition).

At the beginning of the electrical tests, a direct current shall be fixed at the nominal value. This current shall be measured with an appropriate method. If not otherwise specified, no further adjustments during the tests are allowed.

All electrical measurement equipment shall have a tolerance of less than ±2 %.

Mount the circuit breaker in a test fixture (holder) as specified in the applicable part of ISO 10924.

For appropriate cable sizes, see the applicable part of ISO 10924.

Temperature measurements shall be performed at no forced air flow.

Connections shall be made to the circuit breaker with copper cables in accordance with ISO 6722. The cable length between the test fixture and the rest of the test set-up shall be (500 ± 50) mm, if not otherwise specified.

Measure the connection resistance using a dummy with dimensions as specified in the appropriate part of ISO 10924. Use a current as specified in the appropriate part of ISO 10924 for this measurement. For the voltages to be used, see Table 1.

Table 1 — Supply voltage maximum, U_{Smax}

Nominal voltage U_N V	Supply voltage maximum U_{Smax} V
12	16
24	32

5.1.2 General performance requirements

The general performance requirements are as follows:

— marking and labelling shall remain legible;

— colour coding shall remain recognizable;

— after testing, the circuit breaker shall be removable from the test fixture by its intended method;

— manual and switchable circuit breakers shall provide for visible evidence of the electrical state.

5.2 Voltage drop

5.2.1 Purpose

The purpose of this test is to define and measure the energy consumption of the circuit breaker which creates a temperature rise.

5.2.2 Test

The circuit breaker shall be loaded with I_R. Measure the temperature at the hottest spot of the housing by using appropriate equipment. After a minimum of 15 min and once the temperature has been stabilized, record the maximum temperature.

5.2.3 Requirement

The maximum voltage drop shall not exceed the values specified in the applicable parts of ISO 10924.

5.3 Maximum housing temperature

5.3.1 Purpose

The purpose of this test is to evaluate the circuit breaker's maximum surface temperature during normal operation.

5.3.2 Test

Subject the circuit breaker to I_R and measure the housing temperature by using a thermocouple attached to the top of the housing. After the current has been flowing for a minimum of 15 min and once the measurement has been stabilized, record the maximum housing temperature.

5.3.3 Requirement

The maximum housing temperature shall be less than 95 °C.

5.4 Environmental conditions

5.4.1 Purpose

The purpose of these tests (mechanical and climatic loads) is to evaluate the ability of the circuit breaker to function under environmental stresses.

5.4.2 Mechanical loads

5.4.2.1 Test

If mechanical load tests are required, appropriate tests shall be chosen from ISO 16750-3, which shall be agreed between the circuit breaker manufacturer and vehicle manufacturer.

NOTE The rating values are taken into account.

5.4.2.2 Requirement

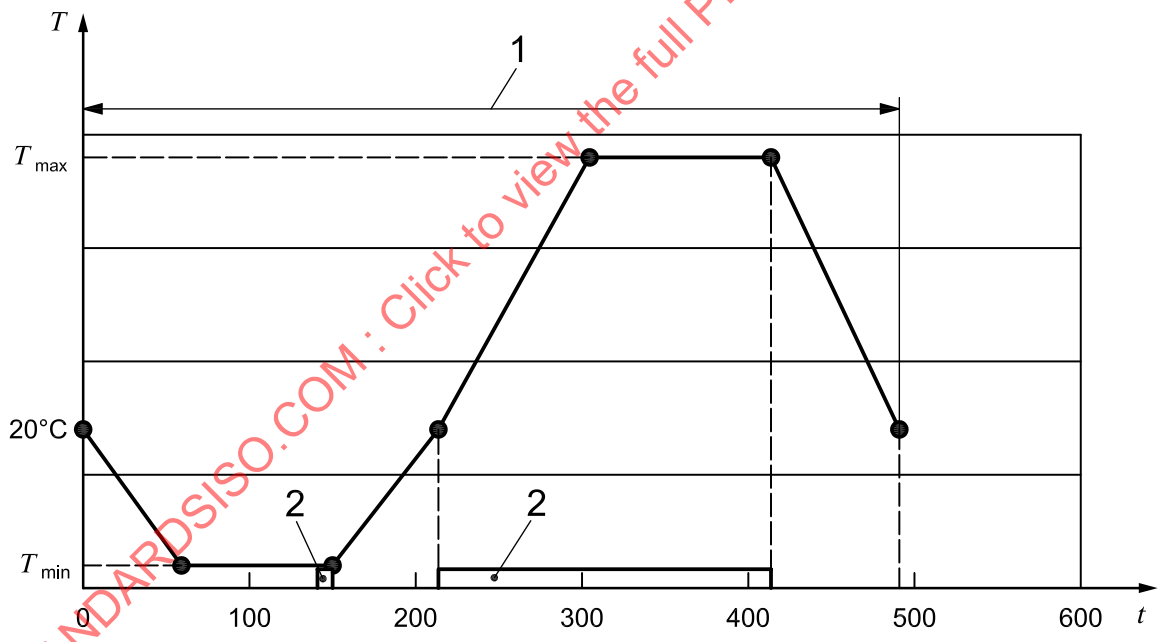
After the mechanical load tests, the circuit breaker shall meet the requirements specified in the applicable parts of ISO 10924.

5.4.3 Climatic loads

5.4.3.1 Test

See ISO 16750-4.

Subject the circuit breaker to a temperature/humidity cycling test as specified in Figure 1. The temperature range shall be in accordance with code G in ISO 16750-4.



Key

1 one cycle

2 operating mode 3.2, in accordance with ISO 16750-1

T temperature, in °C

t time, in min

NOTE See also ISO 16750-4.

Figure 1 — Temperature/humidity cycling

5.4.3.2 Requirement

After a minimum of 10 cycles, the circuit breaker shall meet the requirements specified in the applicable parts of ISO 10924.

5.4.4 Chemical loads

5.4.4.1 Purpose

The purpose of this test is to evaluate the resistance to diesel fuel, “bio” diesel fuel, unleaded petrol (gasoline), brake fluid (DOT4), engine coolant water-glycol mixture 1:1, engine oil (multi-grade) and AUS32 (urea). See ISO 16750-5.

5.4.4.2 Test

Use a cotton cloth with a moistened area of each fluid type in succession. Wipe 5 times with a force of 5 N over the external portions of the circuit breaker (see also test Xb in IEC 60068-2-70).

5.4.4.3 Requirement

After the test, the marking of the circuit breaker shall remain legible and colour coding shall remain recognizable.

5.5 Operating time rating

5.5.1 Purpose

The purpose of this test is to evaluate the ability of the circuit breaker to function when subjected to electrical overloads.

5.5.2 Test

Stabilize the test fixture and circuit breaker at RT before each test. Adjust the power supply to the test current as specified in the applicable parts of ISO 10924. Then, apply the test currents to the circuit breaker. Repeat this procedure for each sample.

The supply voltage shall not exceed the supply voltage maximum of the circuit breaker.

NOTE Electrically reset circuit breakers (type II) have a holding current after activation.

5.5.3 Requirement

The operating time of the circuit breaker shall be within the limits specified in the applicable parts of ISO 10924.

5.6 Current steps

5.6.1 Purpose

The purpose of this test is to evaluate the circuit breaker's ability to withstand the heating due to prolonged low level overloads.

5.6.2 Test

First, apply a current equivalent in value to the rating of the circuit breaker on test for a duration of 5 min. Then, sequentially increase the current in steps of 2,5 % of the circuit breaker rating in intervals of 5 min until the circuit breaker is activated and the current is interrupted.

5.6.3 Requirement

After the current step test, the current through the circuit breaker shall not exceed the value specified in the appropriate part of ISO 10924 at the supply voltage maximum. The circuit breaker shall be removable from the test fixture by its intended method after returning to RT. The devices subjected to the current step test shall additionally be subjected to operating time rating test as described in this clause.

5.7 No current trip and reset temperature

5.7.1 Purpose

The purpose of this test is to evaluate the circuit breaker's design variations and ambient temperature compensation.

5.7.2 Test

Place the circuit breaker into a climate chamber for 30 min at a temperature as follows:

— for rated current of 10 A and less: 72 °C;

— for rated current above 10 A: 102 °C.

After 30 min, raise the temperature at a rate not exceeding 1 °C per minute and record the temperature at which the circuit breaker opens. After the circuit breaker has opened, decrease the temperature at a rate not exceeding 1 °C per minute and record the temperature at which the circuit breaker closes. If more than one circuit breaker is tested at one time, they shall all open before the temperature is decreased.

If a circuit breaker does not trip up to a maximum ambient temperature of 200 °C, the test shall be terminated. In this case, the circuit breaker shall be loaded with 2 times rated current. Once the circuit breaker has opened, decrease the temperature at a rate not exceeding 1 °C per minute and record the temperature at which the circuit breaker closes.

5.7.3 Requirement

Circuit breakers rated 10 A or less shall not open at less than 82 °C and shall re-close before the temperature is below 70 °C.

Circuit breakers rated greater than 10 A shall not open at less than 112 °C and shall re-close before the temperature is below 70 °C.

5.8 Absolute breaking capacity

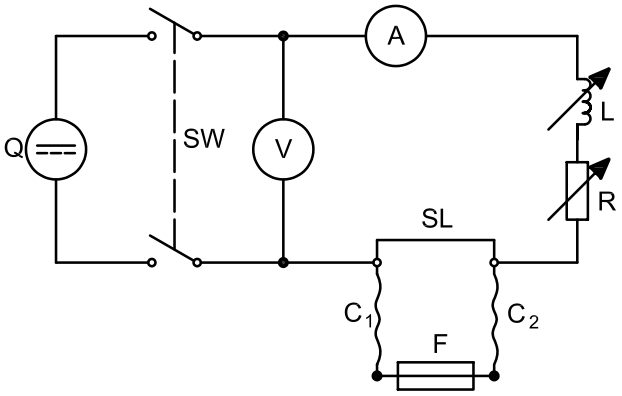
5.8.1 Purpose

The purpose of this test is to evaluate the ability of the circuit breaker to withstand the test breaking current.

5.8.2 Test

A test current $\binom{+5}{0}$% as specified in the appropriate part of ISO 10924 with a $(2{,}0 \pm 0{,}5)$ ms time constant and at a supply voltage maximum shall be applied to the circuit breaker until the thermal element is activated

and the electrical contacts are interrupting the current flow. After interruption, hold U_{Smax} for 30 s on manual reset type circuit breakers only. For non-manual reset circuit breakers, the hold time shall be long enough to see the voltage in the test circuit rise to U_{Smax}. The test circuit shall be in accordance with Figure 2.



Key

A	current meter	Q	power supply
L	adjustable inductor	SW	switch
SL	short circuit line/dummy	R	adjustable resistor
F	circuit breaker under test	V	voltmeter
C_1, C_2	test cables, length (500 ± 50) mm		

Figure 2 — Breaking capacity test circuit

5.8.3 Requirement

The following conditions shall not occur during the test:

— permanent arcing;

— no breakage of the circuit breaker casing shall be apparent;

— welding of the contacts or terminals.

After the test, the circuit breaker shall meet the requirements specified in the appropriate part of ISO 10924 and the circuit breaker shall be removable from the test fixture by its intended method.

If the results of the breaking capacity test are satisfactory, it shall be acceptable that the device be rendered inoperable, but otherwise intact, as described in the appropriate part of ISO 10924.

5.9 Breaking capacity

5.9.1 Purpose

The purpose of this test is to evaluate the ability of the circuit breaker to withstand the test breaking current and to remain

— functional after 1,5 cycles, and

— non-functional (fail-safe) after additional cycles

at breaking current.

5.9.2 Test

See ISO 8820-1 and ISO 8820-3.

This is 1 cycle. If more than 1 cycle is to be tested, a minimum waiting time of 3 min is required before the next cycle starts.

— Subject the circuit breaker to 1,5 cycles as shown in Figure A.3. For electrically reset circuit breaker type, if the circuit breaker does not reset after 0,5 cycles due to normal operation, terminate the test and proceed with the voltage drop test with a test current of 70 % of the rated current.

— After 1,5 cycles, reduce the test current to 70 % of the rated current, apply a test current for 0,5 h and perform the voltage drop test as described in 5.2.

— Cycle the circuit breaker to the breaking current $\binom{+5}{0}$ % until it ceases functioning. For an electrically reset circuit breaker type, if the circuit breaker does not reset after 0,5 cycles due to normal operation, remove the power to allow the circuit breaker to reset and subject the circuit breaker to 100 cycles or until it ceases functioning. For manual reset circuit breaker type, subject the circuit breaker to 100 cycles or until it ceases functioning.

See also 5.2.

5.9.3 Requirement

The following conditions shall not occur during the test:

— permanent arcing;

— no breakage of the circuit breaker casing shall be apparent;

— welding of the contacts or terminals.

After the 1,5 cycle test, the circuit breaker shall be able to hold 80 % of the rated load and meet the voltage drop requirements specified in 5.2. After the test, the circuit breaker shall meet the requirements specified in the appropriate part of ISO 10924 and the circuit breaker shall be removable from the test fixture by its intended method.

If the results of the breaking capacity test are satisfactory, it shall be acceptable that the device be rendered inoperable, but otherwise intact, as described in the appropriate part of ISO 10924.

5.10 Strength of terminals

5.10.1 Purpose

The purpose of this test is to evaluate the ability of the circuit breaker to withstand mechanical stress during insertion and removal.

5.10.2 Test

Forces shall be applied to the terminals of the circuit breaker as specified in the appropriate part of ISO 10924.

5.10.3 Requirement

See ISO 8820-3.

5.11 Endurance

5.11.1 Purpose

The purpose of this test is to evaluate the ability of the circuit breaker to withstand a normal cycling during its life.

5.11.2 Test

5.11.2.1 General

The test shall be performed at maximum supply voltage with a $(2{,}0 \pm 0{,}5)$ ms time constant. Test sequences and cycling profiles are specified in the applicable parts of ISO 10924.

5.11.2.2 Automatic reset (type I) circuit breakers

Apply a multiple I_R to the circuit breaker for a specified time, allowing it to cycle continuously.

5.11.2.3 Electrically reset for (type II) circuit breakers

Apply a multiple I_R to the circuit breaker for numbers of "ON"/"OFF" cycles as specified in the appropriate part of ISO 10924. The "ON" time of each cycle shall be 1 min. Multiple cycles are possible and allowed during this time. The "OFF" time shall be long enough for the circuit breaker to re-close the circuit. At the last cycle, the circuit shall remain on at a voltage level of $0{,}94 U_{Smax}$ for a period of 12 h. After 12 h, the circuit breaker shall be switched off to cool down to re-close the circuit. The test shall then be repeated as specified in the appropriate part of ISO 10924.

5.11.2.4 Manual reset (type III) and switchable (type IV) circuit breakers

5.11.2.4.1 Electro-mechanical cycling at rated current (for switchable (type IV) circuit breakers only)

Mechanically cycle the circuit breaker utilizing the trip mechanism, and subsequently the reset mechanism for numbers of cycles, as specified in the appropriate part of ISO 10924, while I_R is applied to the circuit breaker. See Figure A.1 for the cycling profile.

5.11.2.4.2 Electro-mechanical cycling at overload current

Cycle the circuit breaker for numbers of cycles as specified in the appropriate part of ISO 10924 while a multiple I_R is applied to the circuit breaker. The circuit breaker may trip during this time due to the current applied. If the circuit breaker does not trip within 30 s, the circuit breaker shall be mechanically tripped utilizing the trip mechanism and subsequently the reset mechanism. See Figure A.2 for the cycling profile.

5.11.2.4.3 High current cycling

Apply a multiple I_R to the circuit breaker for numbers of "ON"/"OFF" cycles, as specified in the appropriate part of ISO 10924, utilizing the reset mechanism on the circuit breaker.

5.11.3 Requirement

After the test, the current through the circuit breaker shall not exceed the value specified in the appropriate part of ISO 10924 at the nominal voltage. The following shall not occur:

— permanent arcing;

— ruptures to the external surfaces shall not be visible to the naked eye;

— welding together of the contacts or terminals;

— the circuit breaker shall be removable in one piece from the test fixture by its intended method.

5.12 Dielectric strength

5.12.1 Purpose

The purpose of this test is to evaluate the ability of the circuit breaker to withstand a specific voltage without flash-over.

5.12.2 Test

The test shall be performed in the “OFF” position. Measuring points, test voltage and duration are specified in the applicable part of ISO 10924.

5.12.3 Requirement

During the test, the requirements specified in the applicable part of ISO 10924 shall apply.