FINAL DRAFT
International Standard

ISO/FDIS 10924-2

Road vehicles — Circuit breakers —

Part 2: Guidance for users

ISO/TC **22**/SC **32**

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 32, *Electric and electronic components and general system aspects*.

This second edition cancels and replaces the first edition (ISO 10924-2:2014), which has been technically revised.

The main changes are as follows:

— added Clause 14.

A list of all parts in the ISO 10924 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Road vehicles — Circuit breakers —

Part 2: **Guidance for users**

1 Scope

This document provides guidance for the choice and application of automotive circuit breakers. It describes the various parameters that are taken into account when selecting circuit breakers.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 8820-1, *Road vehicles — Fuse-links — Part 1: Definitions and general test requirements*

ISO 10924-1, *Road vehicles — Circuit breakers — Part 1: Definitions and general test requirements*

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3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 8820-1 and ISO 10924-1 apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

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— IEC Electropedia: available at https://www.electropedia.org/

4 General

4.1 Overview

ISO 10924-1, ISO 10924-3, ISO 10924-4 and ISO 10924-5 define basic requirements and test methods for nominal voltage, rated current, I_R, and time/current characteristics to give comparable and reproducible results of circuit breakers.

In practice, however, there are other parameters which shall be considered for the correct selection of circuit breakers in road vehicles, such as:

— continuous current;

— operating time;

— overload protection of one or more electrical/electronic devices;

— connection resistance;

— types of cables, e.g. different cross section, length, insulation, bundling;

— internal resistances (voltage drop) of the circuit breakers, contacts, cables and devices;

- power dissipation of the components comprising the system;
- short-circuit parameters;
- inrush parameters of devices;
- operating mode of the load;
- operating of one or more electrical/electronic devices;
- orientation and location of the circuit breakers, e.g. engine, passenger or luggage compartment;
- different currents, voltages, and temperatures of the system and surroundings;
- distances or clearances inside circuit breaker boxes or holders;
- different circuit breakers, circuit breaker holders and boxes (see Annex B);
- environmental conditions (mechanical loads, climatically loads, chemical loads);
- forced cooling of the circuit breakers.

NOTE Consult the manufacturers of the circuit-breaker, contacts and cables, because not all of the above points can be addressed in this document.

The parameters listed are not intended to cover all the possible parameters that need to be taken into consideration for circuit breaker selection nor is it intended that all parameters are considered in each vehicle application.

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4.2 Circuit breaker nominal voltage

See ISO 10924-1:—,[1] Clause 3.

4.3 Supply voltage maximum, U_{Smax}

See ISO 10924-1:—, Clause 3.

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4.4 Rated current, I_R, and continuous current

The rated current, I_R, is the current used for identifying the circuit breaker.

The continuous current, I_C, in Figure 1 is the maximum current which the circuit can continuously carry under specified conditions: room temperature (23 °C), duration maximum 1 h, standard test holder, cross sections of wires. The continuous current can be lower than the rated current, I_R.

See *I-t* characteristics of the circuit breaker described in A.2.2.3.

1) Third edition under preparation. Stage at the time of publication: ISO/FDIS 10924-1:2024.

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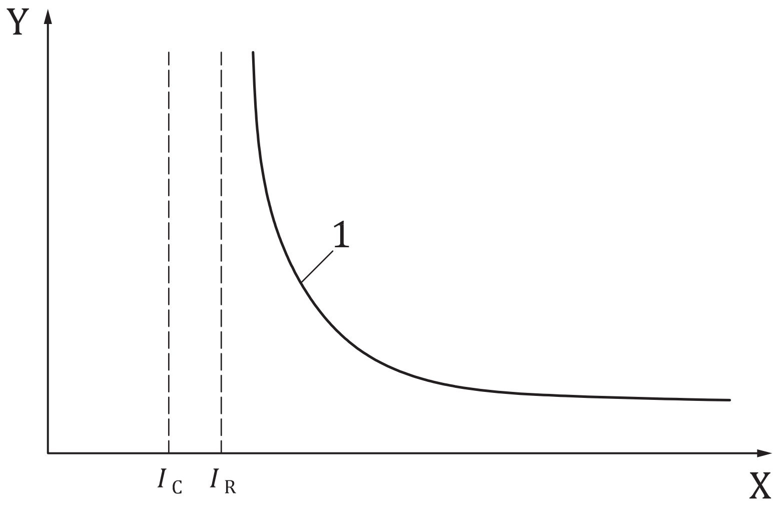

Key

X current, *I*

Y operating time, *t*

I_C continuous current

I_R rated current

1 time current characteristic

Figure 1 — Rated current (I_R), continuous current and time-current characteristic

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5 Current and conductors (cables)

The temperature rise of a cable is a function of current, conductor cross-section, strands, insolating materials time duration and room temperature.

See *I*-*t* - characteristic of the insulated conductor (cable) in A.2.2.4.

Figure 2 shows stabilized temperature rise for various conductor cross sections at room temperature (RT).

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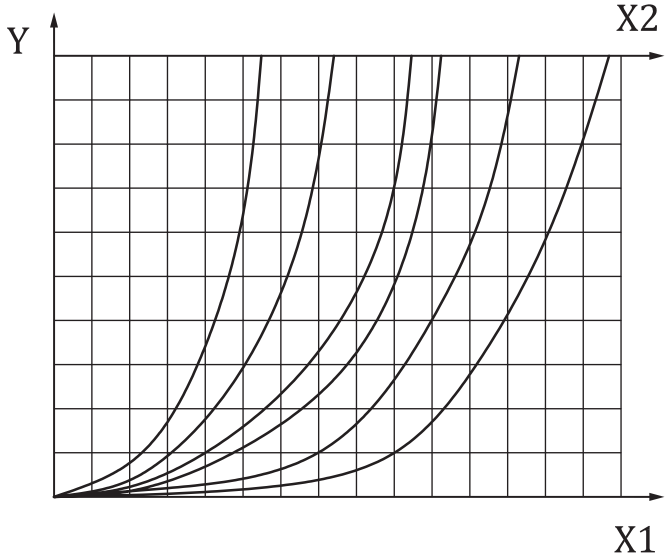

Key

X1 current, *I*

X2 conductor cross section

Y conductor temperature, *T*

Figure 2 — Conductor temperatures for different conductor cross sections vs. current at room temperature

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6 Current and contact resistance

A higher resistance of mated terminals results in a temperature rise and reduced thermal conduction away from the circuit breaker. Hence, the temperature of the circuit breaker terminal is higher and the continuous current for the application lower.

A temperature rise test can be conducted using circuit breakers, circuit breaker holders and connections as specified by the vehicle manufacturer. At a specified test current, the temperature of the connections shall be measured at the points, either tabs or bolt connection of the circuit breaker that protrude from the base of the circuit breaker body (specified in ISO 10924-1 according to the type of circuit breaker). After thermal equilibrium has been achieved, the temperature rise of the connection shall not exceed the limits specified for terminals and cable.

7 Current and ambient temperature

All components of a circuit and their parts have their own characteristic curve as shown in Figure 3.

Each component in a circuit has an upper temperature limit. An increase of temperature results in increased resistance, which can increase the temperature by itself. As a result, the circuit breaker can trip. It is always recommended to consult with specific manufacturers of circuit breakers for current versus temperature curves as both design and thermal materials used result in different curve characteristics.

See *I*-*t* - characteristic of the insulated conductor (cable) A.2.2.4 and rerating factor Table C.1.

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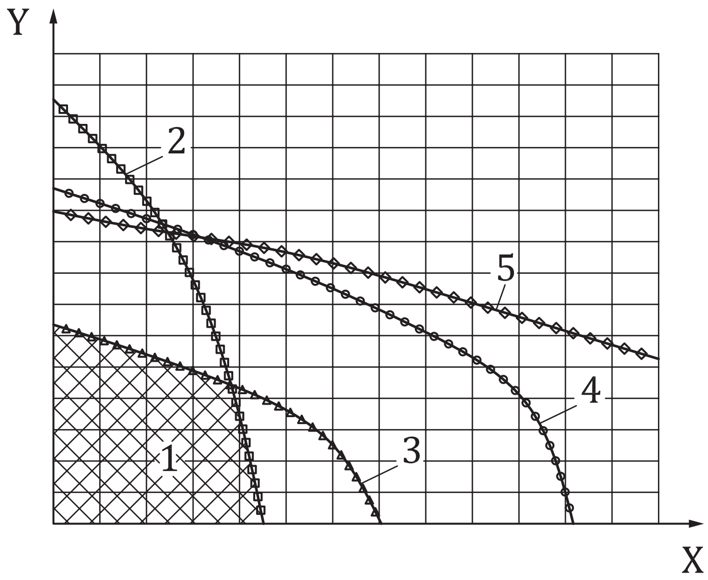

Key

X room temperature, T

Y current, I

1 application area

2 cable

3 connection

4 insulator

5 circuit breaker

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Figure 3 — Maximum continuous currents of circuit components vs. room temperature

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8 Cable protection: temperature versus current characteristics

To ensure satisfactory cable protection, circuit breakers shall be chosen such that they will always open before the maximum allowed cable temperature, $T_{max,}$ is exceeded. Figure 4 shows the correct circuit breaker selection. The maximum allowed temperature is never exceeded, because above a certain minimal operating current, I_f, the circuit breaker trips before reaching the maximum permitted temperature of the cable.

See the selection procedure for circuit breakers and cables in Annex A.

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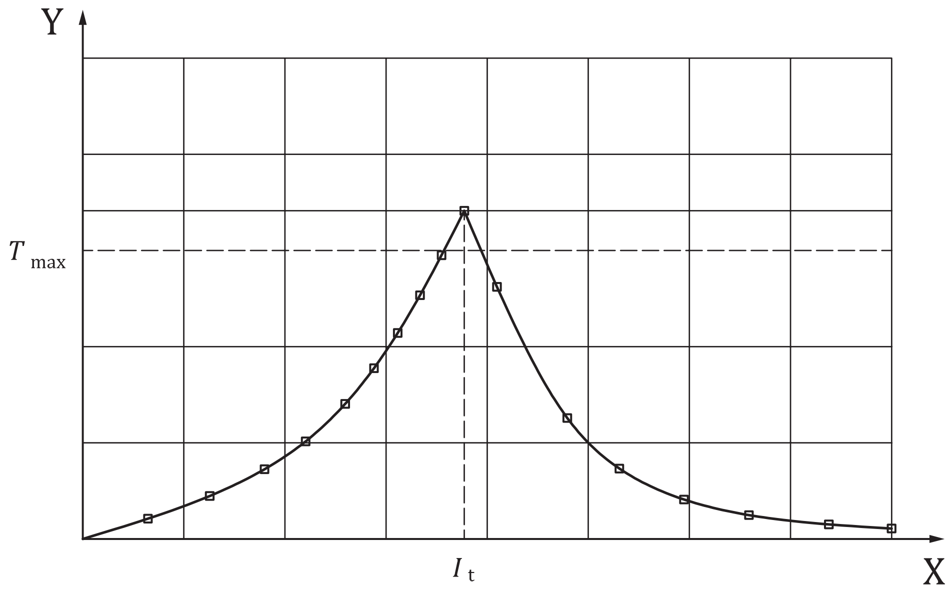

Key

X times rated current

Y cable temperature, T

I_t trip current

T_{max} maximum allowed cable temperature

Figure 4 — Correct circuit breaker selection

Figure 5 shows incorrect circuit breaker selection. The circuit breaker allows some potentially damaging current to flow for too long, causing the cable to overheat.

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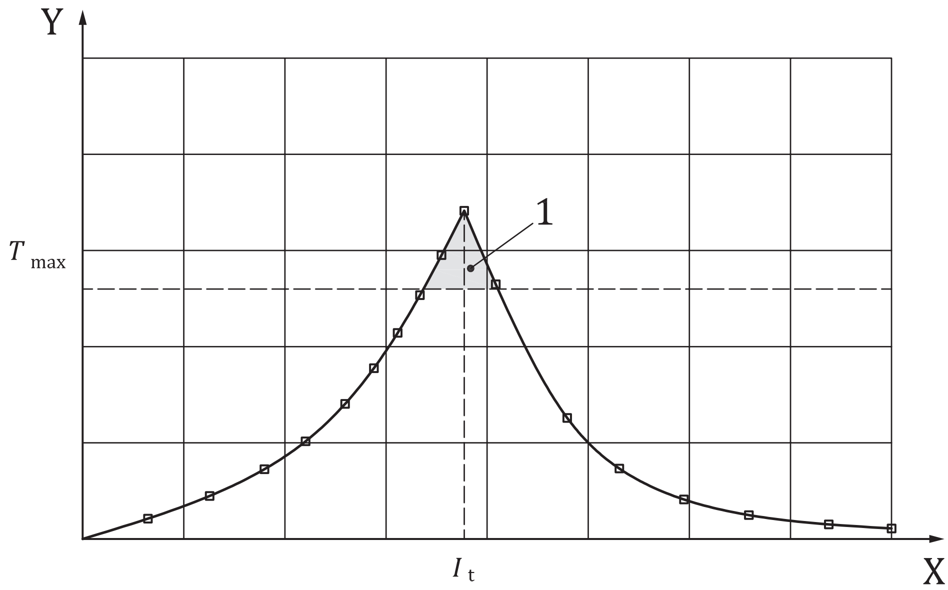

Key

X times rated current

Y cable temperature, *T*

I_t trip current

T_{max} maximum allowed cable temperature

1 unprotected region

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Figure 5 — Incorrect circuit breaker selection

9 Selectivity

Higher level circuit breakers shall not trip when lower level circuit breakers are opening (see Figure 6).

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