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Road vehicles — Environmental conditions and testing for electrical and electronic equipment for drive system of electric propulsion vehicles —

Part 4: Climatic loads

Véhicules routiers — Spécifications d'environnement et essais de l'équipement électrique et électronique pour les véhicules à propulsion électrique —

Partie 4: Contraintes climatiques

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

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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.

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 documents 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 on 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 the following URL: www.iso.org/iso/foreword.html.

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

A list of all parts in the ISO 19453 series can be found on the ISO website.

Road vehicles — Environmental conditions and testing for electrical and electronic equipment for drive system of electric propulsion vehicles —

Part 4:
Climatic loads

1 Scope

This document specifies requirements for the electric propulsion systems and components with maximum working voltages according to voltage class B. It does not apply to high voltage battery packs (e.g. for traction) and systems and components inside. It describes the potential environmental stresses and specifies tests and requirements recommended for different stress levels on/in the vehicle.

This document describes climatic loads.

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

ISO 19453-1, *Road vehicles — Environmental conditions and testing for electrical and electronic equipment for drive system of electric propulsion vehicles — Part 1: General*

ISO 20653, *Road vehicles — Degrees of protection (IP code) — Protection of electrical equipment against foreign objects, water and access*

IEC 60068-1:2013, *Environmental testing — Part 1: General and guidance*

IEC 60068-2-1, *Environmental testing — Part 2-1: Tests — Test A: Cold*

IEC 60068-2-2, *Environmental testing — Part 2-2: Tests — Test B: Dry heat*

IEC 60068-2-11, *Basic environmental testing procedures — Part 2-11: Tests — Test Ka: Salt mist*

IEC 60068-2-14, *Environmental testing — Part 2-14: Tests — Test N: Change of temperature*

IEC 60068-2-30, *Environmental testing — Part 2-30: Tests — Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

IEC 60068-2-52:2017, *Environmental testing — Part 2-52: Tests — Test Kb: Salt mist, cyclic (sodium chloride solution)*

IEC 60068-2-60, *Environmental testing — Part 2-60: Tests — Test Ke: Flowing mixed gas corrosion test*

IEC 60068-2-78, *Environmental testing — Part 2-78: Tests — Test Cab: Damp heat, steady state*

IEC 60664-1:2007, *Insulation coordination for equipment within low-voltage systems — Part 1: Principles, requirements and tests*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 16750-1 and ISO 19453-1 apply.

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

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

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

4 Operating temperature ranges

Choose the applicable temperature range from Table 1 to be presented in the specifications of the device under test (DUT).

In the case of hot soak, choose from Table 2 the relative temperature increase ΔT_{HS} and add it to the maximum temperature T_{max} to have the absolute hot soak temperature (T_{maxHS}).

$$T_{max} + \Delta T_{HS} = T_{maxHS}$$

For further details, refer to 5.2.1.

The paint repair temperature (T_{maxPR}) can be set to a higher value than the operating temperature. Specify this temperature in the specifications of the DUT.

Table 1 — Operating temperature ranges

Code	Minimum operating temperature T_{min} °C	Maximum operating temperature T_{max} °C
A	−20	65
B	−30	65
C	−40	65
D		70
E		75
F		80
G		85
H		90
I		95
J		100
K		105
L		110
M		115
N		120
O		125
P		130
Q		140
R		150
S		155
T		160
U		165
V		170
W		175
X		180
Z	As agreed	

Table 2 — Relative temperature increase in hot soak

Code	ΔT_{HS} K
a	15
b	30
c	50
z	As agreed

NOTE The code letter is defined as a combination of Tables 1 and 2, e.g. Hb (T_{max} = 90 °C and ΔT_{HS} = 30 K).

5 Tests and requirements

5.1 Tests at constant temperature

5.1.1 Low-temperature tests

5.1.1.1 Storage test

5.1.1.1.1 Purpose

This test simulates the exposure of the DUT to low temperatures without electrical operation, e.g. during shipment of the system/component. Failure mode is a malfunction due to insufficient frost resistance, e.g. the freezing of a coolant.

5.1.1.1.2 Test method

Perform the test in accordance with IEC 60068-2-1 at a temperature of −40 °C for a duration of 24 h unless otherwise indicated in the DUT specification. The operating mode of the DUT is 1.1, as defined in ISO 19453-1.

5.1.1.1.3 Requirement

The functional status shall be class C as defined in ISO 19453-1.

5.1.1.2 Operation test

5.1.1.2.1 Purpose

The purpose of the test is to make sure that the device under test maintains the function even after storage at low temperature.

5.1.1.2.2 Test method

Perform the test in accordance with IEC 60068-2-1 at a temperature of T_{min} for a duration of 24 h. The operating mode is 3.2 and/or 4.2 as defined in ISO 19453-1.

5.1.1.2.3 Requirement

The functional status shall be class A as defined in ISO 19453-1.

5.1.2 High-temperature tests

5.1.2.1 Storage test

5.1.2.1.1 Purpose

This test simulates the exposure of the DUT to high temperatures without electrical operation, e.g. during the shipment of the system/component. The failure mode is insufficient heat resistance, e.g. warping of plastic housings.

5.1.2.1.2 Test method

Perform the test in accordance with IEC 60068-2-2 at a temperature of 85 °C for a duration of 48 h unless otherwise indicated in the DUT specification. The operating mode is 1.1 as defined in ISO 19453-1.

5.1.2.1.3 Requirement

The functional status shall be class C as defined in ISO 19453-1.

5.1.2.2 Operation test

5.1.2.2.1 Purpose

This test simulates the exposure of the DUT to high temperatures with electrical operation, e.g. the use of the system/component at a very high ambient temperature. The failure mode is an electrical malfunction caused by high temperature, e.g. thermal degradation of components.

5.1.2.2.2 Test method

Perform the test in accordance with IEC 60068-2-2 at a temperature of T_{max} for a duration of 96 h. Use operating mode 3.2 and/or 4.2 as defined in ISO 19453-1.

5.1.2.2.3 Requirement

The functional status shall be class A as defined in ISO 19453-1.

5.2 Temperature cycling tests

5.2.1 Temperature cycle with specified change rate

5.2.1.1 Purpose

This test simulates varying temperatures with electrical operation of the DUT, e.g. during the use of the system/component at changing ambient temperature. If a system/component is exposed to hot-soak temperatures (e.g. engine-mounted systems/components), an additional short temperature peak is added during the high temperature stage of the profile to ensure proper function during short temperature peaks. The electrical operation is switched off during stages of decreasing temperature to avoid electrical heat dissipation of the system/component which would inhibit reaching T_{min} inside the system/component. The failure mode is an electrical malfunction during temperature change.

NOTE This test is not intended to be a life test.

5.2.1.2 Test method

Perform the temperature cycling in accordance with IEC 60068-2-14.

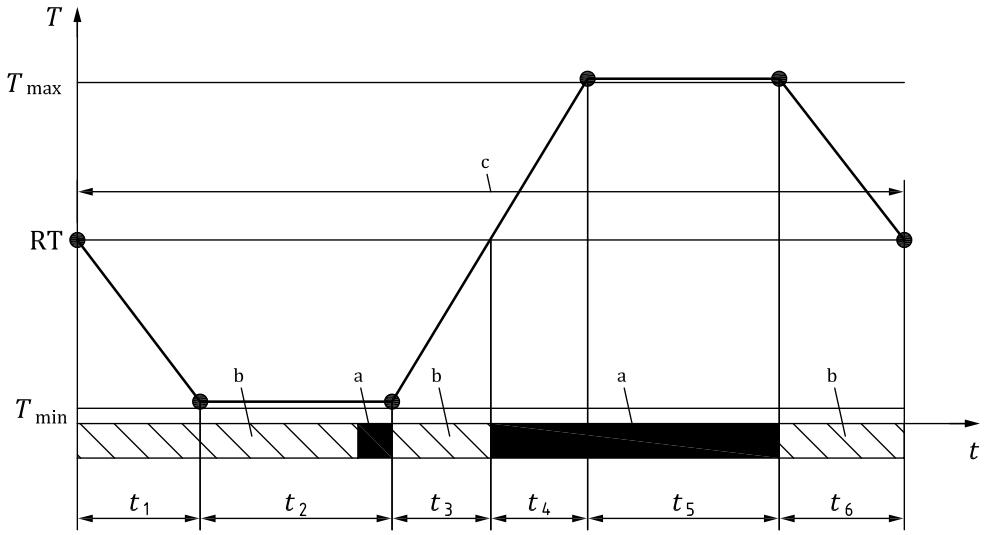
Operate the DUT electrically (functional test) after the whole device has reached T_{min} for the shortest possible duration to check the correct functioning of the device. In addition, an operation check should be done at stable high temperature (see Figure 1). Use operating mode 3.2 and/or 4.2 as defined in ISO 19453-1 for the stages with electrical operation.

The changes in temperature shall correspond to the specifications given in Table 3. For tests including hot-soak temperature (T_{maxHS}), see Table 4 and Figure 2. The supplier and the customer shall agree on a complete profile of temperature cycle.

A long period of electrical operation is started at room temperature (RT) as defined in ISO 19453-1 in order to allow possible condensation of humidity on the DUT. A permanent operation starting at T_{min} would prevent this due to the electrical power dissipation.

Additional drying of the test chamber air is not permitted.

Perform 30 test cycles as specified.



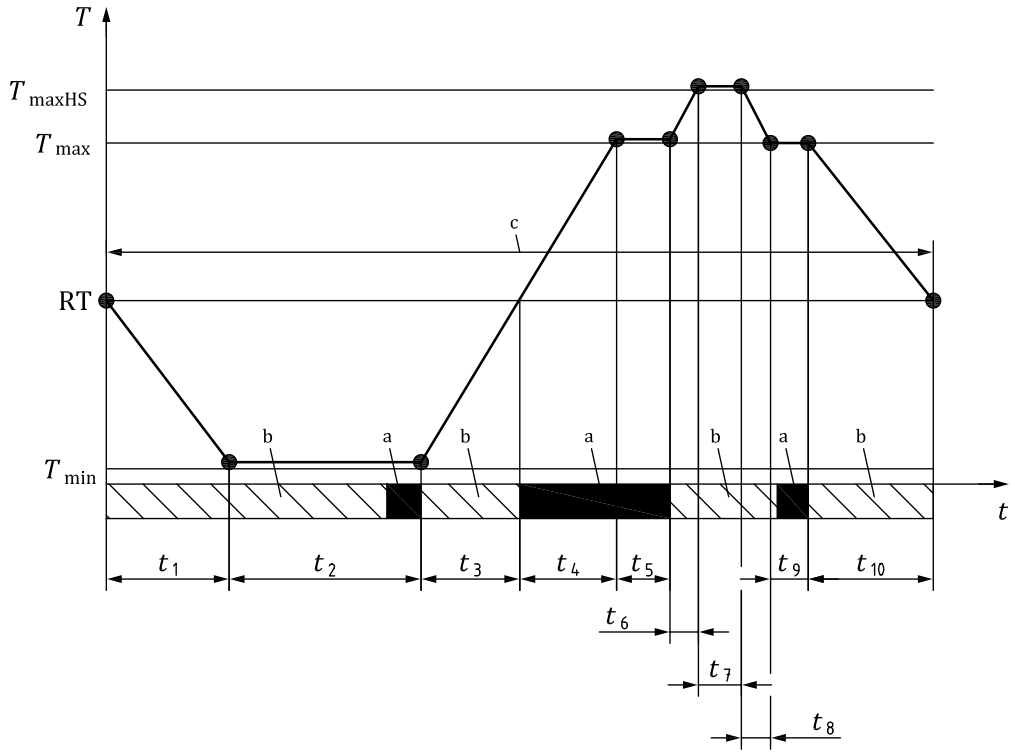
Key

T	temperature, in °C
t	time, in min
t_1, t_2, t_3, t_4, t_5, t_6	time parameter as defined in Table 3
a	Operating mode 3.2 and/or 4.2 as defined in ISO 19453-1.
b	Operating mode 2.1 as defined in ISO 19453-1.
c	One cycle.

Figure 1 — Temperature cycles with specified change rate

Table 3 — Temperature and time duration for temperature cycling (see Figure 1)

Parameter	Duration min	Temperature °C
t_1	As agreed	From RT to T_{min}
t_2	> 30	Stabilized time at T_{min}
t_3	As agreed	From T_{min} to RT
t_4	As agreed	From RT to T_{max}
t_5	> 30	Stabilized time at T_{max}
t_6	As agreed	From T_{max} to RT



Key

T	temperature, in °C
t	time, in min
t_1, t_2, t_3, t_4, t_5, t_6, t_7, t_8, t_9, t_{10}	time parameter as defined in Table 4
a	Operating mode 3.2 and/or 4.2 as defined in ISO 19453-1.
b	Operating mode 2.1 as defined in ISO 19453-1.
c	One cycle.

Figure 2 — Example of a temperature cycle with hot-soak stage

Table 4 — Temperature and time duration for temperature cycling with hot-soak stage (see Figure 2)

Parameter	Duration min	Temperature °C
t_1	As agreed	From RT to T_{min}
t_2	>30	Stabilized time at T_{min}
t_3	As agreed	From T_{min} to RT
t_4	As agreed	From RT to T_{max}
t_5	>30	Stabilized time at T_{max}
t_6	As agreed	From T_{max} to T_{maxHS}
t_7	> 30	Stabilized time at T_{maxHS}
t_8	As agreed	From T_{maxHS} to T_{max}
t_9	> 30	Stabilized time at T_{max}
t_{10}	As agreed	From T_{max} to RT

Instead of operating mode 3.2 and/or 4.2 in Figures 1 and 2, operating mode 2.1 may be used if agreed between the customer and the supplier.