INTERNATIONAL STANDARD

**ISO 16750-4**

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# Road vehicles — Environmental conditions and testing for electrical and electronic equipment —

## Part 4: Climatic loads



*Véhicules routiers — Spécifications d'environnement et essais de l'équipement électrique et électronique —*

*Partie 4: Contraintes climatiques*



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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 16750-4 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.



ISO 16750 consists of the following parts, under the general title *Road vehicles — Environmental conditions and testing for electrical and electronic equipment*:



— *Part 1: General*

— *Part 2: Electrical loads*

— *Part 3: Mechanical loads*

— *Part 4: Climatic loads*

— *Part 5: Chemical loads*

# Road vehicles — Environmental conditions and testing for electrical and electronic equipment —

## Part 4: Climatic loads

## 1 Scope

This part of ISO 16750 describes the climatic loads that can affect of electric and electronic systems and components in respect of their mounting location directly on or in road vehicles and specifies the corresponding tests and requirements.

## 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 12103-1, *Road vehicles — Test dust for filter evaluation — Part 1: Arizona test dust*

ISO 16750-1:2003, *Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 1: General*

ISO 16750-2:2003, *Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 2: Electrical loads*

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

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

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

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

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

IEC 60068-2-38, *Environmental testing — Part 2: Tests — Test Z/AD: Composite temperature/humidity cyclic test*

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

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

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

DIN 40050-9, *Road vehicles; degrees of protection (IP-code); protection against foreign objects; water and contact; electrical equipment*

## 3 Terms and definitions

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

## 4 Operating temperature ranges

The applicable temperature ranges shall be chosen from Table 1 and given in the specification of the device under test (DUT).

**Table 1 — Operating temperature ranges**

| Code | $T_{min}$ °C | $T_{max}$ °C |
|---|---|---|
| A | –20 | 65 |
| B | –30 | 65 |
| C | –40 | 65 |
| D | –40 | 70 |
| E | –40 | 80 |
| F | –40 | 85 |
| G | –40 | 90 |
| H | –40 | 100 |
| I | –40 | 110 |
| J | –40 | 120 |
| K | –40 | 125 |
| L | –40 | 130 |
| M | –40 | 140 |
| N | –40 | 150 |
| O | –40 | 155 |
| P | –40 | 160 |
| Z | As agreed upon | |



In case of hot-soak requirements ($T_{max,HS}$), add 15 °C to $T_{max}$. For details see 5.3.2.

The paint repair temperature ($T_{max,PR}$) can be higher than the operating temperature and shall be given in the specification of the DUT.

# 5 Tests and requirements

## 5.1 Tests at constant temperature

### 5.1.1 Low-temperature tests

#### 5.1.1.1 Storage

##### 5.1.1.1.1 Purpose

This test simulates the exposure of a system/component to low temperatures without electrical operation, for example during shipment. Failure mode is insufficient frost resistance (e.g. freezing of liquid crystal displays).

##### 5.1.1.1.2 Test

Perform the test according to IEC 60068-2-1, cold, at a temperature of –40 °C for a duration of 24 h, unless otherwise specified in the DUT specification. Use Operating mode 1.1 in accordance with ISO 16750-1:2003, Clause 5.

##### 5.1.1.1.3 Requirement

The functional status shall be Class C as defined in ISO 16750-1:2003, Clause 6.

#### 5.1.1.2 Operation



##### 5.1.1.2.1 Purpose



This test simulates the exposure of a system/component to low temperatures with electrical operation, for example use at very low ambient temperature. Failure mode is electrical malfunction caused by low temperature (e.g. freezing of capacitors with liquid electrolyte).

##### 5.1.1.2.2 Test

Perform the test according to IEC 60068-2-1 at a temperature of $T_{min}$ for a duration of 24 h. Use Operating mode 3.2 in accordance with ISO 16750-1:2003, Clause 5.

##### 5.1.1.2.3 Requirement

The functional status shall be Class A as defined in ISO 16750-1:2003, Clause 6.

### 5.1.2 High-temperature tests

#### 5.1.2.1 Storage

##### 5.1.2.1.1 Purpose

This test simulates the exposure of a system/component to high temperatures without electrical operation, for example during shipment. Failure mode is insufficient heat resistance (e.g. warping of plastic housings).

##### 5.1.2.1.2 Test

Perform the test according to IEC 60068-2-2 at a temperature of +85 °C for a duration of 48 h, unless otherwise specified in the DUT's specification. Use Operating mode 1.1 in accordance with ISO 16750-1:2003, Clause 5.

#### 5.1.2.1.3 Requirement

The functional status shall be Class C as defined in ISO 16750-1:2003, Clause 6.

### 5.1.2.2 Operation

#### 5.1.2.2.1 Purpose

This test simulates the exposure of the system/component to high temperatures with electrical operation, for example, use at very high ambient temperature. Failure mode is electrical malfunction caused by high temperature (e.g. thermal degradation of components).

#### 5.1.2.2.2 Test

Perform the test according to IEC 60068-2-2 at a temperature of $T_{max}$ for a duration of 96 h. Use Operating mode 3.2 in accordance with ISO 16750-1:2003, Clause 5.

#### 5.1.2.2.3 Requirement

The functional status shall be Class A as defined in ISO 16750-1:2003, Clause 6.

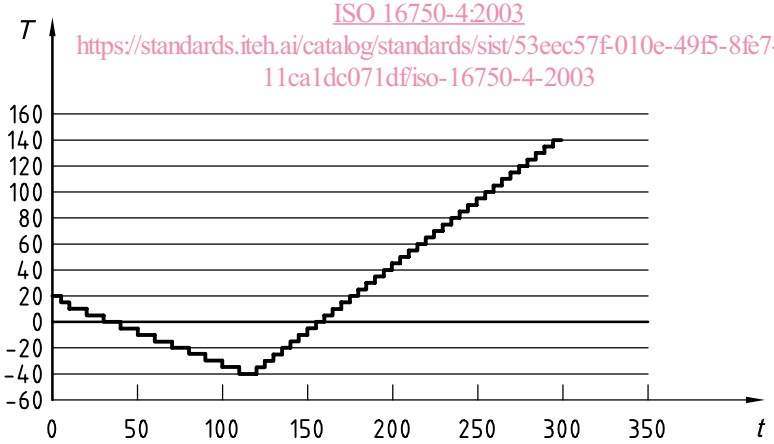
## 5.2 Temperature steps

### 5.2.1 Purpose



This test is for checking the mechanical and electrical device for malfunctions which may occur within a small section of the operating temperature range.






**Key**

$T$ temperature, °C

$t$ time, min

**Figure 1 — Temperature step test — Example** (illustrates code “M” according to Table 1)

### 5.2.2 Test

Install the DUT in a temperature chamber, decrease the temperature in steps of 5 °C from 20 °C to $T_{min}$ and then increase the temperature in steps of 5 °C from $T_{min}$ to $T_{max}$ (see Table 1 and Figure 1). Wait at each step until the DUT has reached the new temperature. Perform functional tests using operating mode 3.2 in accordance with ISO 16750-1:2003, Clause 5, at $U_{min}$ and $U_{max}$, using the appropriate code in accordance with ISO 16750-2:2003, Table 1, at each new temperature. Switch the DUT off during transition to the next temperature.

#### 5.2.3 Requirement

The DUT shall take up its normal function at each temperature between $T_{min}$ and $T_{max}$, i.e. the functional status shall be Class A as defined in ISO 16750-1:2003, Clause 6.

### 5.3 Temperature cycling

#### 5.3.1 General

Temperature cycling is based on IEC 60068-2-14.

#### 5.3.2 Temperature cycle with specified change rate

##### 5.3.2.1 Purpose

This test simulates varying temperatures during electrical operation of a system/component, for example during use at fast-changing ambient temperature. If the 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 phase of the profile to ensure proper functioning during short temperature peaks. The electrical operation is switched off during phases of decreasing temperature in order to avoid electrical heat dissipation of the DUT which would inhibit the reaching of $T_{min}$ inside it. Failure mode is electrical malfunction during temperature change.

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



##### 5.3.2.2 Test

Perform the temperature cycling according to IEC 60068-2-14, Nb



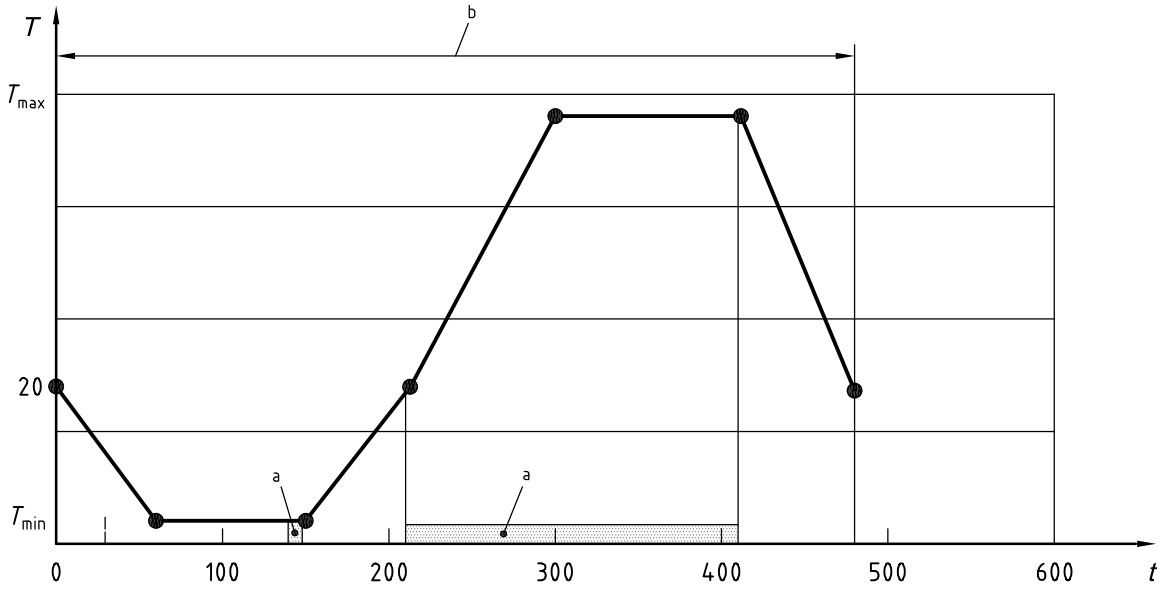
Operate the DUT electrically (functional test) after the whole device has reached $T_{min}$ for the shortest possible duration, in order to check that the device functions correctly. In addition, operate it electrically between 210 min and 410 min of the cycle (see Figure 2). Use Operating mode 3.2 in accordance with ISO 16750-1:2003, Clause 5 for the phases with electrical operation.

The changes in temperature shall be in accordance with Table 2. For tests including hot-soak temperature ($T_{max,HS}$), see Table 3.

Start the long period of electrical operation at 20 °C in order to allow possible condensation of humidity on the DUT. A permanent operation starting at $T_{min}$ would prevent this, owing to the electrical power dissipation.

Additional drying of the test chamber air is not permitted.

Perform 30 test cycles as specified.




**Key**

$T$ temperature, °C

$t$ time, min

a Operating mode 3.2 (see ISO 16750-1).

b One cycle.



**Figure 2 — Temperature cycles with specified change rate ($T_{min}$ and $T_{max}$)**

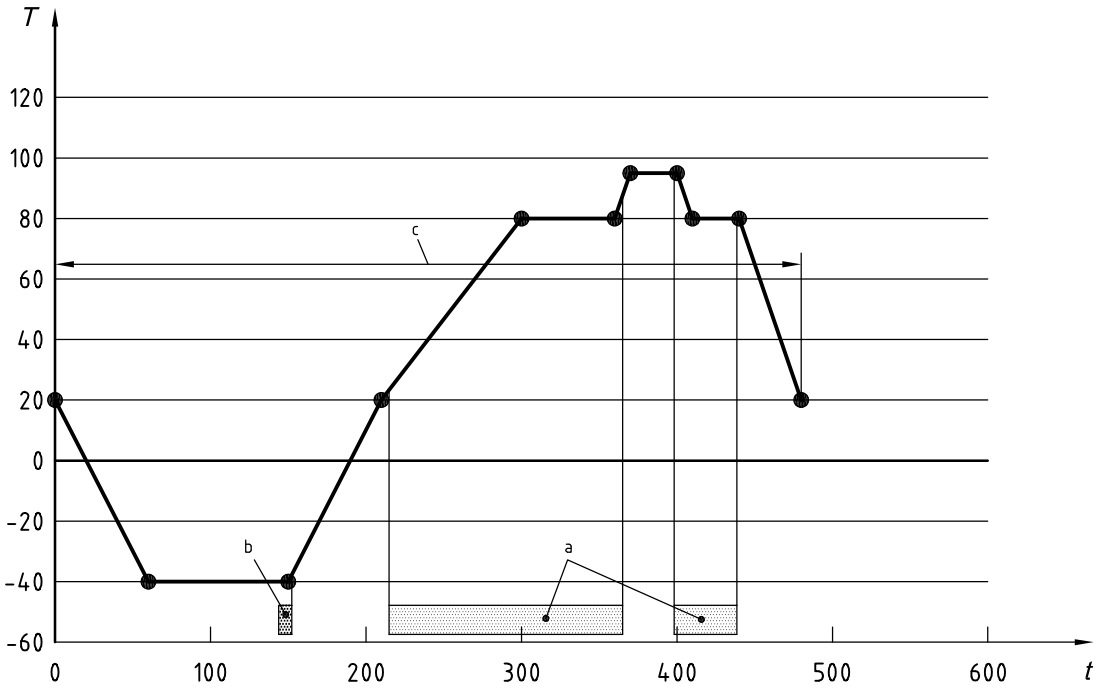


**Table 2 — Temperatures and time duration for temperature cycling (see Figure 2)**

| | Code (see Table 1) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Z[a] |
| **Time** min | **Temperature** °C | | | | | | | | | | | | | | | | |
| 0 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | |
| 60 | –20 | –30 | –40 | –40 | –40 | –40 | –40 | –40 | –40 | –40 | –40 | –40 | –40 | –40 | –40 | –40 | |
| 150 | –20 | –30 | –40 | –40 | –40 | –40 | –40 | –40 | –40 | –40 | –40 | –40 | –40 | –40 | –40 | –40 | |
| 210 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | |
| 300 | 65 | 65 | 65 | 70 | 80 | 85 | 90 | 100 | 110 | 120 | 125 | 130 | 140 | 150 | 155 | 160 | |
| 410 | 65 | 65 | 65 | 70 | 80 | 85 | 90 | 100 | 110 | 120 | 125 | 130 | 140 | 150 | 155 | 160 | |
| 480 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | |

In the vehicle environment, some equipment could experience a faster rate of temperature change or require longer stabilization times than those shown in Figures 2 and 3 and given in Table 2. In such cases, use Code Z.

a As agreed.




**Key**

$T$ temperature, °C

$t$ time, min

a Operating mode 3.2 (see ISO 16750-1).

b Functional test Operating mode 3.2 (see ISO 16750-1).

c One cycle.



**Figure 3 — Example for a temperature cycle with hot-soak phase — Example (illustrates Code E according to Table 1)**

**Table 3 — Temperatures and time duration for temperature cycling with hot-soak phase (see Figure 3) — Illustration of Code E (see Table 1)**

| Time<br>min | Temperature<br>°C |
|---|---|
| 0 | 20 |
| 60 | –40 |
| 150 | –40 |
| 210 | 20 |
| 300 | 80 |
| 360 | 80 |
| 370 | 95 ($T_{max,HS}$) |
| 400 | 95 ($T_{max,HS}$) |
| 410 | 80 |
| 440 | 80 |
| 480 | 20 |