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Third edition
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Road vehicles — Environmental conditions and testing for electrical and electronic equipment —

Part 1: General

Véhicules routiers — Spécifications d'environnement et essais de l'équipement électrique et électronique —
Partie 1: Généralités

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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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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, *Electrical and electronic components and general system aspects*.

This third edition cancels and replaces the second edition (ISO 16750-1:2006), which has been technically revised.

The main change compared to the previous edition is the extension of the variety of operating modes, so that not only “typical” load may be applied during the test but also maximum and minimum load.

A list of all parts in the ISO 16750 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.

Introduction

The concept of the ISO 16750 series is to assist its user in systematically defining and/or applying a set of internationally accepted environmental conditions, tests and operating requirements which are based on the anticipated actual environment in which the equipment will be operated and exposed to during its life cycle.

The following environmental factors have been considered in the development of this document:

— **World geography and climate:** Road vehicles are owned and operated in nearly all land regions of the Earth. Significant variation in environmental conditions due to climatic environment, including diurnal and seasonal cycles, can therefore be expected. Consideration has been given to worldwide ranges in temperature, humidity, precipitation and atmospheric conditions including dust, pollution and altitude.

— **Type of vehicle:** Environmental conditions in and on road vehicles can depend on vehicle design attributes such as engine type, engine size, suspension characteristics, vehicle mass, vehicle size, electrical supply voltage and so on. Consideration has been given to typical types of vehicles including commercial (heavy) trucks, passenger cars and trucks and diesel and gasoline engines.

— **Vehicle use conditions and operating modes:** Environmental conditions in and on the vehicle vary significantly with road quality, type of road surface, road topography, vehicle use (e.g. commuting, towing, cargo transport, etc.) and driving habits. Operating modes such as storage, starting, driving, stopping and so on have been considered.

— **Equipment life cycle:** Electrical and electronic equipment is also resistant to environmental conditions experienced during manufacture, shipping, handling, storage, vehicle assembly and vehicle maintenance and repair. Such conditions and test (e.g. handling drop test) are within the scope of the ISO 16750 series.

— **Vehicle supply voltage:** Supply voltage varies with vehicle use, operating mode, electrical distribution system design and even climatic conditions. Faults within the vehicle electrical system, such as overvoltage alternator and intermittencies in connection systems, can occur. Such conditions are within the scope of the ISO 16750 series.

— **Mounting location in the vehicle:** In current or future car concepts, systems/components are mounted in almost any location of the car. The environmental requirements for each specific application highly depend on its mounting location. Each location in a car has its distinct set of environmental loads. As an example, the range of temperatures in the engine compartment differs significantly from the range in the passenger compartment. This is also true for the vibration loads. But in this case, not only the vibration levels are different, the type of vibration load also varies. Body mount components are typically exposed to random vibrations whereas for engine mount systems/components the additional sine vibration from the engine is considered. Devices installed in doors are exposed to a high number of mechanical shocks from door slamming additionally.

It is desirable for the car manufacturer to group the different environmental load types and levels in a reasonable number of standard requirement sets. This strategy makes it possible to carry systems/components from one car project to another. Furthermore, the exact requirement levels are often unknown when designing a component for a future car concept. The expected environmental loads are usually compiled from other car concepts with similar conditions. The grouping is normally done by mounting location, but it is difficult to define the right number of different mounting locations and respective load profiles, because there is a conflict of aims between having only few requirement classes and tailoring to the requirement levels for each application. The reason is that the environmental loads are not only depending on the mounting location. There are other major factors that affect the stress levels for systems/components. For examples, body styles, drive-train concepts or package densities can create absolutely different requirement levels for devices that are installed in different cars at almost the same location.

The concept of the ISO 16750 series is to define requirement classes for separate load types. It distinguishes between electrical, mechanical, thermal, climatic and chemical loads. For each load type, several requirement classes are defined. Every requirement class is determined by a specific code letter. The complete environmental requirement set is created by defining the code letter combination. The code letters are defined in the respective clauses of this document. Additionally, tables in the annexes of each part consists of usual mounting locations and define examples of their respective code letters. For normal applications, these code letters are used. If an application is very specific and therefore the given code letter combinations cannot be used, it is possible to create new code letter combinations to serve this purpose. In case none of the given code letters is useable, new requirement levels can be created by using the code letter Z. In this case, the specific requirements need to be defined separately but it is desirable not to change the test methods.

It is recommended to consider at least the following mounting locations for a device under test (DUT) with respect to thermal, mechanical, climatic and chemical load.

0.1 Applicability to manufacturers' responsibility

Due to technology limitations or variations in vehicle design, the vehicle manufacturer may be required to place a component in a location where it cannot withstand the environmental conditions described in the ISO 16750 series. Under these circumstances, it is the responsibility of the vehicle manufacturer to provide the necessary environmental protection.

0.2 Applicability to wiring harnesses, cables and electrical connectors

Although some environmental conditions and tests in the ISO 16750 series may be relevant to vehicle wiring harnesses, cables and connectors, its scope is not sufficient to be used as a complete standard. It is therefore not recommended that the ISO 16750 series be directly applied to such devices and equipment. Applicable standards are taken into account.

0.3 Applicability to parts or assemblies in or on equipment

The ISO 16750 series describes environmental conditions and tests to be applied to electrical and electronic equipment directly mounted in or on the vehicle. It is not intended for direct application to parts or assemblies that are part of the equipment. For example, the ISO 16750 series should not be directly applied to integrated circuits (ICs) and discrete components, electrical connectors, printed circuit boards (PCBs), gauges, displays, controls, etc. that are attached in or on the equipment. Electrical, mechanical, climatic and chemical loads for such parts and assemblies can be quite different from those described in the ISO 16750 series.

On the other hand, it is desirable to use the ISO 16750 series to help derive environmental conditions and test requirements for parts and assemblies that are intended for use in road vehicle equipment. For example, a temperature range of −40 °C to 90 °C may be specified for an assembly contained inside a piece of equipment having a temperature range of −40 °C to 70 °C and a temperature rise of 20 °C.

0.4 Applicability relative to system integration and validation

The user of the ISO 16750 series is cautioned to understand that the scope of the ISO 16750 series is limited to conditions and testing at the equipment level, and therefore does not represent all conditions and testing necessary for complete verification and validation of the vehicle system. Environmental and reliability testing of equipment parts and vehicle systems may be required.

For example, the ISO 16750 series does not necessarily ensure that environmental and reliability requirements for solder joints, solderless connections, integrated circuits, and so on are met. Such items are assured at the part, material or assembly level. Likewise, vehicle and system level testing is required to validate the equipment in the vehicle application.

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

Part 1: General

1 Scope

The ISO 16750 series applies to electric and electronic systems/components for vehicles. It describes the potential environmental stresses and specifies tests and requirements recommended for the specific mounting location on/in the vehicle.

This document contains definitions and general notes. Electromagnetic compatibility (EMC) is not covered by the ISO 16750 series.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

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

3.1
hot-soak temperature
T_{maxHS}
maximum value of the ambient temperature which may temporarily occur in the engine compartment after the vehicle has stopped and the engine is turned off

3.2
nominal voltage
U_N
voltage value used to describe the electrical system of a vehicle

3.3
maximum operating temperature
T_{max}
maximum value of the ambient temperature at which the systems/components can be operated continuously

3.4
minimum operating temperature
T_{min}
minimum value of the ambient temperature at which the systems/components can be operated

3.5
paint repair temperature
T_{maxPR}
maximum temperature which occurs during vehicle paint repair

3.6
peak to peak voltage
U_{pp}
superimposed AC voltage

3.7
supply voltage
U_S
voltage of the electrical system of a vehicle that varies with the system load and the operating condition of the generator

3.8
supply voltage minimum
U_{Smin}
lowest supply voltage in the specified supply voltage range of the DUT performance class A

3.9
supply voltage maximum
U_{Smax}
highest supply voltage in the specified supply voltage range of the DUT performance class A

3.10
supply voltage operating mode 3
U_A
supply voltage for generator in operation

3.11
supply voltage operating mode 2
U_B
supply voltage for generator not in operation

3.12
test voltage
voltage(s) applied to the DUT during a test

EXAMPLE U_A and U_B.

4 Classification by mounting location

4.1 Engine compartment

Device mounted:

— to the body;

— to the frame;

— on the flexible plenum chamber, not rigidly attached;

— in the flexible plenum chamber, not rigidly attached;

— on the engine;

— in the engine;

— on the transmission/retarder;

— in the transmission/retarder.

4.2 Passenger compartment

Device mounted in a position:

— without special requirements;

— exposed to direct solar radiation;

— exposed to radiated heat (other than solar radiation).

4.3 Luggage compartment/load compartment

Device mounted inside.

4.4 Mounting on the exterior/in cavities

Device mounted:

— to the body;

— to the frame;

— under the body/wheel housing:

  — sprung masses;

  — unsprung masses (wheel, wheel bracket, axle);

— in/on a passenger compartment door;

— to the engine compartment cover;

— to the luggage compartment lid/door;

— to the trunk lid/door;

— to passenger doors on buses;

— in cavities:

  — open towards exterior;

  — open towards interior;

— in special compartments (e.g. battery box).

4.5 Other mounting locations

For some locations with special environmental conditions (e.g. exhaust system), no standard specifications can be given. In these cases, the load shall be stated in the specification of the device.

5 Operating modes

5.1 Operating mode 1

No voltage is applied to the DUT.

— Operating mode 1.1: not connected to wiring harness.

— Operating mode 1.2: connected to wiring harness simulating vehicle installation.

5.2 Operating mode 2

The DUT is electrically operated with test voltage U_B as in a vehicle with shut-off engine and with all electrical connections made.

— Operating mode 2.1: system/component functions are not activated (e.g. sleep mode).

— Operating mode 2.2: systems/components with electric operation and control in typical operating mode.

— Operating mode 2.3: systems/components with electric operation and control in minimum load.

— Operating mode 2.4: systems/components with electric operation and control in maximum load.

5.3 Operating mode 3

The DUT is electrically operated with test voltage U_A with all electrical connections made.

— Operating mode 3.1: system/component functions are not activated.

— Operating mode 3.2: systems/components with electric operation and control in typical operating mode.

— Operating mode 3.3: systems/components with electric operation and control in minimum load.

— Operating mode 3.4: systems/components with electric operation and control in maximum load.

6 Functional status classification

6.1 General

This element describes the functional status of a DUT during and after a test.

The minimum functional status shall be given in each test. An additional test requirement may be agreed between supplier and vehicle manufacturer.

Unwanted operations of the DUT are not allowed in any of the following classes.

6.2 Class A

All functions of the device/system perform as designed during and after the test.

6.3 Class B

All functions of the device/system perform as designed during the test. However, one or more of them may go beyond the specified tolerance. All functions return automatically to within normal limits after the test. Memory functions shall remain class A.

It shall be specified by the vehicle manufacturer which function of the DUT needs to perform as designed during the test, and which function can be beyond the specified tolerance.

6.4 Class C

One or more functions of a device/system do not perform as designed during the test but return automatically to normal operation after the test.

6.5 Class D

One or more functions of a device/system do not perform as designed during the test and do not return to normal operation after the test until the device/system is reset by simple “operator/use” action.

6.6 Class E

One or more functions of a device/system do not perform as designed during and after the test and cannot be returned to proper operation without repairing or replacing the device/system.

7 Tests and requirements

7.1 General

The values specified in ISO 16750-2, ISO 16750-3, ISO 16750-4 and ISO 16750-5 cover basic requirements.

DUTs with several mounting locations shall be tested to meet the most severe requirements.

7.2 General test conditions

Unless otherwise specified, all tests shall be performed at a room temperature of (23 ± 5) °C and a relative humidity of 25 % to 75 %.

The test voltages shall be as shown in Table 1 unless other values are specified in other parts of ISO 16750 or are agreed upon by the users of ISO 16750, in which case such values shall be documented in the test reports.

Table 1 — Test voltages for operating modes 2 and 3 (see 5.2 and 5.3)

Test voltage	U_N = 12 V system V	U_N = 24 V system V
U_A	14 ± 0,2	28 ± 0,2
U_B	12 ± 0,2	24 ± 0,2

7.3 Test sequence

Prior to testing, a test sequence plan shall be agreed upon, stating the type, number, combination, and sequence of the individual tests.

A life test shall be defined specifically to the product and to be taken into account in the test sequence plan.

An example is given in Annex A.

8 Designation

8.1 Coding

Figure 1 describes the referred tests for the device(s) by a code form for technical specifications and/or other documentation.