INTERNATIONAL STANDARD

ISO 16750-2

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

Part 2: Electrical loads

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

Partie 2: Contraintes électriques

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

This fifth edition cancels and replaces the fourth edition (ISO 16750-2:2012), which has been technically revised.

The main changes are as follows:

— introduction of use of operating mode for the electrical tests;

— introduction of concept with redundant supplies for relevant test cases;

— more detailed specification of direct current supply voltage test;

— more detailed specification of jump start test (overvoltage test at RT);

— introduction of transient overvoltage test;

— complete update of superimposed alternating voltage test (e.g. updated test method, extension of frequency range to 200 kHz, etc.);

— more detailed specification of slow decrease and increase of supply voltage test;

— introduction of micro interruption in supply voltage test;

— more detailed specification of reset behaviour at voltage drop test;

— explanation of severity levels in starting profile test;

— more detailed specification of reversed voltage test;

— more detailed specification of ground reference and supply offset test;

— single line interruption test divided in two test cases; static interruption (single interruption event) and dynamic interruption (multiple interruption events, i.e. bursts);

— short circuit protection test changed to short circuit/overload protection test. more detailed specification on test cases. Introduction of test case overloading of load circuits;

— more detailed description of origin of load dump pulse in Annex B;

— various editorial updates and clarifications.

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.

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

Part 2: Electrical loads

1 Scope

This document applies to electric and electronic systems/components for road vehicles. This document describes the potential environmental stresses and specifies tests and requirements for the specific mounting location on/in the road vehicle.

This document describes electrical loads.

This document is not intended to apply to environmental requirements or testing for systems and components of motorcycles and mopeds. Electromagnetic compatibility (EMC) is not covered by this document.

Electrical loads are independent from the mounting location, but can vary due to the electrical impedance (including both the resistance and the inductance) in the vehicle wiring harness and connection system.

Systems and their components released for production, or systems and their components already under development prior to the publication date of this document, can be exempted from fulfilling the changes in this edition compared to the previous one.

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 (all parts), *Road vehicles — Fuse-links*

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

ISO 16750-4:2023, *Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 4: Climatic loads*

3 Terms and definitions

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

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

4 Test and requirements

4.1 General

If not otherwise specified, the following tolerances shall apply:

— frequency and time: ±5 %;

— voltages: ±0,2 V;

— currents: ±2 %;

— inductance: ±10 %;

— resistance: ±10 %.

All voltage curves are shown without load.

If not otherwise specified, measure all voltages at the relevant terminals of the DUT.

For devices and units operating on secondary feed (e.g. 5 V sensor being supplied from 12 V supplied DUT), special considerations shall apply to voltage supply range, and specific tests shall be adjusted with consideration to the actual vehicle installation. Which tests that are applicable and what considerations that apply shall be agreed between the customer and the supplier.

NOTE For a device or unit working on secondary feed, the electrical testing is sometimes carried out together with the 12/24 V supplied DUT providing the secondary feed.

A minimum of two DUTs shall be used for validation. If judged necessary by agreement between the customer and the supplier, an increased sample size may be used for final validation phases (process validation).

For redundant supplies and redundantly supplied DUTs, see definition in ISO 16750-1.

4.2 Direct current (DC) supply voltage

4.2.1 Purpose

The purpose of this test is to verify equipment functionality at minimum and maximum supply voltage.

4.2.2 Test method

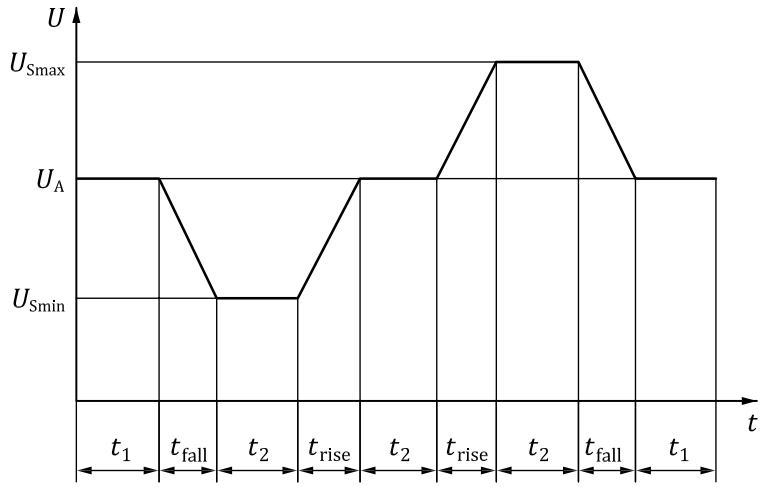
Set the supply voltage as specified in Table 3 or Table 4 to all relevant inputs (connections) of the DUT. Use the test profile as described in Figure 1 and Table 2. The test profile shall be run with the DUT in operating mode 3.3, with the DUT in operating mode 3.4 (i.e. to test both minimum and maximum load conditions), and at both T_{min} and T_{max}, as defined in ISO 16750-1. If agreed between the customer and the supplier, one of the operating modes 3.3 or 3.4 may be chosen for the test.

The test profile shall also be run once at room temperature at normal loading conditions, operating mode 3.2 as defined in ISO 16750-1.

See Table 1 for combinations of test conditions.

Table 1 — DC supply voltage, combinations of test conditions

Temperature / operating mode	T_{min}	RT	T_{max}
Operating mode 3.3	U_{Smin} / U_{Smax}	-	U_{Smin} / U_{Smax}
Operating mode 3.2	-	U_{Smin} / U_{Smax}	-
Operating mode 3.4	U_{Smin} / U_{Smax}	-	U_{Smin} / U_{Smax}



Key

t time, in seconds

U test voltage, in volts

Figure 1 — DC supply voltage test profile

Table 2 — Test parameters for DC supply voltage

U_A	See ISO 16750-1
U_{Smax}	See Table 3 or Table 4
U_{Smin}	See Table 3 or Table 4
t_1	30 s
t_2	60 s
t_{rise}	1 V/s
t_{fall}	1 V/s

If the DUT is supplied by two or more redundant supplies, all different possible combinations of U_{Smin} and U_{Smax} on the supply input ports of the DUT shall be tested.

The voltages listed in Table 3 or Table 4 are relevant within the operating temperature range as specified in ISO 16750-4, without time limits. When considering the minimum and maximum voltage levels in the vehicle it should be noted that these are highly dependent on the voltage supply in the electrical system, e.g. DC/DC, alternator.

Table 3 — Supply voltage for system devices with 12 V nominal voltage

Code	Minimum supply voltage, U_{Smin}	Maximum supply voltage, U_{Smax}
A	6 V	16 V
B	8 V	16 V
C	9 V	16 V
D	10,5 V	16 V
Z	As agreed	

Table 4 — Supply voltage for system devices with 24 V nominal voltage

Code	Minimum supply voltage, U_{Smin}	Maximum supply voltage, U_{Smax}
E	10 V	32 V
F	16 V	32 V

Table 4 *(continued)*

Code	Minimum supply voltage, U_{Smin}	Maximum supply voltage, U_{Smax}
G	22 V	32 V
H	18 V	32 V
Z	As agreed	

4.2.3 Requirements

Functional status class A as defined in ISO 16750-1 is required during active operating modes when tested in the supply voltage ranges given in Table 3 or Table 4, respectively.

4.3 Overvoltage

4.3.1 Long term overvoltage

4.3.1.1 Test at a temperature of (T_{max} – 20) °C for alternator failure

4.3.1.1.1 Purpose

This test simulates the condition where the alternator regulator fails, so that the output voltage of the alternator rises above normal values.

This test is relevant for both 12 V and 24 V systems.

4.3.1.1.2 Test method

Heat the DUT in a hot air oven to a temperature that is 20 K below the maximum operating temperature, T_{max}.

For 12 V systems, apply a voltage of 18 V for 60 min to all relevant inputs (connections) of the DUT.

For 24 V systems, apply a voltage of 36 V for 60 min to all relevant inputs (connections) of the DUT.

The operating mode of the DUT shall be 3.4, as defined in ISO 16750-1.

If the DUT is supplied by two or more redundant supplies, and if agreed between the customer and the supplier, the test voltage as specified above shall be applied to one of the redundant supply lines at a time. The other supply or supplies shall then be kept at U_A as defined in ISO 16750-1.

4.3.1.1.3 Requirements

Minimum functional status class C as defined in ISO 16750-1 is required.

Where more stringent requirements are necessary, functional status class A as defined in ISO 16750-1 is required during active operating modes.

4.3.1.2 Test at room temperature and T_{min} for jump start

4.3.1.2.1 Purpose

This test simulates a jump start from a 24 V system to a 12 V system vehicle. A simulated use case could be a jump start from a donor vehicle using a 24 V system, but without engine running in the donor vehicle (i.e. without applied charging on the 24 V side). A use case could also be a jump start from a 24 V stand-alone battery pack. This test is only applicable for 12 V systems. The test shall be done both in room temperature conditions and at T_{min}. If agreed between the customer and the supplier, test at T_{min} can be omitted.

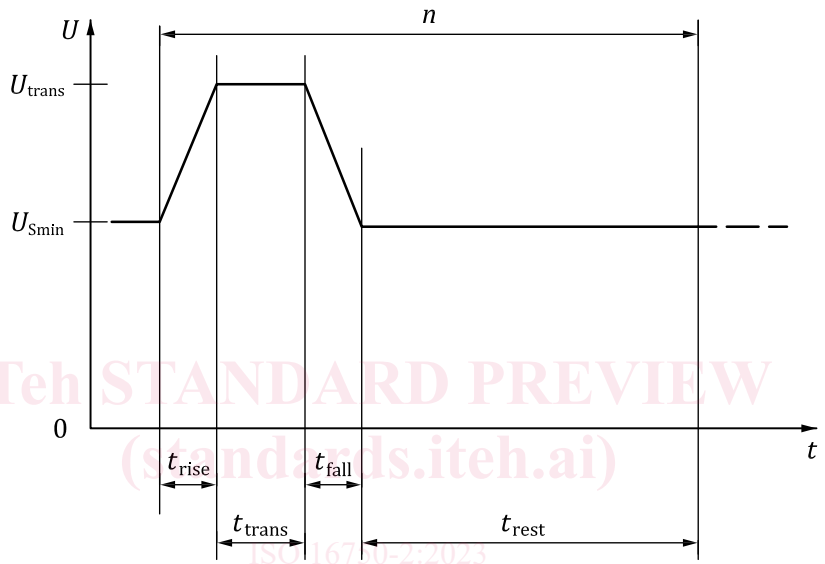
4.3.1.2.2 Test method

Ensure that the DUT has stabilized at temperature given in Table 5. Apply a voltage of 26 V for (60 ± 6) s to all relevant inputs (connections) of the DUT as described in Figure 2 and Table 5.

For DUTs necessary for engine start, the operating mode shall be 2.2, as defined in ISO 16750-1. For all other DUTs, the operating mode shall be 2.3.

If the DUT is supplied by two or more redundant supplies, and if agreed between the customer and the supplier, the test voltage shall be applied to one of the redundant supply lines at a time. The other supply or supplies shall then be kept at U_B as defined in ISO 16750-1.

Test shall be performed one time for each temperature value given in Table 5.



Key

t	time, in seconds
U	test voltage, in volts
U_{trans}	transient test voltage, in volts
U_{Smin}	supply voltage, in volts
n	number of transients in sequence
t_{fall}	fall time, in seconds
t_{trans}	transient duration, in seconds
t_{rise}	rise time, in seconds
t_{rest}	rest time between transient events, in seconds

Figure 2 — Jump start transient

Table 5 — Jump start test values

Parameter	Temperature	t_{rise}	t_{fall}	t_{trans}	t_{rest}	U_{Smin}	U_{trans}	n
12 V system	RT	≤ 10 ms	≤ 10 ms	60 s	120 s	10,8 V	26 V	1
	T_{min}	≤ 10 ms	≤ 10 ms	60 s	120 s	10,8 V	26 V	1

4.3.1.2.3 Requirements

If not otherwise agreed between the customer and the supplier, minimum functional status class C as defined in ISO 16750-1 is required.

Where more stringent requirements are necessary, functional status class A as defined in ISO 16750-1 is required during active operating modes.

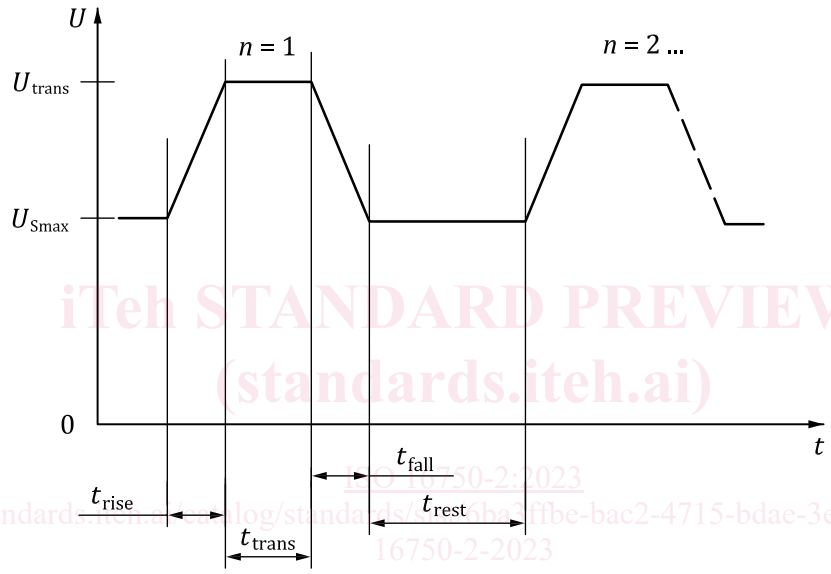
4.3.2 Transient overvoltage

4.3.2.1 Purpose

This test simulates when a DUT is affected by switching loads or loads injecting current in the electrical distribution system. This test is relevant for both 12 V and 24 V systems.

4.3.2.2 Test method

Apply the test pulse five times as specified in Figure 3 and Table 6 simultaneously to all relevant inputs (connections) of the DUT. The operating mode of the DUT shall be 3.4, as defined in ISO 16750-1.



Key

t	time, in seconds
U	test voltage, in volts
U_{Smax}	maximum supply voltage, in volts
U_{trans}	transient overvoltage, in volts
n	number of test pulse in sequence
t_{fall}	fall time, in seconds
t_{trans}	transient pulse duration, in seconds
t_{rise}	rise time, in seconds
t_{rest}	rest time between transient pulses, in seconds

Figure 3 — Test profile for transient overvoltage

Table 6 — Transient overvoltage test values

Parameter	t_{rise}	t_{fall}	t_{rest}	t_{trans}	U_{trans}	n
12 V system	1 ms	1 ms	1 s	400 ms	18 V	5
24 V system	2 ms	2 ms	1 s	400 ms	36 V	5

If the DUT is supplied by two or more redundant supplies, and if agreed between the customer and the supplier, the test voltage cycle as specified in Figure 3 and Table 6 shall be applied to one of the

redundant supply lines at a time. The other supply or supplies shall then be kept at U_A as defined in ISO 16750-1.

4.3.2.3 Requirements

Minimum functional status class B as defined in ISO 16750-1 is required during active operating modes.

For specific applications where there is a need for more stringent control of the voltage range (where deviations outside of normal voltage range could be considered harmful for design reasons) functional status class C as defined in ISO 16750-1 can be considered if agreed between the customer and the supplier.

4.4 Superimposed alternating voltage

4.4.1 Purpose

This test is intended to check immunity of a component to ripples in the on-board system, caused, for example, by an alternator or a DC/DC converter.

It specifies a conducted voltage test method and procedure for determining the immunity of electronic components. The method is applied to all DUT power supply lines simultaneously. For a DUT with redundant supplies, any combination of exposures shall be agreed between the customer and the supplier.

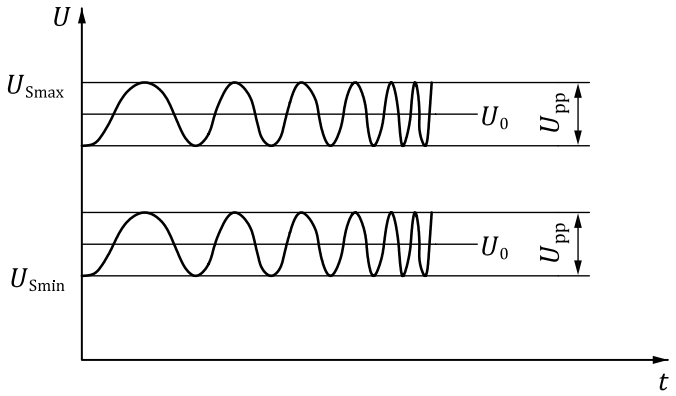
The severity level 1, 2, 3 and 4 shall be chosen in accordance with the application, see Table 8.

This test is relevant for both 12 V and 24 V systems.

4.4.2 Test method

4.4.2.1 General

Figure 4 is showing a rough overview of the test voltage profile for min. and max. applied superimposed alternating voltage, a more precise description of the voltage profile can be found in 4.4.2.2 and 4.4.2.3.



Key

t	time, in seconds
U	test voltage, in volts
U_{Smin}	minimum supply voltage, in volts
U_{Smax}	maximum supply voltage, in volts
U_0	DC level of applied test voltage, in volts
U_{pp}	voltage ripple peak-to-peak value, in volts

Figure 4 — Test profiles for Superimposed alternating voltage