INTERNATIONAL STANDARD

ISO 16750-2

Second edition
2006-08-01

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

Reference number
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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Contents

Page

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 16750-2 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

This second edition cancels and replaces the first edition (ISO 16750-2:2003), which has been technically revised.

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 2: Electrical loads

1 Scope

This part of ISO 16750 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 part of ISO 16750 describes the electrical loads. Electromagnetic compatibility (EMC) is not covered by this part of ISO 16750. Electrical loads are independent from the mounting location, but may vary due to the electrical resistance in the vehicle wiring harness and connection system.

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 8820 (all parts); *Road vehicles — Fuse-links*

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

ISO 16750-4:2003, *Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 4: Climatic loads*

3 Terms and definitions

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

4 Tests and requirements

4.1 General

If not otherwise specified, the following tolerances shall apply:

— frequency and time: ± 5 %;

— voltages: ± 0,2 V;

— resistance: ± 10 %.

4.2 D.C. 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

Set the supply voltage as specified in Table 1 or Table 2 to all relevant inputs of the device under test (DUT). Operating modes are specified in ISO 16750-1.

Measure all voltages at the relevant terminals of the DUT.

The voltages which are listed in Table 1 or Table 2 are relevant within the operating temperature range as specified in ISO 16750-4, without time limits.

Table 1 — Supply voltage for U_N = 12 V system devices

Code	Supply voltage V	
	$U_{S\,min}$	$U_{S\,max}$
A	6	16
B	8	16
C	9	16
D	10,5	16

Table 2 — Supply voltage for U_N = 24 V system devices

Code	Supply voltage V	
	$U_{S\,min}$	$U_{S\,max}$
E	10	32
F	16	32
G	22	32

4.2.3 Requirement

All DUT functions shall remain class A, as defined in ISO 16750-1, when tested in the supply voltage ranges given in Table 1 or Table 2, respectively.

4.3 Overvoltage

4.3.1 U_N = 12 V systems

4.3.1.1 Test at T = (T_{max} –20 °C)

4.3.1.1.1 Purpose

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

4.3.1.1.2 Test

Heat the DUT in a hot air oven to a temperature of T = (T_{max} –20 °C). Apply a voltage of 18 V for 60 min to all relevant inputs of the DUT.

4.3.1.1.3 Requirement

The functional status for the DUT shall be minimum class C as defined in ISO 16750-1. Functional status shall be class A where more stringent requirements are necessary.

4.3.1.2 Test at room temperature

4.3.1.2.1 Purpose

This test simulates a jump start.

4.3.1.2.2 Test

Ensure that the DUT has stabilized at room temperature. Apply a voltage of 24 V for 60 s ± 10 % to all relevant inputs of the DUT.

4.3.1.2.3 Requirement

The functional status shall be minimum class D as defined in ISO 16750-1. Functional status shall be class C where more stringent requirements are necessary.

4.3.2 U_N = 24 V systems

4.3.2.1 Purpose

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

4.3.2.2 Test at T = (T_{max} –20 °C)

Heat the DUT in a hot air oven to a temperature of T = (T_{max} –20 °C). Apply a voltage of 36 V for 60 min to all relevant inputs of the DUT.

4.3.2.3 Requirement

The functional status shall be minimum class C as defined in ISO 16750-1. Functional status shall be class A where more stringent requirements are necessary.

4.4 Superimposed alternating voltage

4.4.1 Purpose

This test simulates a residual a.c. on the d.c. supply.

4.4.2 Test

Connect the DUT as shown in Figure 1. Apply the following test simultaneously to all applicable inputs (connections) of the DUT. The severity 1, 2 or 3 shall be chosen according to the application.

— Test voltage $U_{S\ max}$ (see Figure 2): 16 V for U_N = 12 V systems;

32 V for U_N = 24 V systems;

— a.c. voltage (sinusoidal): Severity 1: U_{PP} = 1 V for U_N = 12 V and 24 V;

Severity 2: U_{PP} = 4 V for U_N = 12 V and 24 V;

Severity 3: U_{PP} = 10 V for U_N = 24 V systems only.

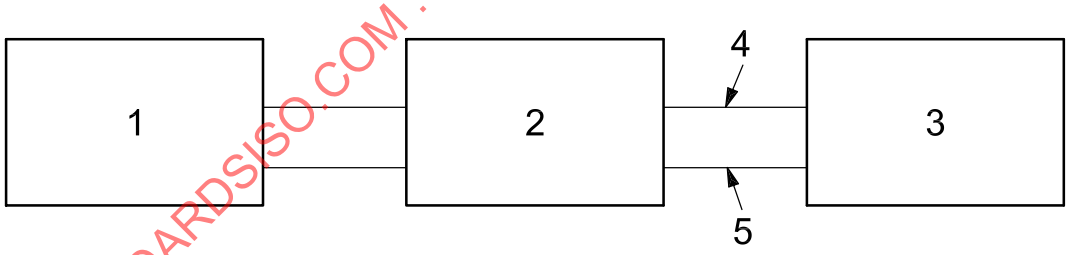
— Internal resistance of the power supply: 50 mΩ to 100 mΩ;

— Frequency range (see Figure 3): 50 Hz to 20 kHz;

— Type of frequency sweep (see Figure 3): Triangular, logarithmic;

— Sweep duration (see Figure 3): 120 s;

— Number of sweeps: 5 (continuously).



Key

1 sweep generator
2 power supply unit capable of being modulated
3 DUT
4 positive
5 ground or return

Figure 1 — Test set-up to superimpose a.c. voltage on component power supply lines

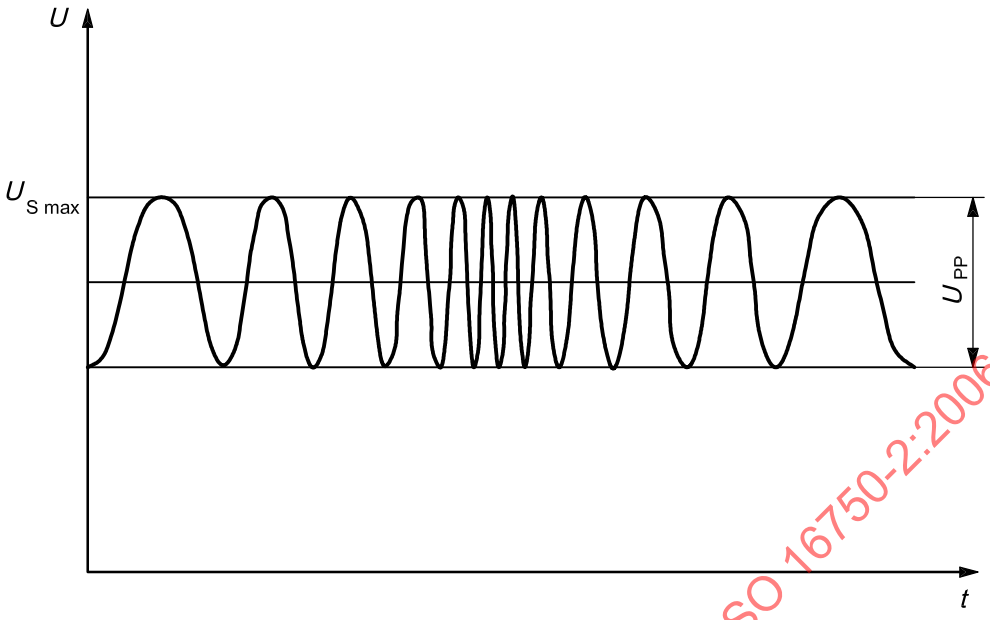
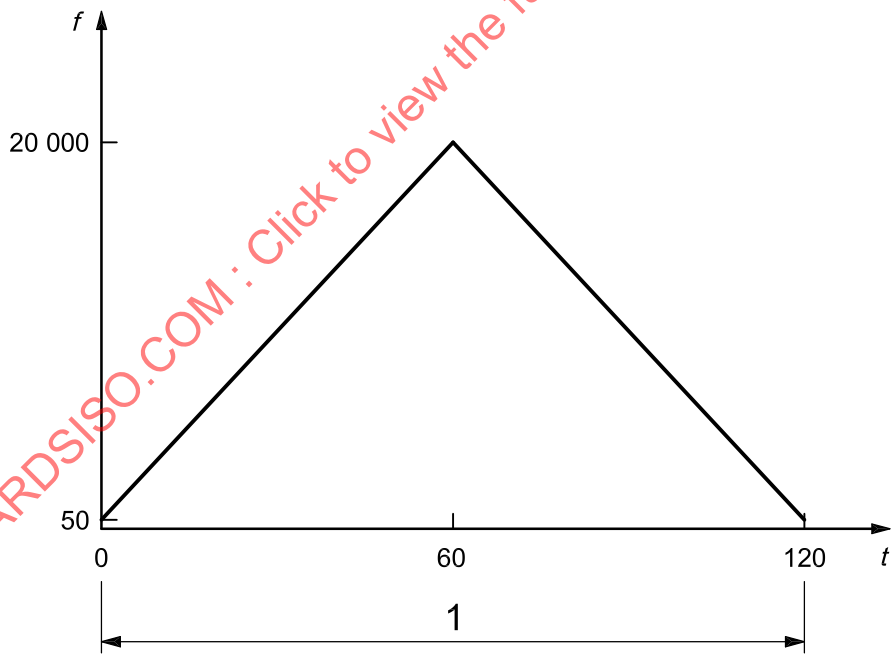


Figure 2 — Test voltage with superimposed sinusoidal a.c. voltage



Key

1 one cycle
f frequency, Hz (logarithmic scale)
t time, s

Figure 3 — Frequency sweep

4.4.3 Requirement

The functional status shall be class A as defined in ISO 16750-1.

4.5 Slow decrease and increase of supply voltage

4.5.1 Purpose

This test simulates a gradual discharge and recharge of the battery.

4.5.2 Test

Apply the following test simultaneously to all applicable inputs (connections) of the DUT.

Decrease the supply voltage from $U_{S\,max}$ to 0 V and increase it from 0 V to $U_{S\,max}$, applying a change rate of (0,5 ± 0,1) V per minute.

4.5.3 Requirement

The functional status inside the supply voltage range (Table 1 or Table 2) shall be as in 4.2.3. Outside that range, it shall be minimum class D as defined in ISO 16750-1. Functional status of class C may be specified where more stringent requirements are necessary.

4.6 Discontinuities in supply voltage

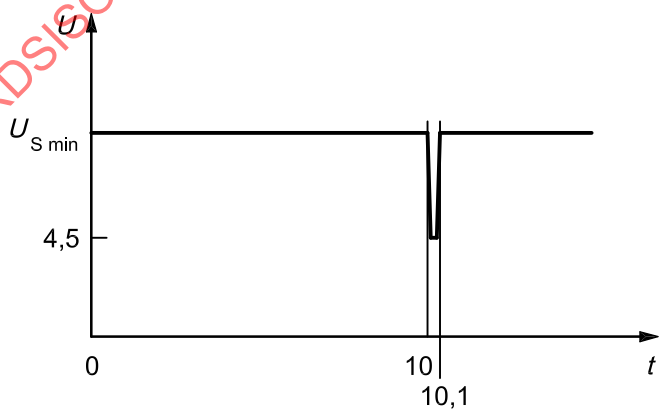
4.6.1 Momentary drop in supply voltage

4.6.1.1 Purpose

This test simulates the effect when a conventional fuse element melts in another circuit.

4.6.1.2 Test

Apply the test pulse (see Figures 4 and 5) simultaneously to all relevant inputs (connections) of the DUT. The rise time and fall time shall be ⩽ 10 ms.

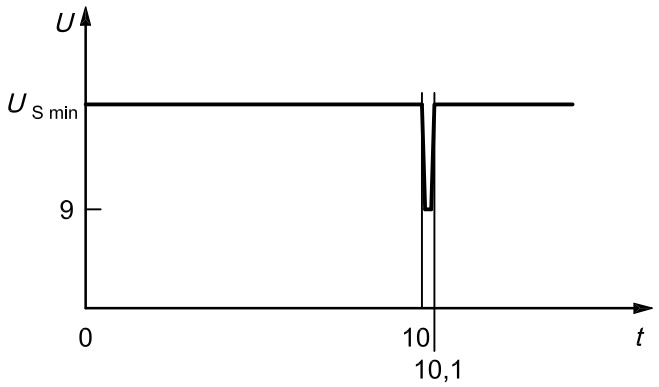


Key

U voltage, V

t time, s

Figure 4 — Short voltage drop (U_N = 12 V systems)



Key

U voltage, V

t time, s

Figure 5 — Short voltage drop (U_N = 24 V systems)

4.6.1.3 Requirement

Functional status shall be class B as defined in ISO 16750-1. Reset is permitted upon agreement.

4.6.2 Reset behaviour at voltage drop

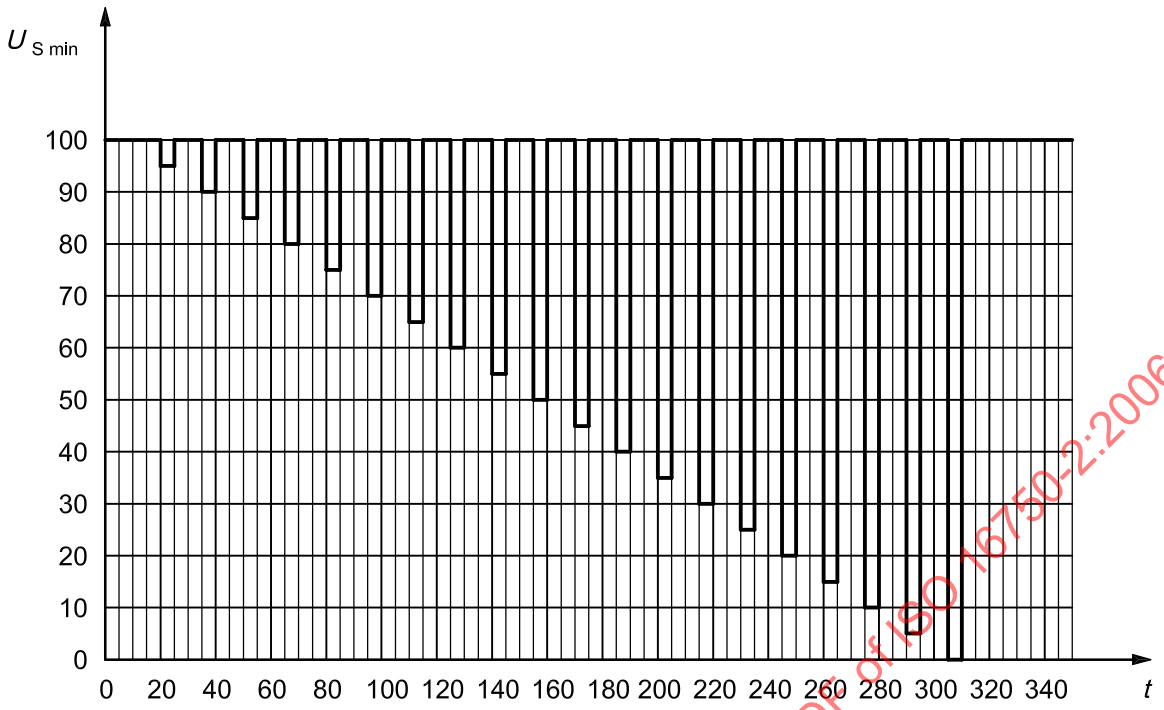
4.6.2.1 Purpose

This test verifies the reset behaviour of the DUT at different voltage drops. This test is applicable to equipment with reset function [e.g. equipment containing microcontroller(s)].

4.6.2.2 Test

Apply the test pulse simultaneously in Figure 6 to all relevant inputs (connections) and check the reset behaviour of the DUT.

Decrease the supply voltage by 5 % from $U_{S\,min}$ to 0,95 $U_{S\,min}$. Hold this voltage for 5 s. Raise the voltage to $U_{S\,min}$. Hold $U_{S\,min}$ for at least 10 s and perform a functional test. Then decrease the voltage to 0,9 $U_{S\,min}$, etc. Continue with steps of 5 % of $U_{S\,min}$, as shown in Figure 6, until the lower value has reached 0 V. Then raise the voltage to $U_{S\,min}$ again.



Key

$U_{S\,min}$ minimum supply voltage

t time, s

Figure 6 — Supply voltage profile for the reset test

4.6.2.3 Requirement

Functional status shall be class C as defined in ISO 16750-1.

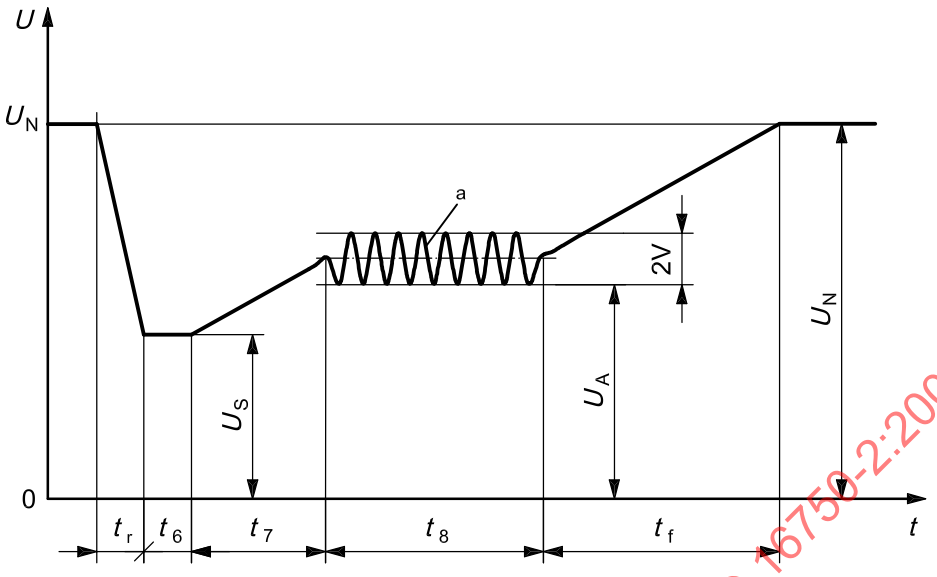
4.6.3 Starting profile

4.6.3.1 Purpose

This test verifies the behaviour of a DUT during and after cranking.

4.6.3.2 Test

Apply 10 times the starting profile, as specified in Figure 7 and Table 3 or Table 4, simultaneously to all relevant inputs (connections) of the DUT. A break of 1 to 2 s between the starting cycles is recommended. One or more profiles, as described in Table 3 and Table 4, shall be chosen according to the application.



a f = 2 Hz,

Figure 7 — Starting profile

Table 3 — Values for U_N = 12 V system devices

Code	Supply voltage V		Levels/voltages/duration of starting profile				
			I	II	III	IV	Tolerances
			U_S = 8 V	U_S = 4,5 V	U_S = 3 V	U_S = 6 V	+ 0,2 V
			U_A = 9,5 V	U_A = 6,5 V	U_A = 5 V	U_A = 6,5 V	
			t_r = 5 ms				± 10 %
			t_6 = 15 ms				
			t_7 = 50 ms				
			t_8 = 1 s	t_8 = 10 s	t_8 = 1 s	t_8 = 10 s	
			t_f = 40 ms	t_f = 100 ms	t_f = 100 ms	t_f = 100 ms	
	$U_{S\,min}$	$U_{S\,max}$	Functional status				—
A	6	16	A	B	B	A	
B	8	16	A	B	C	B	
C	9	16	B	C	C	C	
D	10,5	16	B	C	C	C	

Table 4 — Values for U_N = 24 V system devices

			Levels/voltages/duration of starting profile			
			I	II	III	Tolerances
			U_S = 10 V	U_S = 8 V	U_S = 6 V	+ 0,2 V
			U_A = 20 V	U_A = 15 V	U_A = 10 V	
			t_r = 10 ms			± 10 %
			t_6 = 50 ms			
			t_7 = 50 ms			
Code	Supply voltage V		t_8 = 1 s	t_8 = 10 s	t_8 = 1 s	
			t_f = 40 ms	t_f = 100 ms	t_f = 40 ms	
	$U_{S\,min}$	$U_{S\,max}$	Functional status			—
E	10	32	A	B	B	
F	16	32	B	C	C	
G	22	32	B	C	C	

4.6.3.3 Requirement

Functions of the DUT that are relevant to vehicle operation during cranking shall be class A, all other functions of the DUT shall be according to Table 3 and/or Table 4.

4.7 Reversed voltage

4.7.1 Purpose

This test checks the resistance of a device against the connection of a reversed battery in case of using an auxiliary starting device.

This test is not applicable to

— generators, or

— relays with clamping diodes without external reverse polarity protection device.

4.7.2 Test

4.7.2.1 General

Connect and fuse the DUT as in the real vehicle, but without generator and battery. Choose the applicable voltages from the following cases and apply them simultaneously to all relevant power terminals with reversed polarity.

4.7.2.2 Case 1

If the DUT is used in a vehicle in which the alternator circuit is not fused and the rectifier diodes withstand a reversed voltage for 60 s, apply a test voltage of 4 V for U_N = 12 V systems with reversed polarity simultaneously to all relevant inputs (terminals) of the DUT for a duration of 60 s ± 10 %. This test is not applicable for U_N = 24 V systems.

4.7.2.3 Case 2

In all other cases, apply the test voltage U_A (see Table 5 and ISO 16750-1) with reversed polarity simultaneously to all relevant inputs (terminals) of the DUT for a duration of 60 s ± 10 %.

Table 5 — Voltage ranges

Nominal voltage, U_N V	U_A V
12	14
24	28

4.7.3 Requirement

After replacing all blown fuse links, the functional status shall be class C as defined in ISO 16750-1.

4.8 Ground reference and supply offset

4.8.1 Purpose

This test shall be agreed between customer and supplier.

This test serves to verify reliable operation of a component if two or more power supply paths exist. For instance, a component may have a power ground and a signal ground that are outputs on different circuits.

4.8.2 Test

All inputs and outputs shall be connected to representative loads or networks to simulate the in-vehicle configuration. Apply U_A to the DUT and confirm normal operation.

The ground/supply offset test applies to ground/supply lines. The offset shall be applied to each ground/supply line and between each ground/supply line separately in sequence.

For all DUTs, the offset voltage shall be 1,0 V.

a) Apply U_A to the DUT.

b) Subject ground/supply line to the offset voltage relative to the DUT ground/supply line.

c) Perform a functional test under this condition.

d) Repeat No. 3 for each next ground/supply line combination.

Repeat the test with reverse offset voltage.

4.8.3 Requirement

Functional performance status class A for all functional groups: there shall be no malfunction or latch-up of the DUT.

4.9 Open circuit tests

4.9.1 Single line interruption

4.9.1.1 Purpose

This test simulates an open contact condition.

NOTE This is not a test for connectors.

4.9.1.2 Test

Connect and operate the DUT as intended. Open one circuit of the DUT/system interface. Then restore the connection. Observe the device behaviour during and after the interruption.

Repeat for each circuit of the DUT/system interface.

— Interruption time: 10 s ± 10 %.

— Open circuit resistance: ⩾ 10 MΩ.

4.9.1.3 Requirement

Functional status shall be class C as defined in ISO 16750-1.

4.9.2 Multiple line interruption

4.9.2.1 Purpose

The purpose of this test to ensure functional status as defined in the specification of the DUT when the DUT is subjected to a rapid multiple line interruption.

NOTE This is not a test for connectors.

4.9.2.2 Test

Disconnect the DUT, then restore the connection. Observe the device behaviour during and after the interruption.

— Interruption time: 10 s ± 10 %.

— Open circuit resistance: ⩾ 10 MΩ.

For multi-connector devices, each possible connection shall be tested.

4.9.2.3 Requirement

Functional status shall be class C as defined in ISO 16750-1.

4.10 Short circuit protection

4.10.1 Purpose

These tests simulate short circuits to the inputs and outputs of a device.

4.10.2 Signal circuits

4.10.2.1 Test

Connect all relevant inputs and outputs of the DUT in sequence for a duration of 60 s ± 10 % to $U_{S\ max}$ ($U_{S\ max}$: see Tables 1 and 2) and to ground. All other inputs and outputs remain open or as agreed upon.

Perform this test with:

— connected supply voltage and ground terminals:

  1) outputs active,

  2) outputs inactive;

— disconnected supply voltage terminals;

— disconnected ground terminals.

All unused inputs shall remain open unless otherwise agreed between customer and supplier.

4.10.2.2 Requirement

Functional status shall be class C as defined in ISO 16750-1.

4.10.3 Load circuits

4.10.3.1 Test

Connect the DUT to the power supply. The load circuits shall be in operation. For test duration, the appropriate part of ISO 8820 (operating time rating) shall be used considering the upper tolerance plus 10 %. If protection other than fuses is used (e.g. electronic protection), the test duration shall be agreed between manufacturer and user.

4.10.3.2 Requirements

All electronically protected outputs shall withstand the currents as ensured by the corresponding protection and shall return to normal operation upon removal of the short circuit current (minimum class C as defined in ISO 16750-1).

All conventional fuse protected outputs shall withstand the currents as ensured by the corresponding protection and shall return to normal operation upon replacement of the conventional fuse (minimum class D as defined in ISO 16750-1).

All unprotected outputs may be damaged by the test current (functional status class E as defined in ISO 16750-1) provided that the materials in the DUT are compliant with the flammability requirements of UL94-V0 (see Bibliography [1]).

4.11 Withstand voltage

4.11.1 Purpose

This test ensures the dielectric withstand voltage capability of circuits with galvanic isolation. This test is required only for systems/components which contain inductive elements (e.g. relays, motors, coils) or are connected to circuits with inductive load.