INTERNATIONAL STANDARD

ISO 16750-2

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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

Reference number
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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 16750-2 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electric 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 2: Electrical loads

1 Scope

This part of ISO 16750 describes the electrical loads that can affect electric and electronic systems and components in respect of their mounting location directly on or in road vehicles. It does not cover electromagnetic compatibility (EMC).

NOTE Electrical loads are independent of the mounting location but can vary because of 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*

UL[1)] 94, *Tests for Flammability of Plastic Materials for Parts in Devices and Appliances*

3 Terms and definitions

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

1) Underwriters Laboratories Inc.

4 Supply voltage

4.1 Direct current

4.1.1 Purpose

This test verifies the equipment functionality in the range between minimum and maximum supply voltage.

4.1.2 Test

Set the supply voltage in accordance with Tables 1 and 2 to all relevant inputs of the device under test (DUT). See ISO 16750-1 for supply voltages for operating Modes 2 and 3.

Measure all voltages at the relevant terminals of the DUT.

The voltages given in Tables 1 and 2 are relevant within the operating temperature range according to ISO 16750-4:2003, Table 1, without time limits.

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

Code	Supply voltage V	
	U_{min}	U_{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_{min}	U_{max}
E	10	32
F	16	32
G	22	32

NOTE The extension to a power supply system with voltage U = 42 V is under consideration.

4.1.3 Requirement

All DUT functions shall remain Class A as defined in ISO 16750-1:2003, Clause 6, when tested in the supply voltage ranges given in Table 1 and Table 2, respectively.

4.2 Overvoltage

4.2.1 U_N = 12 V systems

4.2.1.1 Test at T = (T_{max} –20 °C)

4.2.1.1.1 Purpose

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

4.2.1.1.2 Test

Heat the DUT in a hot air oven to a temperature of T = (T_{max} –20 °C). Apply a voltage of 18 V ± 0,2 V for 60 min ± 10 % to all relevant inputs of the DUT.

4.2.1.1.3 Requirement

The functional status for the DUT shall be a minimum of Class C as defined in ISO 16750-1:2003, Clause 6. Functional status shall be Class A where more stringent requirements are necessary.

4.2.1.2 Test at room temperature

4.2.1.2.1 Purpose

This test simulates a jump start.

4.2.1.2.2 Test

Ensure that the DUT has stabilized at room temperature. Apply a voltage of 24 V ± 0,2 V for 60 s ± 10 % to all relevant inputs of the DUT.

4.2.1.2.3 Requirement

The functional status shall be a minimum of Class D as defined in ISO 16750-1:2003, Clause 6. Functional status shall be Class C where more stringent requirements are necessary.

4.2.2 U_N = 24 V systems

4.2.2.1 Purpose

This test simulates the condition under which the regulator at the generator fails.

4.2.2.2 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 (34 ± 0,2) V for 60 min ± 10 % to all relevant inputs of the DUT.

4.2.2.3 Requirement

The functional status shall be a minimum of Class C as defined in ISO 16750-1:2003, Clause 6. Functional status shall be Class A where more stringent requirements are necessary.

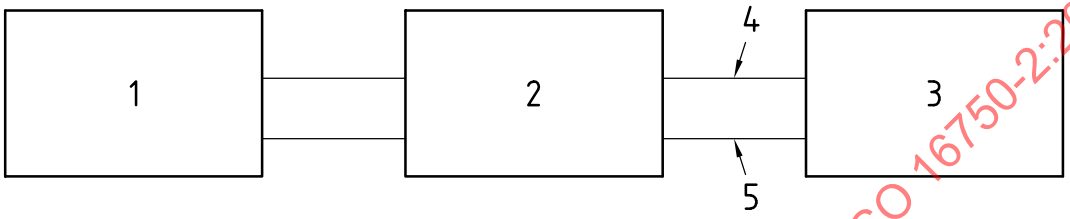
4.3 Superimposed alternating voltage

4.3.1 Purpose

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

4.3.2 Test

Connect the DUT as shown in Figure 1. Perform the test, in accordance with Table 3, simultaneously on all applicable inputs (connections) of the DUT. Choose the severity class, Severity 1 or 2, according to the application.



Key

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

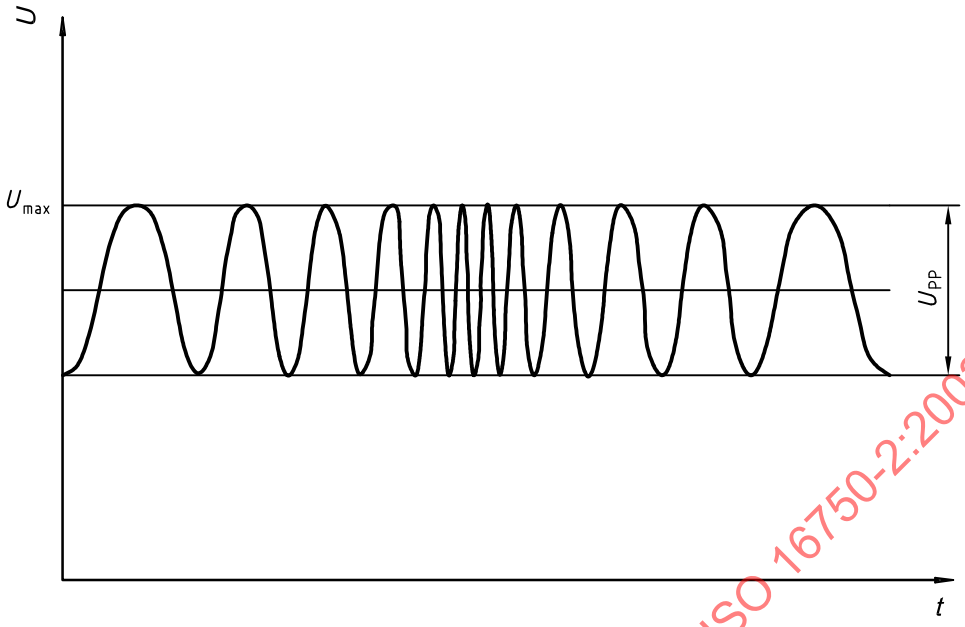
Figure 1 — Test set-up for superimposing a.c. voltage on component power supply lines

Table 3 — Test values

Test voltage U_{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 Severity 2: U_{PP} = 4 V
Internal resistance of power supply	$\leqslant$ 100 mΩ
Frequency range (see Figure 3)	50 Hz to 20 kHz
Type of frequency sweep (see Figure 3)	Triangular, linear
Sweep duration (see Figure 3)	120 s
Number of sweeps	5

4.3.3 Requirement

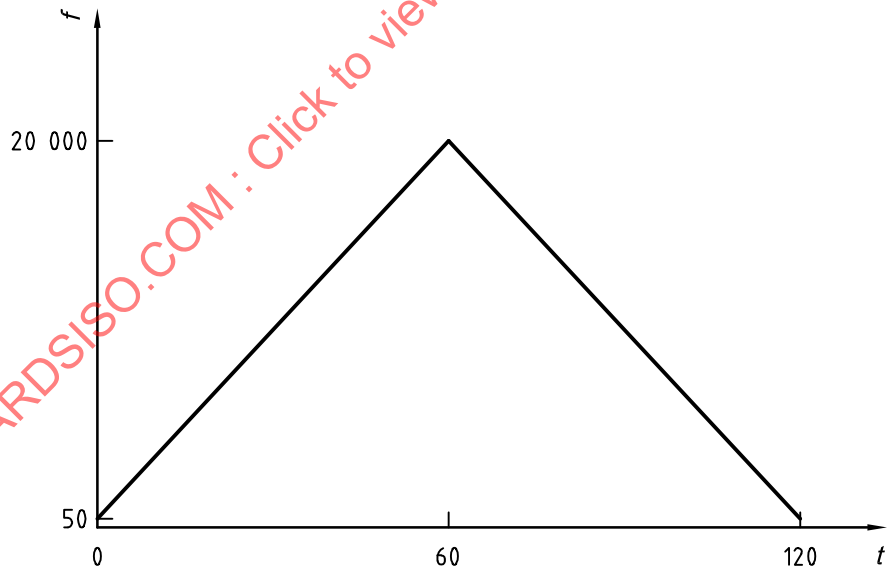
The functional status shall be Class A as defined in ISO 16750-1:2003, Clause 6.



Key

U voltage, V
t time

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



Key

f frequency, Hz
t time, s

Figure 3 — Frequency sweep

4.4 Slow decrease and increase of supply voltage

4.4.1 Purpose

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

4.4.2 Test

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

Decrease the supply voltage from U_{max} to 0 V and then increase it from 0 V to U_{max}, applying a change rate of (0,5 ± 0,1) V/min.

4.4.3 Requirement

The functional status shall be a minimum of Class D as defined in ISO 16750-1:2003, Clause 6. Functional status shall be Class C where more stringent requirements are necessary.

4.5 Discontinuities in supply voltage

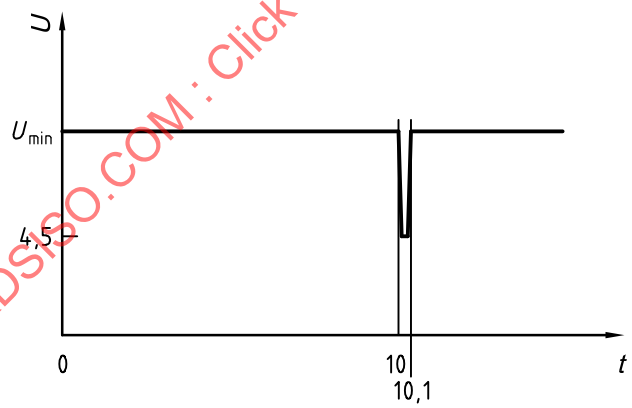
4.5.1 Momentary drop in supply voltage

4.5.1.1 Purpose

This test simulates the effect when a conventional fuse element melts in another circuit. See Figures 4 and 5.

4.5.1.2 Test

Apply the test pulse simultaneously to all relevant inputs (connections) of the DUT.



Key

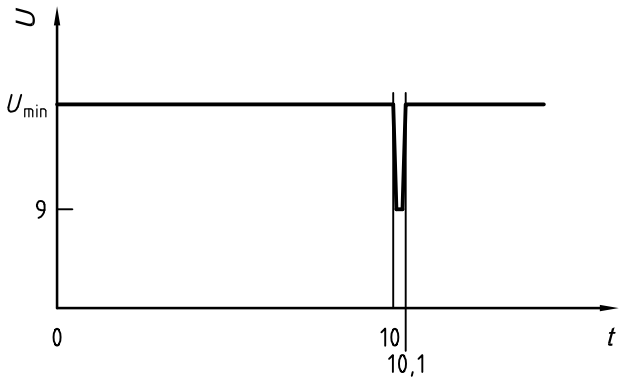
U voltage, V

t time, s

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

U_{min} = voltage to be decided according to the application (see Table 1, Codes B, C and D).

The rise time and fall time shall be ⩽ 10 ms.



Key

U voltage, V

t time, s

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

U_{min} = voltage to be decided according to the application (see Table 2, Codes F and G).

The rise time and fall time shall be $\leqslant$ 10 ms.

4.5.1.3 Requirement

The functional status shall be Class B as defined in ISO 16750-1:2003, Clause 6. Reset is permitted upon agreement.

4.5.2 Reset behaviour at voltage drop

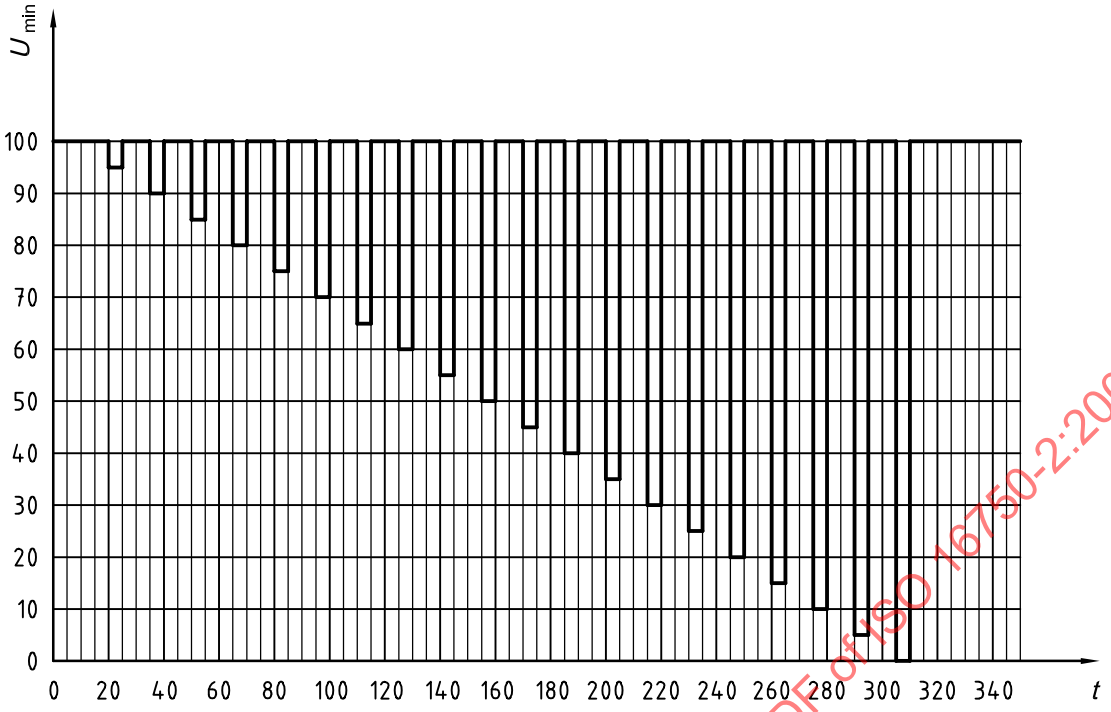
4.5.2.1 Purpose

This test verifies the reset behaviour of the DUT at different voltage drops. It is applicable to equipment with a reset function (e.g. equipment containing one or more microcontrollers).

4.5.2.2 Test

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

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



Key

U_{min} minimum voltage, %
t time, s

Figure 6 — Supply voltage profile for reset test

4.5.2.3 Requirement

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

4.5.3 Starting profile

4.5.3.1 Purpose

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

4.5.3.2 Test

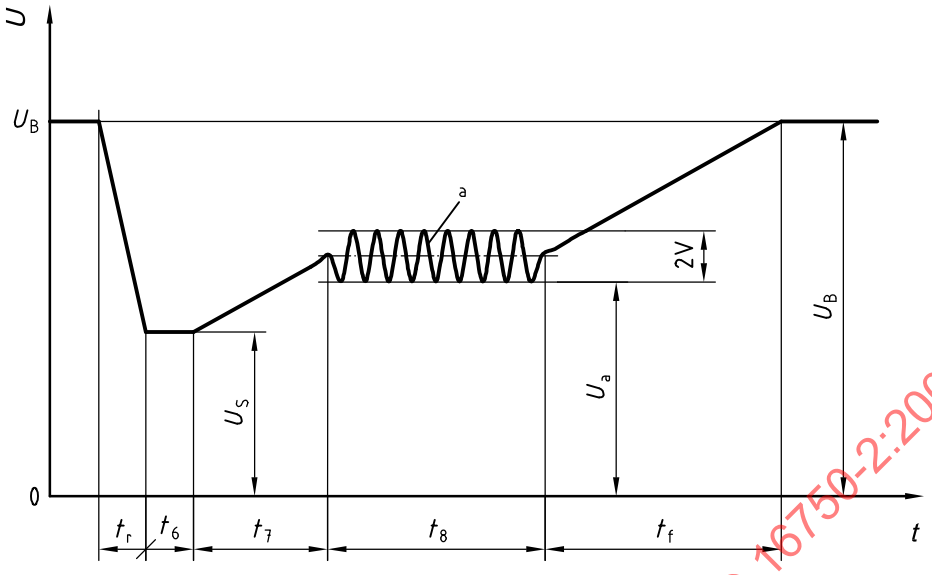
Apply the starting profile in accordance with 4.5.3.2.1 simultaneously to all relevant inputs (connections) of the DUT.

4.5.3.2.1 Profile

See Table 4 and Figure 7, and Tables 5 and 6.

Table 4 — Time periods

Time period	U_N = 12 V systems	U_N = 24 V systems
	ms	
t_r	5	10
t_6	15	50
t_7	50	50



Key

U voltage, V

t time

a f = 2 Hz.

Figure 7 — Starting profile

Table 5 — Values for U_N = 12 V system devices

	Unit	Levels/voltages/durations of starting profile		
		I	II	III
	V	U_S = 8	U_S = 4,5	U_S = 3
	V	U_a = 9,5	U_a = 6,5	U_a = 5
	s	t_8 = 1	t_8 = 10	t_8 = 1
	ms	t_f = 40	t_f = 100	t_f = 100

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

Table 6 — Values for U_N = 24 V system devices

	Unit	Voltages/durations of starting profile
	V	U_S = 8
	V	U_a = 15
	s	t_8 = 20
	ms	t_f = 40

Code	Supply voltage V		Functional status
	U_{min}	U_{max}	
E	10	32	A
F	16	32	B
G	22	32	C

4.5.3.2.2 Requirement

Relevant devices for vehicle function during cranking shall be Class A, others shall be Class C, as defined in ISO 16750-1:2003, Clause 6.

4.6 Reversed voltage

4.6.1 Purpose

This test is a check of the resistance of the DUT against the connection of a reversed battery when an auxiliary starting device is used.

This test is not applicable to alternators, nor is it applicable to relays having clamping diodes without an external reverse polarity protection device.

4.6.2 Test

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

— **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, for U_N = 12 V systems, apply a test voltage U_T = (4 ± 0,2) V with reversed polarity simultaneously to all relevant inputs (terminals) of the DUT for a duration of (60 ± 6) s. This test is not applicable for U_N = 24 V systems.

— **Case 2**

In all other cases, apply the voltage U_A (see ISO 16750-1 and Table 7) with reversed polarity simultaneously to all relevant inputs (terminals) of the DUT for a duration of (60 ± 6) s.

Table 7 — Voltage ranges

U_N	U_A	U_C
V		
12	14 ± 0,2	4
24	28 ± 0,2	Under consideration

4.6.3 Requirement

After replacement of all activated fuse links, the functional status shall be Class C as defined in ISO 16750-1:2003, Clause 6.

4.7 Open circuit tests

4.7.1 Single line interruption

4.7.1.1 Purpose

This test simulates an open contact condition.

4.7.1.2 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.

— Interruption time: (10 ± 1) s.

— Open circuit resistance: ⩾ 100 MΩ.

Repeat for each circuit of the DUT/system interface.

4.7.1.3 Requirement

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

4.7.2 Multiple line interruption

4.7.2.1 Purpose

The purpose of this test is to evaluate the effect of disconnection of the DUT connector or connectors under Operating mode 3.2 according to ISO 16750-1:2003, Clause 5.

NOTE This is not a test for connectors.

4.7.2.2 Test

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

— Interruption time: (10 ± 1) s.

— Open circuit resistance: ⩾ 100 MΩ.

For multi-connector devices, test each possible connection.

4.7.2.3 Requirement

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

4.8 Short circuit protection

4.8.1 Purpose

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

4.8.2 Signal circuits

4.8.2.1 Test

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

Perform this test with

a) supply voltage and ground connected

   1) outputs active,

   2) outputs inactive,

b) supply voltage disconnected, and

c) ground disconnected.

4.8.2.2 Requirement

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

4.8.3 Load circuits

4.8.3.1 Test

Connect the DUT to the power supply. The load circuits shall be in operation. For the appropriate test duration see the appriopriate part of ISO 8820, 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.

4.8.3.2 Requirements

All outputs shall withstand the currents as assured by the corresponding protection.

The DUT may be damaged by the test current (functional status Class E as defined in ISO 16750-1:2003, Clause 6) provided that the flammability class V0 according to UL 94 is complied with.

4.9 Withstand voltage

4.9.1 Purpose

This test checks the insulation behaviour/dielectric strength of circuits with galvanic separation, such as connector pins, relays or cables.

This test is required only for systems/components containing inductive elements (e.g. relays, motors, coils).