INTERNATIONAL STANDARD

**ISO 21848**

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# Road vehicles — Electrical and electronic equipment for a supply voltage of 42 V — Electrical loads

*Véhicules routiers — Équipement électrique et électronique pour une tension d'alimentation de 42 V — Contraintes électriques*

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# Foreword

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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 21848 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

# Road vehicles — Electrical and electronic equipment for a supply voltage of 42 V — Electrical loads

## 1 Scope

This International Standard describes the electrical loads that can affect electric and electronic systems and components of road vehicles for a supply voltage of 42 V, which may be used in a single or a multiple voltage electrical system.

In addition, it specifies the tests and resulting requirements, test equipment accuracy being agreed upon between the vehicle manufacturer and the supplier. It does not cover electromagnetic compatability (EMC).

NOTE Electrical loads are independent from the mounting location.

This International Standard also provides design guidance for the interaction of 42 V with other system voltages.

## 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 7637-2, *Road Vehicles — Electrical disturbances by conduction and coupling — Part 2: Electrical transient conduction along supply lines only*

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*

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

UL[1)] 94, *Standard for Test 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 and the following shall apply.

**3.1**
$U_{high}$
upper limit of the normal d.c. supply voltage range

1) Underwriters Laboratories Inc.

**3.2**
$U_{low}$
lower limit of the normal d.c. supply voltage range

**3.3**
$U_{max,dyn}$
maximum dynamic overvoltage associated with generator load dump transient protection

**3.4**
$U_T$
voltage applied during testing under defined conditions and which may be static voltage or transient

**3.5**
$U_S$
minimum permissible dynamic undervoltage associated with the starting pulse

**3.6**
$U_A$
minimum permissible steady-state voltage during cranking of the combustion engine including a possible ripple

# 4 Supply voltage

## 4.1 Direct current

### 4.1.1 Purpose

This test verifies the device under test (DUT) functionality in the range between minimum and maximum supply voltage.

### 4.1.2 Test

Set the supply voltage in accordance with Table 1 to all relevant inputs (connections) of the DUT.

Measure all voltages at the relevant terminals of the DUT.

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

**Table 1 — Supply voltage for $U_N$ = 42 V system devices**

| Code | Supply voltage V | |
|---|---|---|
| | $U_{low}$ | $U_{high}$ |
| L | 30 | 48 |

### 4.1.3 Requirement

All DUT functions shall remain Class A as defined in ISO 16750-1:2003, Clause 6.

## 4.2 Overvoltages

### 4.2.1 Maximum continuous voltage

Under all conditions the maximum continuous supply voltage for the DUT shall not exceed $U_{high}$ according to Table 1.

### 4.2.2 Maximum dynamic voltage

#### 4.2.2.1 Immunity

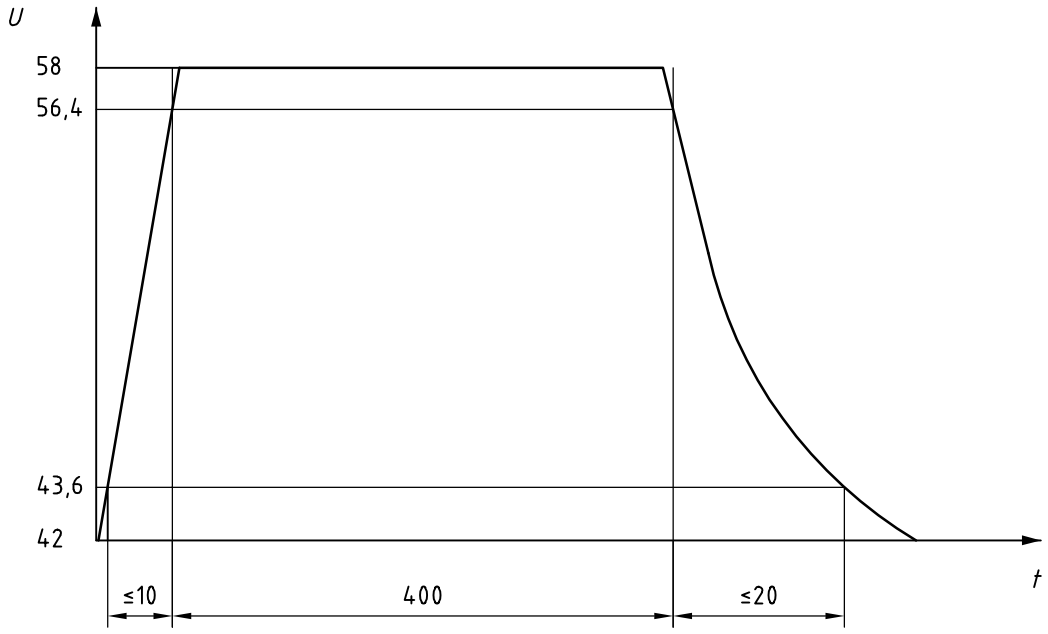
Except for 4.2.2.1.1 to 4.2.2.1.3 below, immunity to voltage transients shall be in accordance with ISO 7637-2:2004.

#### 4.2.2.1.1 Purpose

This test verifies functionality of the DUT when subjected to the maximum dynamic voltage, $U_{max,dyn}$. It simulates the maximum dynamic voltage for high-energy pulses in a 42 V vehicle electrical system, caused by load dump, and is the upper voltage limit for load dump protection.

#### 4.2.2.1.2 Test

Apply one test pulse to the DUT according to Figure 1.




**Key**

$t$ time, ms

$U$ voltage, V

**Figure 1 — Test pulse for $U_{max,dyn}$**

The internal resistance $R_i$ of the load dump test pulse generator shall be (100 to 500) m$\Omega$.

#### 4.2.2.1.3 Requirement

The functional status shall be minimum Class D according to ISO 16750-1:2003, Clause 6. Special requirements may be agreed between vehicle manufacturer and supplier.

#### 4.2.2.2 Emission

No electrical and electronic equipment shall produce a voltage on the network exceeding 50 V except the generator during load dump and pulses as specified by ISO 7637-2.

Except for 4.2.2.1.1 to 4.2.2.1.3, measures shall be taken to ensure that 50 V is never exceeded (e.g. protection devices at the source and/or adjustment of generator voltage).

### 4.3 Superimposed alternating voltage

#### 4.3.1 Purpose

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

The DUT is checked for undesirable resonance modes and induced thermal stress.

#### 4.3.2 Test

Connect the DUT as shown in Figure 2. Perform the test, in accordance with Table 2 and Figure 2, simultaneously on all applicable inputs (connections) of the DUT.

NOTE Do not apply these test voltages to the battery.

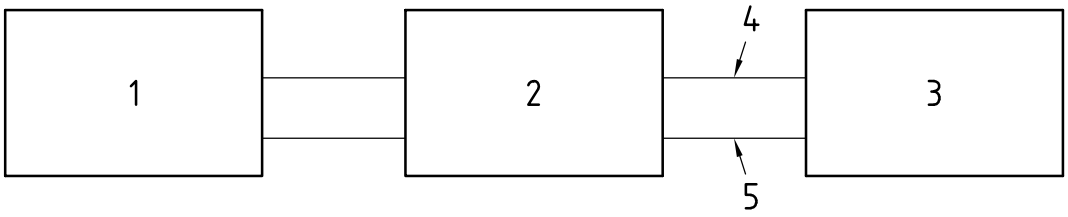


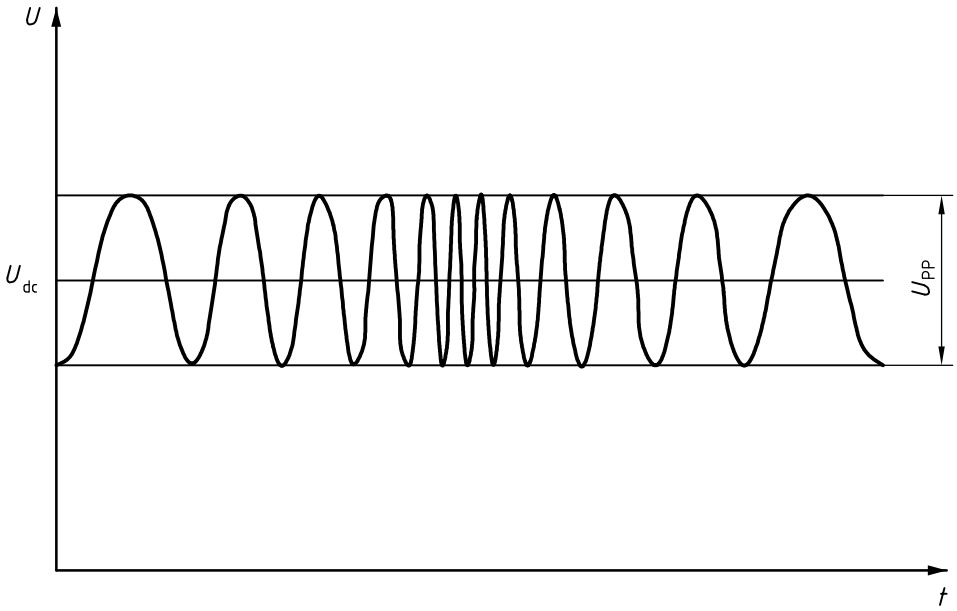

**Figure 2 — Test set-up for superimposing a.c. voltage on component power supply lines**

**Table 2 — Test values**

| | |
|---|---|
| **Test voltage** (see Figure 3) | $U_{dc}$ + 0,5 $U_{PP}$ sin($\omega t$) |
| **a.c. voltage (sinusoidal)** | a) $U_{dc}$ = 48 V; $U_{PP}$ = 4 V for 50 Hz to 1 kHz<br>b) $U_{dc}$ = 48 V; $U_{PP}$ = 1 V for 1 kHz to 20 kHz<br>c) $U_{dc}$ = 32 V; $U_{PP}$ = 4 V for 50 Hz to 1 kHz<br>d) $U_{dc}$ = 32 V; $U_{PP}$ = 1 V for 1 kHz to 20 kHz |
| **Internal resistance of power supply** | 50 mΩ to 100 mΩ |
| **Frequency range** | See Figure 4 |
| **Type of frequency sweep** | See Figure 4 |
| **Sweep duration (one sweep)** (see Figure 4) | 120 s |
| **Number of continuous sweeps per test** | 5 |

### 4.3.3 Requirement

The functional status shall be Class A according to ISO 16750-1:2003, Clause 6.

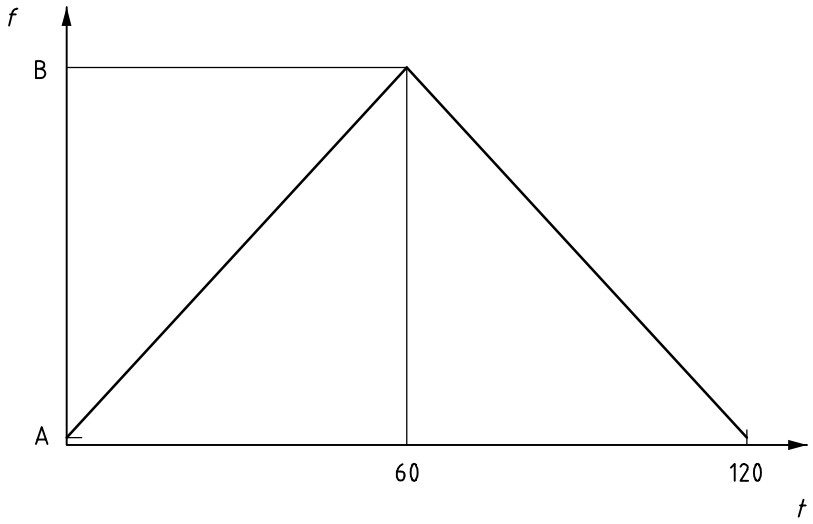



**Key**

$U$ voltage, V

$t$ time, s

**Figure 3 — Test voltage with superimposed sinusoidal a.c. voltage**




**Key**

$f$ frequency, Hz logarithmic scale

$t$ time, s

A 50 Hz [Table 2, a) and c)] or 1 kHz [Table 2, b) and d)]

B 1 kHz [Table 2, a) and c)] or 20 kHz [Table 2, b) and d)]

**Figure 4 — Frequency sweep**

## 4.4 Slow decrease and increase of supply voltage

### 4.4.1 Purpose

This test verifies functional status operation according to the specification of the DUT when subjected to 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 $U_{high}$ to 0 V and then increase it from 0 V to $U_{high}$, applying a change rate of (3 ± 0,1) V/min, unless otherwise specified.

### 4.4.3 Requirement

The functional status shall be Class A as defined in ISO 16750-1:2003, Clause 6, between $U_{high}$ and $U_{low}$.

The functional status shall be a minimum of Class D as defined in ISO 16750-1:2003, Clause 6, between $U_{low}$ and 0 V.

## 4.5 Discontinuities in supply voltage

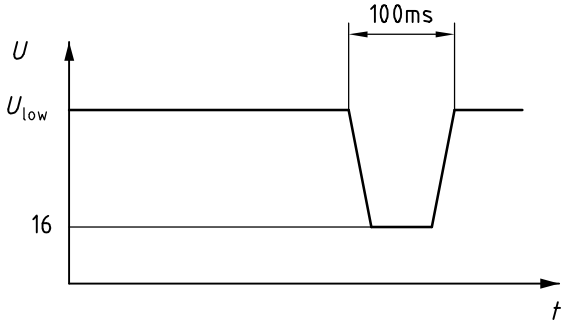
### 4.5.1 Momentary drop in supply voltage

#### 4.5.1.1 Purpose

This test verifies functional status operation according to the specification of the DUT when subjected to a momentary voltage drop. It simulates the impact on the power supply of a short circuit in another branch while a fuse element melts and clears.

#### 4.5.1.2 Test

Expose all relevant inputs (connections) of the DUT to the test pulse given in Figure 5.




**Key**

$t$ time, s

$U$ voltage, V

**Figure 5 — Momentary voltage drop**

The rise time and fall time between $U_{low}$ and the 16 V level shall be ⩽ 10 ms.

#### 4.5.1.3 Requirement

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

### 4.5.2 Reset behaviour at voltage drop

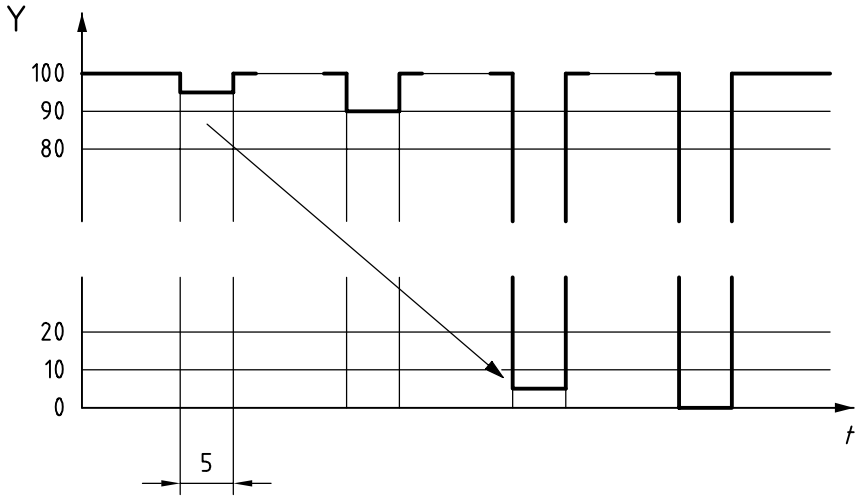
#### 4.5.2.1 Purpose

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 pulses in accordance with Figure 6 as specified in the application, and check the reset behaviour of the DUT.

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




**Key**

$Y$ $U_{low}$, %

$t$ time, s

**Figure 6 — Supply voltage profile for reset test**

The rise time and fall time shall be between 10 ms and 1 s.

#### 4.5.2.3 Requirement

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

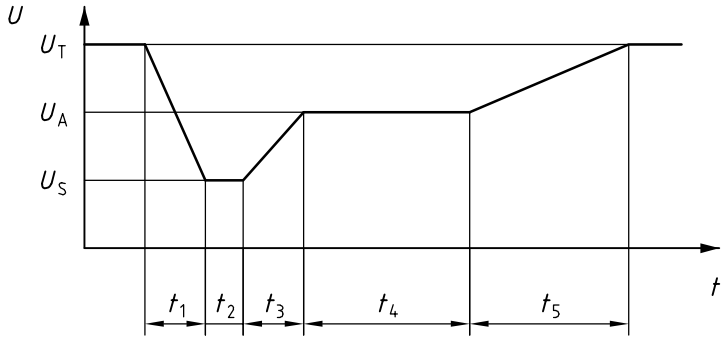
### 4.5.3 Starting profile

#### 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 as specified in Figure 7, with the values given in Table 3, simultaneously to all relevant inputs (connections) of the DUT.




**Key**

$t$ time, s

$U$ voltage, V

**Figure 7 — Starting pulse**

**Table 3 — Voltage profile of the starting pulse**

| $U_T$ V | $U_S$ V | $U_A$ V | $t_1$ ms | $t_2$ ms | $t_3$ ms | $t_4$ ms | $t_5$ ms |
|---|---|---|---|---|---|---|---|
| 42 | 18 | 21 | 5 | 15 | 50 | 10 000 | 100 |

#### 4.5.3.3 Requirement

Functions that are relevant to vehicle operation during cranking shall be Class A. For special requirements, Class B may be agreed between vehicle manufacturers and suppliers.

Functions not required during cranking shall be minimum Class C according to 16750-1:2003, Clause 6.

Special requirements for voltages and durations during $t_1$, $t_2$, and/or $t_3$ may be agreed between vehicle manufacturers and suppliers

### 4.6 Reversed voltage

#### 4.6.1 Purpose

The test is a check of the robustness of the DUT against the connection of a reversed battery.

This test shall only be applied to DUTs used in a 42 V electrical system incorporating centralized reverse voltage protection consisting of a series fuse and a reverse polarity shunt diode.

This test is not applicable

— to generators, or

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

#### 4.6.2 Test

Apply a negative voltage simultaneously to all relevant power terminals of the DUT.

Conditions are the following:

a) $U_T = -2$ V

b) $t = 100$ ms (duration of the applied voltage)

c) $R_i = 1$ mΩ (internal resistance of the battery source)

NOTE The duration $t$ and voltage $U_T$ are chosen on the basis of the capability of current semiconductor and fuse technology.

#### 4.6.3 Requirement

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

NOTE Design precautions shall be taken to ensure –42 V cannot be applied to any component (e.g. loss of common ground).

### 4.7 Open-circuit tests

#### 4.7.1 Single line interruption

##### 4.7.1.1 Purpose

This test simulates a rapid single line interruption.

NOTE This is not a test for connectors. Because of potential arcing damage to a contact if opened under load, it is recommended that the single line interruption be created and restored electronically.

##### 4.7.1.2 Test

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

— Test voltage $U_T = 42$ V

— Interruption time $t = (10 \pm 1)$ s

— Open-circuit resistance $R \geqslant 10$ MΩ

Repeat for each contact of the DUT 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

This test is to evaluate the effect when the DUT is subjected to a rapid multiple line interruption.

NOTE This is not a test for connectors. Because of potential arcing damage to a contact if opened under load, it is recommended that the multiple line interruption be created and restored electronically.

#### 4.7.2.2 Test

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

— Test voltage $U_T = 42$ V

— Interruption time $t = (10 \pm 1)$ s

— Open-circuit resistance $R \geqslant 10$ MΩ

Repeat for each connection of the DUT interface.

#### 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 Signal circuits

#### 4.8.1.1 Purpose

This test simulates short circuits to the signal inputs of a device.

NOTE This test is applicable only to DUTs with internal electronics.

#### 4.8.1.2 Test

Set $U_T = U_{high}$. Connect all relevant signal inputs of the DUT in sequence for a duration of 60 s to $U_T$ and to ground.

NOTE Signal return circuits are considered grounds and are exempted from test 4.8.1.2. Connection of a signal return to unfused $U_{high}$ will damage the DUT.

Perform this test with

a) supply voltage and ground connected,

b) supply voltage disconnected, and

c) ground disconnected.

#### 4.8.1.3 Requirement

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

### 4.8.2 Load circuits

#### 4.8.2.1 Purpose

This test verifies that all output load drivers for 42 V loads shall withstand the short-circuit currents as allowed by the corresponding protection. Values shall be given in the specification of the DUT.

#### 4.8.2.2 Test

Connect the DUT to a power supply with $U_T = U_{high}$ and $R_i = (20 \text{ to } 100)$ mΩ. The outputs shall be in operation.

For high side outputs, ground the output circuit for 60 s.

For low side outputs, connect $U_T$ to the output circuit for 60 s.

#### 4.8.2.3 Requirement

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 16750-1:2003, Clause 6).

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 16750-1:2003, Clause 6).

All unprotected outputs 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.

### 4.8.3 Multiple voltage systems (42 V plus lower voltages)

In a multiple voltage system, the possibility exists of short circuits between 42 V and lower voltages.

Implementation of a central overvoltage protection feature is recommended in the 12 V system of vehicles with a 12 V/42 V dual voltage vehicle electrical system. The overvoltage protection feature should consider the maximum jump start voltage defined for a 12 V system (“overvoltage test at room temperature” as defined in ISO 16750-2:2003, 4.2.1).

## 4.9 Withstand voltage

### 4.9.1 Purpose

This test checks the dielectric withstand voltage capability of circuits with galvanic isolation.

It is required only for systems/components which contain inductive elements (e.g. relays, motors, coils) or are connected to circuits with inductive load.

The deliberate overvoltage between the galvanically isolated current carrying parts of the DUT could have a negative effect on insulation performance caused by the electrical field. This test stresses the insulation system and checks the ability of the dielectric material to withstand a higher voltage caused by switching off inductive loads.

### 4.9.2 Test

Perform a “damp heat cyclic test” in accordance with ISO 16750-4:2003, 5.6.2.

Return the system/components to room temperature for 0,5 h.

Apply a sinusoidal test voltage of 1000 V rms (50 to 60) Hz to the DUT for 60 s as follows:

— between terminals with galvanic isolation;

— between terminals and housing with electrically conductive surface with galvanic isolation;

— between terminals and an electrode wrapped around the housing (for example metal foil, sphere bath) in the case of plastic housing.

#### 4.9.3 Requirement

There shall be no dielectric breakdown nor flash-over. After performing the test, the functional status shall be Class A as defined in ISO 16750-1:2003, Clause 6.

### 4.10 Insulation resistance

#### 4.10.1 Purpose

This test is for checking a minimum value of ohmic resistance required to avoid current between galvanically isolated circuits and conductive parts of the DUT.

The test gives an indication of the relative quality of the insulation system and material.

#### 4.10.2 Test

Perform a “damp heat cyclic test” in accordance with ISO 16750-4:2003, 5.6.2.

Return the system/components to room temperature for 0,5 h.

Apply a test voltage to the DUT of 500 V d.c. for a duration of 60 s, as follows:

— between terminals with galvanic isolation;

— between terminals and housing with an electrically conductive surface with galvanic isolation;

— between terminals and an electrode wrapped around the housing (for example metal foil) in the case of plastic material housing.

For particular applications, the test voltage may be reduced to 100 V d.c. if agreed between vehicle manufacturer and supplier.

#### 4.10.3 Requirement

The insulation resistance shall be $> 10\ M\Omega$. After performing the test, the functional status shall be Class A according to ISO 16750-1:2003.

### 4.11 Electromagnetic compatibility

EMC specifications are given in the Bibliography (see [1] to [7]) for information only. Performance measurements based on these specifications are not included in the scope of ISO 21848.

# Bibliography

[1] ISO 7637 (all parts), *Road vehicles — Electrical disturbances from conduction and coupling*

[2] ISO/TR 10305 (all parts), *Road vehicles — Calibration of electromagnetic field strength measuring devices*

[3] ISO 10605, *Road vehicles — Test methods for electrical disturbances from electrostatic discharge*

[4] ISO 11451 (all parts), *Road vehicles — Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy*

[5] ISO 11452 (all parts), *Road vehicles — Electrical disturbances by narrowband radiated electromagnetic energy — Component test methods*

[6] CISPR[2)] 12, *Vehicles, boats and internal combustion engine driven devices — Radio disturbance characteristics — Limits and methods of measurement for the protection of receivers except those installed in the vehicle/boat/device itself or in adjacent vehicles/boats/devices*

[7] CISPR[2)] 25, *Limits and methods of measurement of radio disturbance characteristics for the protection of receivers used on board vehicles*

2) The International Special Committee on Radio Interference. The vehicle emissions test methods and limits of CISPR 12 and CISPR 25 are applicable to all road vehicles regardless electrical system voltage. The applicability of standards other than CISPR 12 and CISPR 25 to the 42 V network is still under discussion and investigation.

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