# INTERNATIONAL STANDARD

# ISO 7637-3

Third edition
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# Road vehicles — Electrical disturbances from conduction and coupling —

## Part 3:
## Electrical transient transmission by capacitive and inductive coupling via lines other than supply lines



*Véhicules routiers — Perturbations électriques par conduction et par couplage —*



*Partie 3: Transmission des perturbations électriques par couplage capacitif ou inductif le long des lignes autres que les lignes d'alimentation*

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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 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).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information.



The committee responsible for this document is 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 7637-3:2007), which has been technically revised.



ISO 7637 consists of the following parts, under the general title *Road vehicles — Electrical disturbances from conduction and coupling*:

— *Part 1: Definitions and general considerations*

— *Part 2: Electrical transient conduction along supply lines only*

— *Part 3: Electrical transient transmission by capacitive and inductive coupling via lines other than supply lines*

The following parts are under preparation:

— *Part 4: Electrical transient conduction along shielded high voltage supply lines only*

— *Part 5: Enhanced definitions and verification methods for harmonization of pulse generators according to ISO 7637-2* [Technical Report]

Annex A forms an integral part of this part of ISO 7637.

Annex B and Annex C are informative.

# Introduction

The fast transient pulse test uses bursts composed of a number of fast transient pulses, which are coupled into lines (I/O lines in particular) of electronic equipment. The fast rise time, the repetition rate and the low energy of the fast transient bursts are significant to the test.

The slow transient pulse test applies a number of single pulses, as used for conducted transient pulse test, to the DUT.

# Road vehicles — Electrical disturbances from conduction and coupling —

## Part 3:
## Electrical transient transmission by capacitive and inductive coupling via lines other than supply lines

## 1 Scope

This part of ISO 7637 defines bench test methods to evaluate the immunity of devices under test (DUTs) to transient pulses coupled to lines other than supply lines. The test pulses simulate both fast and slow transient disturbances caused by the switching of inductive loads and relay contact bounce.

The following three test methods are described in this part of ISO 7637:

— capacitive coupling clamp (CCC) method;

— direct capacitive coupling (DCC) method;

— inductive coupling clamp (ICC) method.



This part of ISO 7637 applies to road vehicles fitted with nominal 12 V or 24 V electrical systems.

For transient pulses immunity, Annex B provides recommended test severity levels in line with the functional performance status classification (FPSC) principle described in ISO 7637-1.



## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 7637-1, *Road vehicles — Electrical disturbances from conduction and coupling — Part 1: Definitions and general considerations*

ISO 7637-2, *Road vehicles — Electrical disturbances from conduction and coupling — Part 2: Electrical transient conduction along supply lines only*

ISO 11452-4, *Road vehicles — Component test methods for electrical disturbances from narrowband radiated electromagnetic energy — Part 4: Harness excitation methods*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7637-1 apply.

# 4 Test methods

## 4.1 General

This Clause describes bench test methods for testing the immunity of electrical system components or devices under test (DUTs) against coupled transient pulses. These tests shall be performed in the laboratory.

The defined transient pulses represent the characteristics of most of the known transient pulses which may occur in the vehicle.

Some transient pulse tests may be omitted if a device, depending on its function or its configuration, is not subjected to comparable transient pulses in the vehicle. It is part of the vehicle manufacturer's responsibility to define the transient pulse tests needed for specific components.

A test plan shall be written to define the following:

— the test methods to be used;

— the transient pulses tests to be applied;

— the transient pulses levels;

— the number of transient pulses to be applied;

— the DUT operating modes;

— the wiring harness (test versus production);

— the leads to be included in the capacitive coupling clamp, if used;

— the leads to be tested using the direct coupling capacitor method, if used;

— the capacitance values to be used, if the direct coupling capacitor method is used for specific communication lines;

— the leads to be included in the inductive coupling clamp, if used; and

— the type of inductive coupling clamp, if the inductive coupling method is used.



Suggested transient pulse test severity levels for the evaluation of immunity of DUTs can be chosen from Table B.1 and Table B.2.

The transient pulse test severity levels should be mutually agreed upon between the vehicle manufacturer and the supplier prior to the test.

The applicability of the three different test methods is indicated in Table 1.

It is sufficient to select one test method for slow transient pulses and one test method for fast transient pulses.

**Table 1 — Test method applicability**

| Transient pulses type | CCC method | DCC method | ICC method |
|---|---|---|---|
| Slow transient pulses 2a (5.3.2) | Not applicable | Applicable | Applicable |
| Fast transient pulses 3a and 3b (5.3.3) | Applicable | Applicable | Not applicable |

## 4.2 Standard test conditions

Standard test conditions shall be according to ISO 7637-1 for the following:

— test temperature;

— supply voltage.

Unless otherwise defined in this part of ISO 7637, the tolerance on test severity levels is $\binom{+10}{0}$ %.

## 4.3 Ground plane

The ground plane shall be made of 0,5 mm thick (minimum) copper, brass or galvanized steel.

Unless otherwise specified in the test plan, the minimum width of the ground plane shall be 1 000 mm, or underneath the entire setup width (excluding power supply and transient pulse generator) plus 200 mm, whichever is larger.

Unless otherwise specified in the test plan, the minimum length of the ground plane shall be 2 000 mm, or underneath the entire setup length (excluding power supply and transient pulse generator) plus 200 mm, whichever is larger.

## 4.4 General test setup conditions

The DUT is arranged and connected according to its requirements. The DUT should be connected to the original operating devices (loads, sensors, etc.) using the test setup described in 4.5.4, 4.6.4 and 4.7.4, unless otherwise agreed between the vehicle manufacturer and the supplier.



If the actual DUT operating signal sources are not available, they may be simulated.

The DUT shall be placed on a non-conductive, low relative permittivity material ($\varepsilon_r \leq 1,4$), at (50 ± 5) mm above the ground plane. If the DUT is locally grounded (maximum length of 200 mm), then the DUT's ground supply line shall be connected to the ground plane as defined in the test plan.

Grounding of the DUT case to the ground plane shall reflect the vehicle installation and shall be defined in the test plan.

All harnesses shall be placed on a non-conductive, low relative permittivity (dielectric-constant) material ($\varepsilon_r \leq 1,4$), at (50 ± 5) mm above the ground plane.

Unless otherwise specified in the test plan, all loads, sensors, etc. grounds (lines, metallic cases) are connected to the ground plane using the shortest possible length.

To minimize extraneous capacitive coupling to the DUT, it is advisable that the minimum distance between the DUT and all other conductive structures, such as walls of a shielded enclosure (with the exception of the ground plane underneath the test setup), should be more than 0,5 m.

## 4.5 CCC method

### 4.5.1 General

The CCC method is suitable for coupling the fast transient pulses, particularly for DUTs with a moderate or large number of leads to be tested. It will not couple the slow transient pulses.

### 4.5.2 Generator verification

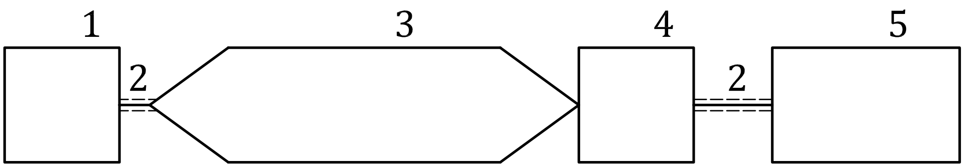
The transient pulse parameters (see Figure 10 and Figure 11) shall be verified prior to the test according to ISO 7637-2. Verification shall be performed with the 50 Ω load condition only.

### 4.5.3 Transient pulses level adjustment

The transient pulse generator shall be connected as shown in Figure 1.

The transient pulse level is adjusted with a 50 Ω input oscilloscope connected through a 50 Ω coaxial cable to a 50 Ω attenuator which is directly connected to the output of the CCC (no intermediate cable connections) as shown in Figure 1. There shall be no lines routed through the coupling clamp during adjustment. Examples of test severity levels are listed in Annex B.

NOTE The open circuit voltage of the transient pulses generator is approximately twice the value of the specific test voltage, due to 50 Ω loading of the attenuator and the oscilloscope.




**Key**

1 transient pulses generator

2 50 Ω coaxial cable (≤1 m)

3 CCC

4 50 Ω attenuator

5 oscilloscope (50 Ω input)



**Figure 1 — Setup for transient pulses level adjustment — CCC method**



### 4.5.4 DUT test



Ensure that the general test setup conditions defined in 4.4 are applied.

The test setup using the CCC is shown in Figure 2. The coupling circuit consists of a CCC through which lines of the DUT are installed as agreed between the vehicle manufacturer and the supplier and documented in the test plan. The coupling length is 1 m.

The DUT 12/24 V supply lines (ground and supply) should not be included in the CCC. Any other ground or supply line delivered by the DUT to an auxiliary equipment (sensors, actuators) shall be included in the CCC. If the auxiliary equipment is locally grounded, this local ground connection shall be excluded from the CCC. Any exception about ground or supply lines included in the CCC shall be stated in the test plan.

All lines which are placed in the CCC shall lie flat in single layer (typically 10 to 20 lines). This may require multiple tests to be performed in order to test all the DUT lines.

The hinged lid of the CCC shall be placed as flat as possible to ensure contact with the test harness which should be positioned as flat as possible.

Twisted and shielded wire configurations shall be maintained inside the CCC.

The test conditions for a DUT with multiple connectors (single test on all the branches or test on individual branch) or for a harness with more than 10 to 20 lines shall be specified in the test plan.

The distance between the DUT and the CCC, and between peripheral devices and the CCC, shall be greater than or equal to 300 mm. The portions of the lines being tested which are outside the CCC shall be placed at a distance of (50 ± 5) mm above the ground plane and oriented at 90° ± 15° to the longitudinal CCC axis.

The lines which are not under CCC test are routed outside the coupling clamp. They shall be placed on a (50 ± 5) mm height insulating support and shall be placed at a minimum distance of 100 mm to the coupling clamp.

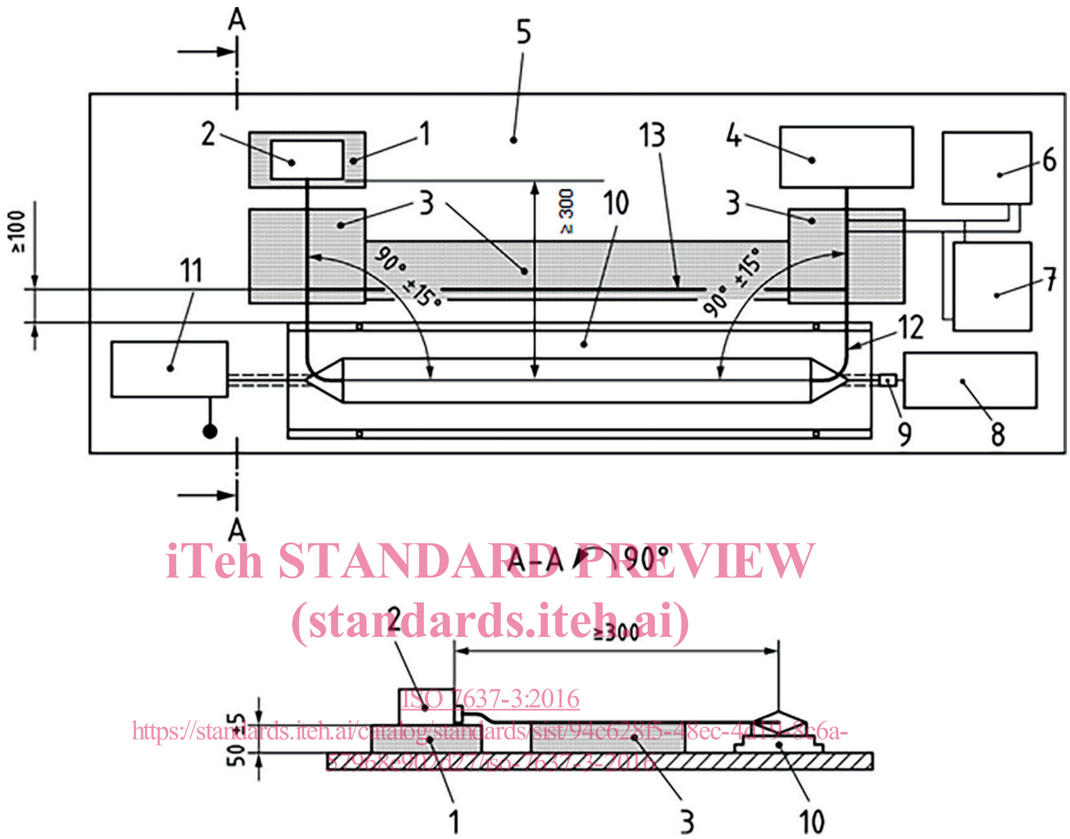
 

It is not necessary for lines which are not under the CCC to be placed in a straight line as illustrated in Figure 2. Arrangement due to additional length should be defined in test plan.

The DUT shall be placed on the same end of the CCC as the transient pulses generator.

The test shall be performed with a total harness length of 1 700 mm (+300 mm/0 mm).

Dimensions in millimetres






**Key**

| | | | |
|---|---|---|---|
| 1 | insulation support | 8 | oscilloscope (50 Ω input) |
| 2 | DUT (grounding as specified in test plan) | 9 | 50 Ω attenuator |
| 3 | insulating supports for test harness | 10 | CCC |
| 4 | load simulator | 11 | transient pulses generator |
| 5 | ground plane | 12 | lines to be tested |
| 6 | power supply | 13 | lines not to be tested |
| 7 | battery | | |

**Figure 2 — Test setup for CCC method — DUT Test**

## 4.6 DCC method

### 4.6.1 General

The DCC method uses capacitors for transient coupling. The values of capacitors are defined in Table 2 except for coupling to communication lines (e.g. CAN BUS) for which specific values shall be defined in the test plan.

**Table 2 — Capacitor values for DCC test method**

| Test pulse | Capacitor value |
|---|---|
| Slow transient pulses | 0,1 µF |
| Fast transient pulses | 100 pF |
| NOTE The characteristics of the non-polarized capacitors are defined as tolerance of ±10 %, rating of at least twice the maximum applied voltage, and dissipation factor less than or equal to 1 %. | |

### 4.6.2 Generator verification

The transient pulse parameters (see Figure 8, Figure 9, Figure 10 and Figure 11) shall be verified (according to ISO 7637-2) prior to performing the test. Verification shall include measurement of open circuit and loaded conditions.

When verifying fast transient pulse characteristics under open circuit conditions, it is recommended to use a 1 kΩ to 50 Ω adapter, with an oscilloscope configured for 50 Ω input. This minimizes the oscillations that can result when measuring a transient pulse with significantly short transient pulse rise time and duration into an open-circuit condition.

### 4.6.3 Transient pulses level adjustment

Prior to testing, the transient pulse level shall be adjusted at the output of the capacitor. Examples of test severity levels are listed in Annex B.

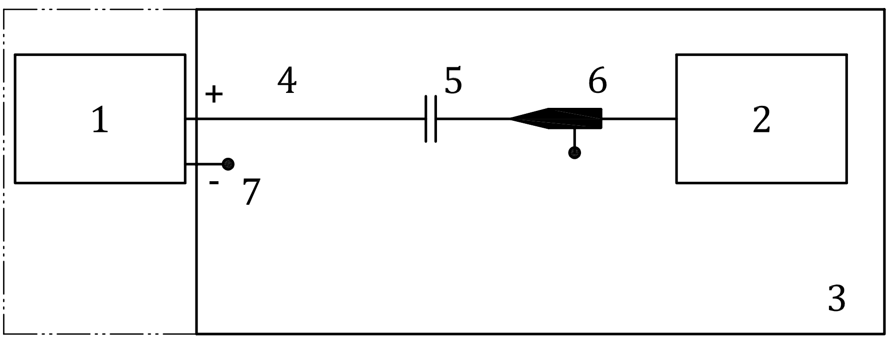
— For slow transient pulses, use the setup shown in Figure 3a. The transient pulse level shall be measured using a high impedance passive probe whose characteristics conform with those defined in ISO 7637-2, 5.5.



— For fast transient pulses, use the setup shown in Figure 3b. The output of the capacitor shall be connected to the 1 kΩ to 50 Ω adapter. The adaptor is connected to an oscilloscope configured for 50 Ω input. The measured peak pulse level is corrected for this adaptor. The capacitor shall be placed in a shielded box which shall be grounded. The 50 Ω coaxial cable shall be connected to this box.



The generator ground shall be bonded to the ground plane with a DC resistance ≤2,5 mΩ and a bond length of less than 100 mm.




**Key**

1 transient pulses generator
2 high impedance input oscilloscope
3 ground plane
4 connecting wiring
5 coupling capacitor
6 high impedance passive voltage probe (see ISO 7637-2)
7 ground connection (maximum length of 100 mm)

**Figure 3a — Setup for slow transient pulses level adjustment — DCC method**