INTERNATIONAL STANDARD

ISO 7637-2

Second edition
2004-06-15

Corrected version
2004-09-15

Road vehicles — Electrical disturbances from conduction and coupling —

Part 2: Electrical transient conduction along supply lines only

Véhicules routiers — Perturbations électriques par conduction et par couplage —

Partie 2: Transmission des perturbations électriques transitoires par conduction uniquement le long des lignes d'alimentation

Reference number
ISO 7637-2:2004(E)

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 7637-2 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

This second edition of ISO 7637-2 cancels and replaces ISO 7637-1:1990 and ISO 7637-2:1990, of which it constitutes a technical revision. Note that ISO 7637-1:2002 cancelled and replaced ISO 7637-0:1990.

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: Vehicles with nominal 12 V or 24 V supply voltage — Electrical transient transmission by capacitive and inductive coupling via lines other than supply lines*

This corrected version of ISO 7637-2:2004 incorporates the following corrections.

— In Table 4, the value for the parameter t_r has been corrected from "$\left(10\,^{0}_{-0,5}\right)$ µs" to "$\left(1\,^{0}_{-0,5}\right)$ µs".

— Some typographical corrections have been made.

Road vehicles — Electrical disturbances from conduction and coupling —

Part 2: Electrical transient conduction along supply lines only

1 Scope

This part of ISO 7637 specifies bench tests for testing the compatibility to conducted electrical transients of equipment installed on passenger cars and light commercial vehicles fitted with a 12 V electrical system or commercial vehicles fitted with a 24 V electrical system — for both injection and the measurement of transients. Failure mode severity classification for immunity to transients is also given. It is applicable to these types of road vehicle, independent of the propulsion system (e.g. spark ignition or diesel engine, or electric motor).

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 7637-1:2002, *Road vehicles — Electrical disturbances from conduction and coupling — Part 1: Definitions and general considerations*

ISO 8854:1988, *Road vehicles — Alternators with regulators — Test methods and general requirements*

3 Terms and definitions

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

4 Test procedure

4.1 General

These tests for measuring the transient emission on supply lines and the immunity of devices against such transients are called “bench tests”, made in the laboratory.

The methods, some of which require the use of the artificial network, will provide comparable results between laboratories. They will also give the basis for the development of devices and systems, and may be used during the production phase (see Annex B).

A bench test method for the evaluation of the immunity of a device against supply line transients may be performed by means of a test pulse generator; this may not cover all types of transients which can occur in a vehicle. Therefore, the test pulses described in 5.6 are characteristic of typical pulses.

In special cases, it could be necessary to apply additional test pulses. However, some pulses may be omitted if a device, depending on its function or its connection, is not influenced by comparable transients in the vehicle. It is the vehicle manufacturer's responsibility to define the test pulses required for a specific device.

Unless otherwise specified, a tolerance of ±10 % applies to all variables used.

4.2 Test temperature and test voltage

The ambient temperature during the test shall be (23 ± 5) °C.

The test voltages shall be according to Table 1 unless other values are agreed upon by the users of this part of ISO 7637, in which case such values shall be documented in test reports.

Table 1 — Test voltages

Test voltage	12 V system V	24 V system V
U_A	13,5 ± 0,5	27 ± 1
U_B	12 ± 0,2	24 ± 0,4

4.3 Voltage transient emissions test

This subclause specifies a test procedure for evaluating the automotive electrical and electronic components of the device under test (DUT), considered a potential source of conducted disturbances, for conducted emissions of transients along the battery-fed or switched supply lines.

Care shall be taken to ensure that the surrounding electromagnetic environment does not interfere with the measurement set-up.

Voltage transients from the disturbance source, the DUT, are measured using the artificial network to standardize the impedance loading on the DUT (see 5.1). The disturbance source is connected via the artificial network to the shunt resistor, R_s (see 5.2), the switch, S (see 5.3), and the power supply (see 5.4), as shown in Figure 1 a) or b).

All wiring connections between artificial network, switch, and the DUT shall be spaced $\left(50\,^{+10}_{\ 0}\right)$ mm above the metal ground plane.

The cable sizes shall be chosen in accordance with the real situation in the vehicle, i.e. the wiring shall be capable of handling the operating current of the DUT, and as agreed between vehicle manufacturer and supplier.

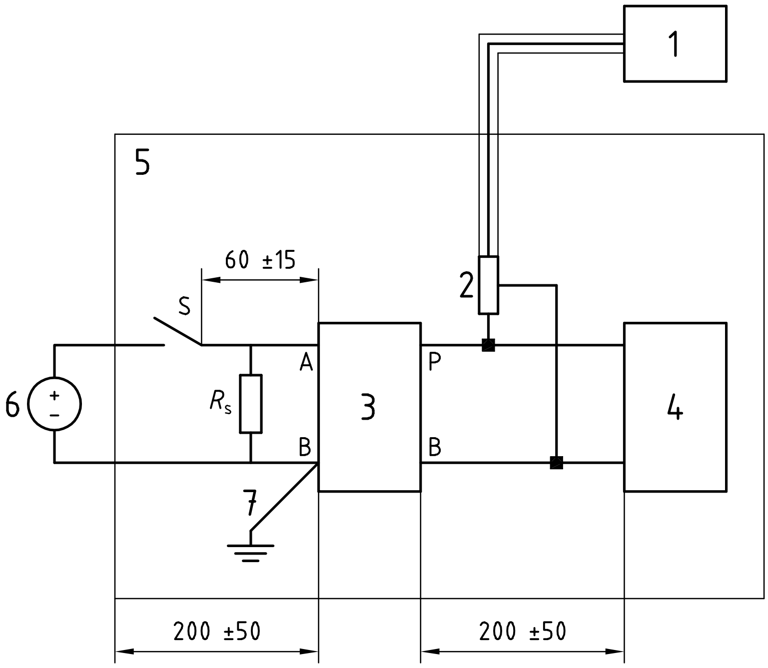
If no requirements are specified in the test plan, then the DUT shall be placed on a non-conductive material $\left(50\,^{+10}_{\ 0}\right)$ mm above the ground plane.

The disturbance voltage shall be measured as close to the DUT terminals as possible [see Figure 1 a) or b], using a voltage probe (see 5.5.2) and an oscilloscope (see 5.5.1) or waveform acquisition equipment (see 5.5.3).

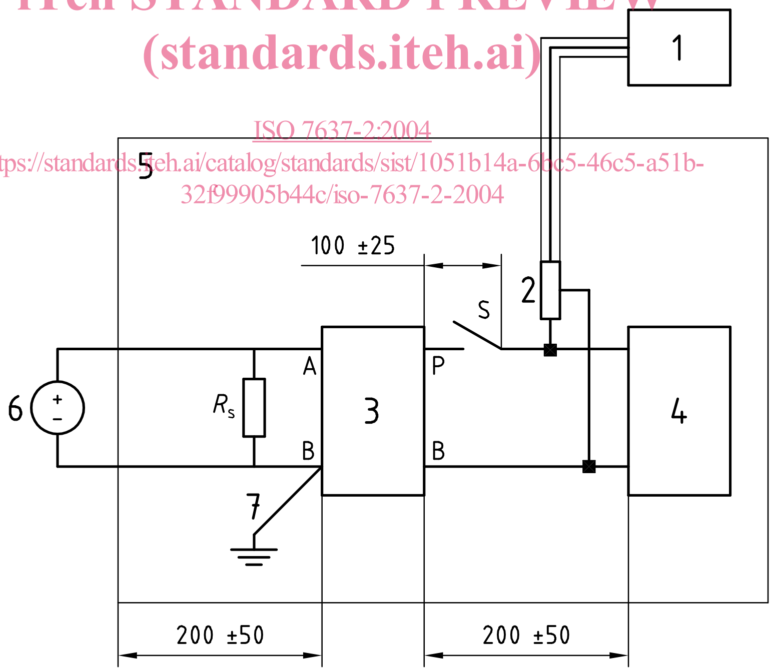
Repetitive transients shall be measured with the switch S closed. If the transient is caused by a supply disconnection, measurement shall be started at the moment of opening switch S.

For evaluation and values, see Annex C.

Dimensions in millimetres
Drawing not to scale



a) Slow pulses (millisecond range or slower)



b) Fast pulses (nanosecond-to-microsecond range)

Key

1 oscilloscope or equivalent
2 voltage probe
3 artificial network
4 DUT (source of transient)
5 ground plane
6 power supply
7 Ground connection; length < 100 mm

NOTE For A, B, P, see Figure 3.

Figure 1 — Transient emission test set-up

DUT operating conditions of particular interest in the measurements are the turn on, the turn off, and the exercising of the various operating modes of the DUT. The exact operating conditions of the DUT shall be specified in the test plan.

The sampling rate and trigger level shall be selected to capture a waveform displaying the complete duration of the transient, with sufficient resolution to display the highest positive and negative portions of the transient.

Utilising the proper sampling rate and trigger level, the voltage amplitude shall be recorded by actuating the DUT according to the test plan. Other transient parameters, such as rise time, fall time and transient duration, may also be recorded. Unless otherwise specified, ten waveform acquisitions are required. Only those waveforms with the highest positive and negative amplitude (with their associated parameters) shall be recorded.

The measured transient shall be evaluated according to Annex C. All pertinent information and test results shall be reported. If required per the test plan, include transient evaluation results with respect to the performance objective as specified in the test plan.

4.4 Transient immunity test

The test set-up for transient immunity measurements of electrical/ electronic devices shall be as shown in Figure 2.

For test pulses 3a and 3b, the leads between the terminals of the test pulse generator and the DUT shall be laid out in a straight parallel line at a height of $\left(50^{+10}_{\ 0}\right)$ mm above the ground plane and shall have a length of (0,5 ± 0,1) m.

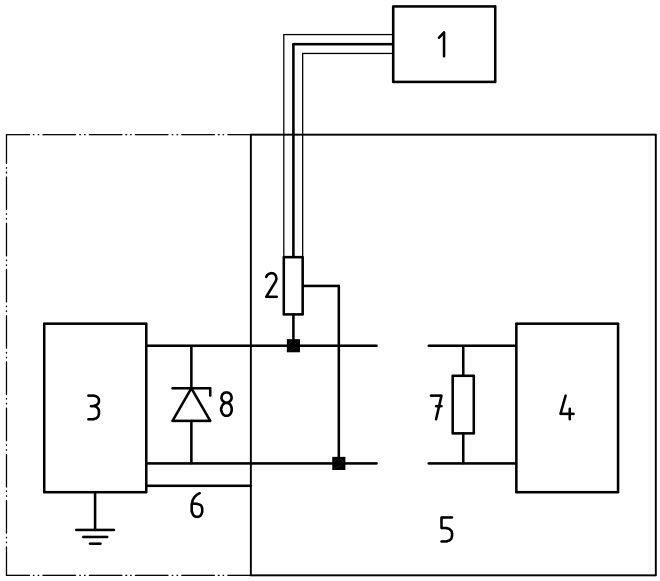
The test pulse generator (see 5.6) is set up to provide the specific pulse polarity, amplitude, duration and resistance with the DUT and optional resistance R_v disconnected [see Figure 2 a)]. The appropriate values are selected from Annex A. Next, the DUT is connected to the generator [see Figure 2 b)], while the oscilloscope is disconnected.

Depending on the real conditions, the function of the DUT may be evaluated during and/or after the application of the test pulses.

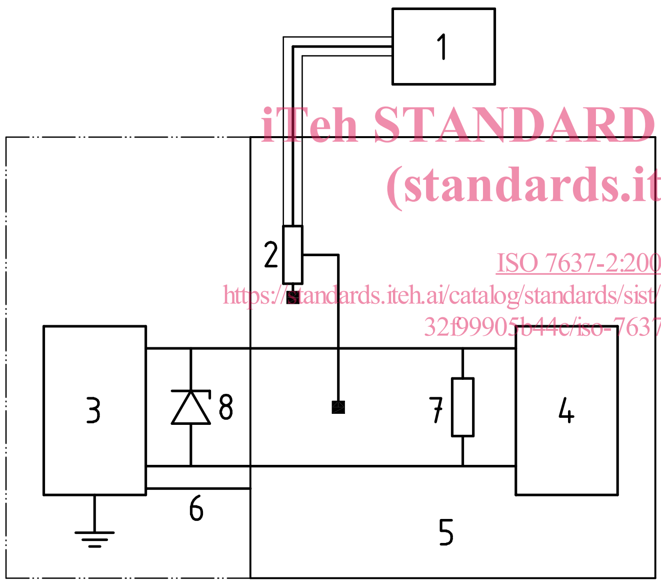
For correct generation of the required test pulses, it may be necessary to switch the power supply on and off. The switching can be performed by the test pulse generator if the power supply is integral to it.

One way to simulate the waveform of an alternator with centralized load dump suppression (see Figure 12), is to connect a suppression diode (or diode bridge) across the output terminals of the test pulse generator [see Figure 2 a) and b]. Since a single diode will generally have part-to-part variation and may not be able to handle the large alternator currents, the use of a bridge arrangement [an example is shown in Figure 2 c)] is recommended. The same generator shall be used for test pulses 5a and 5b.

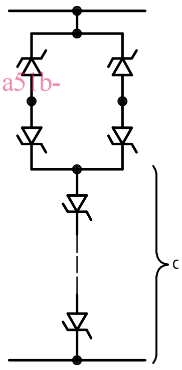
The suppression diodes and the suppressed voltage levels (clamping voltage) used by different car manufacturers are not standard. The supplier (parts manufacturers) must, therefore, obtain the diode and clamping voltage specification information from the manufacturer to be able to perform this test. The single diodes are added to the diode bridge as needed to provide the specified clamping voltage.



a) Pulse adjustment



b) Pulse injection



c) Example of suppression diode bridge for test pulse 5b only

Key

1 oscilloscope or equivalent
2 voltage probe
3 test pulse generator with internal power supply resistance R_i
4 DUT
5 ground plane
6 Ground connection (maximum length for test pulse 3: 100 mm)
7 optional resistor (R_v) [a]
8 optional diode bridge [b]

[a] For simulation of vehicle system loading for load dump test pulses 5a and 5b only. If used, the value of R_v shall be specified in the test plan (typical value 0,7 Ω to 40 Ω).

[b] For simulation of load dump waveform for alternator with centralized load dump suppression for pulse 5b only [see Figure 2 c)].

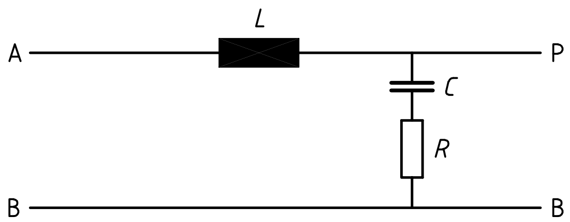
[c] Add forward biased diodes as required to achieve max. open-circuit (suppressed) voltage.

Figure 2 — Transient immunity test set-up

5 Test instrument description and specifications

5.1 Artificial network

The artificial network is used as a reference standard in the laboratory in place of the impedance of the vehicle wiring harness, in order to determine the behaviour of equipment and electrical and electronic devices. An example of a schematic diagram is shown in Figure 3.



Key

A power supply terminal

B common terminal (may be grounded)

C capacitor

L inductance

P terminal for DUT

R resistor

Main characteristics of the components:

L = 5 µH (air-core winding)

Internal resistance between terminals P and A: < 5 mΩ

C = 0,1 µF for working voltages of 200 V a.c. and 1 500 V d.c.

R = 50 Ω

Figure 3 — Example schematic diagram of artificial network

The artificial network shall be able to withstand a continuous load corresponding to the requirements of the DUT.

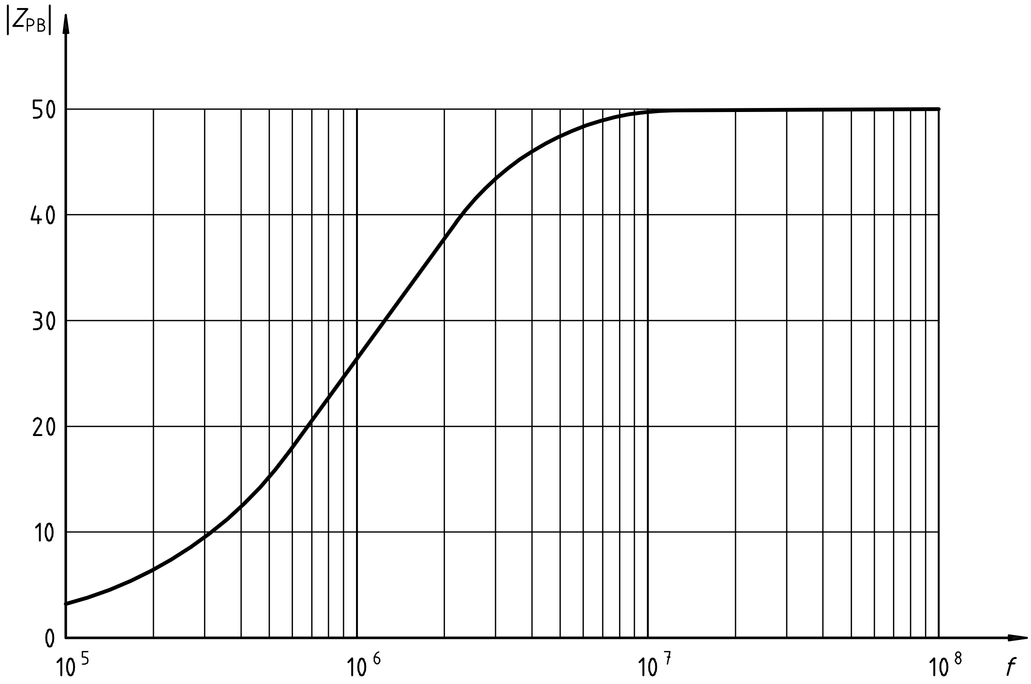
The resulting values of impedance $|Z_{PB}|$, measured between the terminals P and B while terminals A and B are short-circuited, are given in Figure 4 as a function of frequency assuming ideal electric components. In reality, the impedance of an artificial network shall not deviate more than 10 % from the curve given in Figure 4.

If the artificial network has a metal enclosure, it shall be placed flat on the ground plane and the ground terminal on the power source end shall be connected to the ground plane as shown in Figures 1 a) and b).

5.2 Shunt resistor R_s

The shunt resistor R_s (see Figure 1) simulates the d.c. resistance of other vehicle devices which are connected in parallel to the DUT and are not disconnected from it by the ignition switch. R_s is selected to correspond to the resistance measured on the wiring harness between the disconnected ignition switch terminal and ground, with the switch off, and shall be specified by the vehicle manufacturer. In the absence of any specification, a value of R_s = 40 Ω shall be used. If a wire-wound resistor is used, the winding shall be bifilar (i.e. with a minimum reactive component).

To simulate the worst-case condition, R_s may be switched off.



Key

$|Z_{PB}|$ impedance (Ω)

f frequency (Hz)

Figure 4 — Impedance $|Z_{PB}|$ as function of frequency from 100 kHz to 100 MHz (A, B short-circuited)

5.3 Switch S

The switching device S can be located on either side of the artificial network as shown in Figure 1 depending on the actual application. For the measurement of transients ($t_d \approx$ µs range), the switch on the DUT side of the artificial network must be actuated.

During the test, only one of the switching devices shown in Figure 1 shall be actuated (the contact of the other switching device shall be closed). The selection of the switching device shall be specified in the test plan prior to the test and documented in the test report.

As S significantly influences the disturbance transient characteristics, the recommended switching devices are described below:

a) For the measurement of high voltage transients (with amplitudes over 400 V), the switching device is recommended to be a standard production switch that is used in the vehicle with the DUT. If such a device is not available, an automotive relay with the following characteristics shall be used:

   — contact rating, $I = 30$ A, continuous, resistive load;

   — high purity silver contact material;

   — no suppression across relay contact;

   — single/double position contact electrically insulated from the coil circuit;

   — coil with transient suppression.

   The switching relay shall be replaced if significant contact degradation occurs.

b) An unequivocal assessment of the disturbance is only possible if a switch with reproducible properties is used. For this purpose, an electronic switch is proposed. It is probable that amplitudes of disturbance are higher than those normally encountered with conventional switches (arcing). This shall be taken into account when evaluating test results. The electronic switch is very appropriate for controlling the function of suppressors used. For the measurement of lower voltage transients (with amplitudes less than 400 V), such as those produced by sources with transient suppressions, an electronic switch with the following characteristics should be used:

— maximum voltage, $U_{max} = 400$ V at 25 A;

— maximum current, $I_{max} = 25$ A continuously, 100 A for $\Delta t \leqslant 1$ s;

— voltage drop, $\Delta U \leqslant 1$ V at 25 A;

— test voltages, $U_{A1} = 13{,}5$ V, $U_{A2} = 27$ V;

— switching time, $\Delta t_s = 300$ ns ± 20 % with DUT;

— $R = 0{,}6\ \Omega$, $L = 50$ µH (1 kHz);

— shunt resistor $R_s = 10\ \Omega$, 20 Ω, 40 Ω, and connection for external resistors;

— trigger: internal and external;

— voltage probe: 1: 100.

The switch shall withstand short-circuiting.

An artificial network according to 5.1 and Figures 3 and 4 shall be implemented, but it shall be possible to switch it off (50 Ω artificial network is defined up to 100 MHz).

5.4 Power supply

The continuous supply source shall have an internal resistance R_i of less than 0,01 Ω d.c. and an internal impedance $Z_i = R_i$ for frequencies less than 400 Hz. The output voltage shall not deviate more than 1 V from 0 to maximum load (including inrush current) and shall recover 63 % of its maximum excursion within 100 µs. The superimposed ripple voltage, U_r, shall not exceed 0,2 V peak-to-peak and shall have a minimum frequency of 400 Hz.

If a standard power supply (with sufficient current capacity) is used to simulate the battery, it is important that the low internal impedance of the battery be also simulated.

When a battery is used, a charging source may be needed to achieve the specified reference levels (13,5 V and 27 V, respectively).

5.5 Measurement instrumentation

5.5.1 Oscilloscope

The use of a digitizing oscilloscope (minimum single sweep sampling rate of 2 GHz/s and 400 MHz bandwidth with input sensitivity: at least 5 mV/div.) is preferred. If a digitizing oscilloscope is not available, an analog storage oscilloscope may be used, which shall have the following minimum specifications:

— bandwidth d.c. to at least 400 MHz;

— writing speed of at least 100 cm/µs;

— input sensitivity of at least 5 mV/division.

The recording may be made with an oscilloscope camera or any other appropriate recording device.

5.5.2 Voltage probe

Characteristics of the voltage probe are

— attenuation of 100/1,

— maximum input voltage of at least 1 kV,

— input impedance Z and capacitance C according to Table 2 ;

— maximum probe cable length of 3 m;

— maximum probe ground length of 0,13 m.

The lengths will influence the measurement results and shall be stated in the test report.

Table 2 — Voltage probe parameters

f MHz	Z kΩ	C pF
1	> 40	< 4
10	> 4	< 4
100	> 0,4	< 4

5.5.3 Waveform acquisition equipment

Equipment that is capable of acquiring fast rise time transient waveforms may be used instead of an oscilloscope.

5.6 Test pulse generator for immunity testing

The test pulse generator shall be capable of producing the open circuit test pulses according to 5.6.1 to 5.6.5 at the maximum value of $|U_s|$. Moreover, U_s shall be adjustable within the limits given in Tables 3 to 9.

Peak voltage U_s shall be adjusted to the test levels specified in Annex A with a tolerance of $\left(^{+10}_{\ 0}\right)\%$. The timing ($t$) tolerances and internal resistance (R_i) tolerance shall be ± 20 %, unless otherwise specified.

A verification procedure for the generator performance and tolerances is given in Annex D.

Recommended values for the evaluation of immunity of devices are given in Annex A.