TRANSIENT NOISES LED ON SUPPLY LINES EMITTED BY ELECTRONIC, ELECTRICAL AND ELECTROMECHANICAL DEVICES

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1 SUBJECT

The present standard is valid for devices installed on vehicles with a 12 V or a 24 V electric system equipped with internal combustion engines with “DIESEL” or “OTTO” cycles.

2 PURPOSE

The present standard aims to define a test procedure at the bed and on vehicle to measure transient noises produced by the devices on supply lines next to the switching of switches or remote control switches or to the key insertion or removal.
It further defines the acceptability levels for the above–said devices.

NOTE **:** *The measures provided in this standard must be carried out on electronic, electrical and electromechanical systems. It is fundamentally important that the tested components are really those that will be installed on the vehicle, in order to reproduce the various noises that are really occurring.*

3 GENERAL TEST CONDITIONS

The tests must be carried out on the electronic devices that have already passed the functional checks required by IVECO STD. 18–2252 and by the specific Specifications.

3.1 Test environment

Room whose dimensions are such as to house instruments and test table, whose minimum sizes are 2 x 1 m; the test environment must be free from noises that can affect the test results.

– Temperature: 23 ± 5 °C
– Relative humidity 45 – 70 %
– Atmospheric pressure: 860 – 1060 mbar

Edition	Date	Description of modifications	Group
1	03.03.1992	New.	PEL
2	24.04.1992	Current transients speed modified at point 8 (it was 0.1 A/µs).	
3	03.09.1993	Points 4.9 and 6 modified.	
4	28.08.1999	Point 8 modified, Tables 1 and 2 and Figures 4 and 5 removed.	
5	02.07.2001	Revised with respect to previous edition and points 2, 4.7, 6 and 7 modified.	
6	03.03.2006	Added: Supervisor and Manager. Modified points: 4.1, 4.3 4.7, 4.9, 5 and Standards Quoted Added point 4.7.1 and Figure 3. Editing modifications.	
7	15.01.2009	Supervisor, points 4.7.1.2 and 8 changed. Manager updated.	

3.2 **Test voltage**

The one required on drawing or on the specific Specification about the tested device (see **Table I**):

TABLE I

Voltage	For 12 V systems (V)	For 24 V systems (V)
U_A	13.5 ± 0.5	27 ± 1
U_B	12 ± 0.2	24 ± 0.4

Where:

U_A = System voltage (engine ON)

U_B = Battery voltage (engine OFF)

4 TEST EQUIPMENT

4.1 Digital oscilloscope

With the following properties:

– Sampling rate: > 400 MSample/sec and 2 GHz/s single sweep sampling rate.

– Analogic pass band: > 100 MHz

– Vertical resolution: at least 8 bit

– Input sensitivity: ≥ 5mV/division

– Input impedance: 50 Ω/1M Ω

– Measurement channels: at least 2

– Writing rate: ≥ 100 cm/µs

– Possibility of copying on plotters or printers

4.2 Current probe

– Frequency band:	DC–50 MHz DC–15 MHz	for 20A probes for 100A probes
– Dynamics:	from 1mA/Div to 5A/Div from 10mA/Div to 50A/Div	for 20A probes for 100A probes
– Sensitivity:	1mA 0mA	for 20A probes for 100A probes

4.3 Passive voltage probe

To be used for measurements in the frequency range that is less than 250 MHz and with noise amplitudes that are greater than 400 V; complying with the following technical requirements:

- Attenuation 100/1
- Max. sustained voltage > 1 kV
- Impedance: > 40 KΩ to 1 MHz
> 4 KΩ to 10 MHz
> 400 Ω to 100 MHz
- Capacity < 4 pF
- Max. probe length ≤ 3 m
- lMax. length of probe ground cable ≤ 13 cm .

4.4 Active voltage probe

To be used for measurements in the frequency range that is more than 250 MHz and with noise amplitudes that are less than 400 V; complying with the following technical requirements:

– Frequency band:	> 900 MHz	> 900 MHz	> 900 MHz
– Attenuation:	x1	x10	x100
– Max. sustained voltage:	± 100 V	± 200 V	± 200 V
– Resistance to load:	100 KΩ	1 MΩ	1 MΩ
– Load capacity:	3 pF	1.5 pF	1.5 pF
– Offset:	± 5.6 V	± 56 V	± 200 V
– Linearity range:	± 0.6 V	± 6 V	± 60 V

4.5 Ground plane

Sheet made of material with high electrical conductivity (Cu, Al, Brass); minimum thickness 1.5 mm, minimum dimensions 2 x 1 m.
The ground plane will have to be connected to the earth plate of the building through an adequate copper plait welded to the plane itself.

4.6 Test table

It must be made of insulating material (for example wood), whose dimensions are suitable to house the ground plane.

4.7 Impedance stabilization network (L.I.S.N.)

It must be realized according to the wiring diagram in **Figure 1** and have the impedance characteristic varying with frequency as indicated in **Figure 2**.
It must also comply with the following requirements:

– The resistance between P and A terminals must be less than 5 mΩ.;

– The impedance measured between P and B terminals, when A and B terminals are short–circuited, must not be different more than 10% from the theoretical curve shown in **Figure 2**, in the 100 KHz – 20 MHz frequency band;

– Capacity C2 must support continuous voltages that are greater than 1500 V and 200 V alternate current;

– Inductance L must support the supply current for the tested device, and be < 5 µH;

– It is necessary to check that the L.I.S.N. is equipped with a switch without recoils that can be remotely piloted and is positioned on the supply side, with a switching time < 1 µs and a voltage drop < 1 V;

– The resistance on the supply side must be 40 Ω for voltage measurements and 2 Ω for current measurements.

It shall only be used during measurements performed with devices installed at the bench, whereas it is not required during measurements on vehicle.

4.7.1 **Switch**

The switch shall be installed at both ends of the artificial network according to actual application, as shown in **Figure 3**.

4.7.1.1 Voltages: > 400 V
the switch shall have the following properties:

- 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

Replace the switch when contacts are worn.

4.7.1.2 Voltages: < 400 V,
switch shall have the following characteristics:

- max. voltage: 400 V at 25 A;
- max. current: 25 A continuous, 100 A for $\Delta t \leq 1$ s;
- voltage drop ≤ 2 V a 25 A;
- current switching time: Δ_{ts} = 300 nS ± 20% at 13,5 V with load R inserted = 0,6 Ω and L = 50 µH (1 KHz);
- shunt resistance Rs = 10, 20, 40, 120 Ω and connection for external resistor;
- trigger: internal and external;
- voltage probe: 1 : 100.

4.8 **System stimulating and/or mechanically loading the tested device**

- It must allow the correct operation of the tested device under normal employment conditions, as provided by the drawing or the related Specification.
- It must be able to correctly interface with the tested system's sensors, without altering their electrical properties (impedances).

4.9 **Power supply**

Power supply with adjustable voltage between 0 and 40 V – 80 A with internal resistance Ri < 0.01 Ω in d.c. and internal impedance Zi = Ri for frequency < 400 Hz.
Power supply shall have Ripple ≤ 0.2 $V_{peak\ to\ peak}$.
Output voltage shall not deviate more than 1 V from zero at max. load (including inrush current) and it shall cover 63% of its max. range within 100 µS.
It shall be buffer–connected to the 12 V– 70 Ah – 350 A battery (1 battery for 12 V tests, 2 batteries in series for 24 V tests).

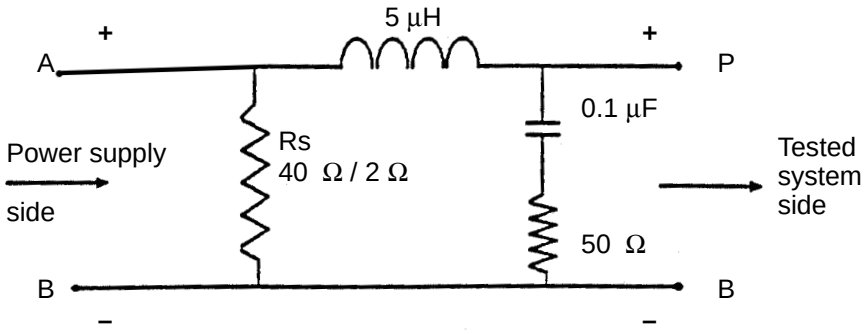


FIGURE 1 – L.I.S.N. WIRING DIAGRAM

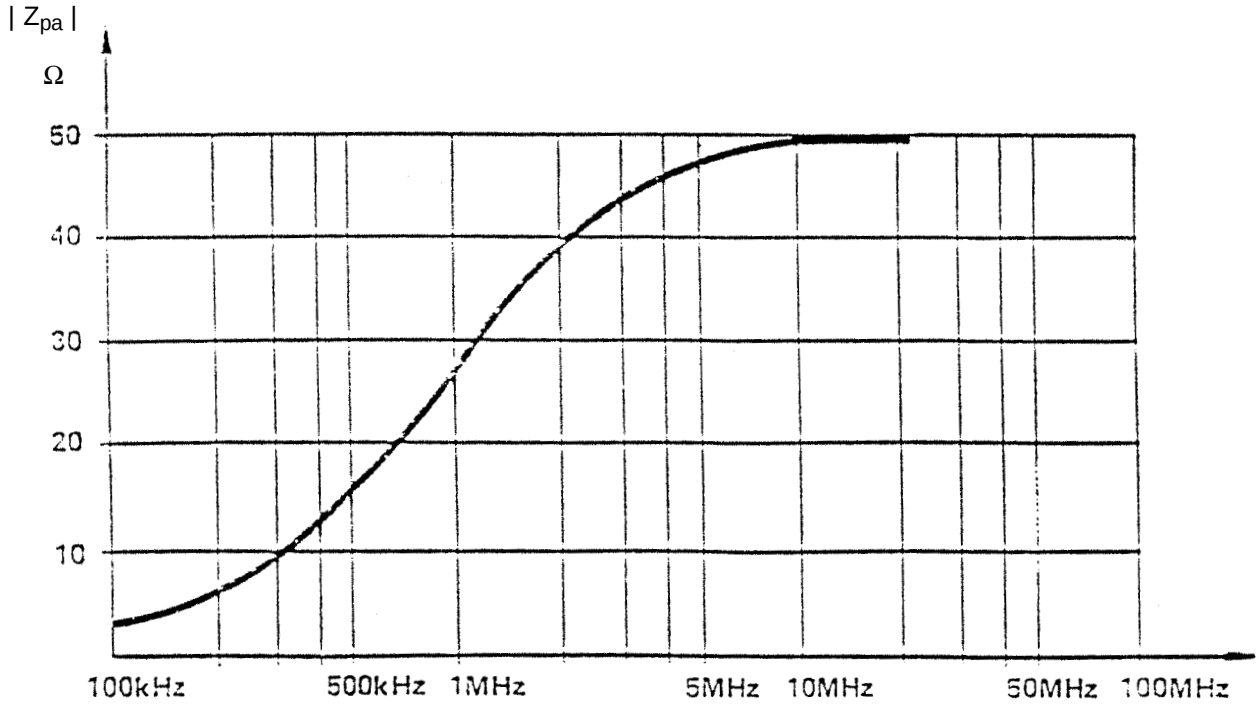
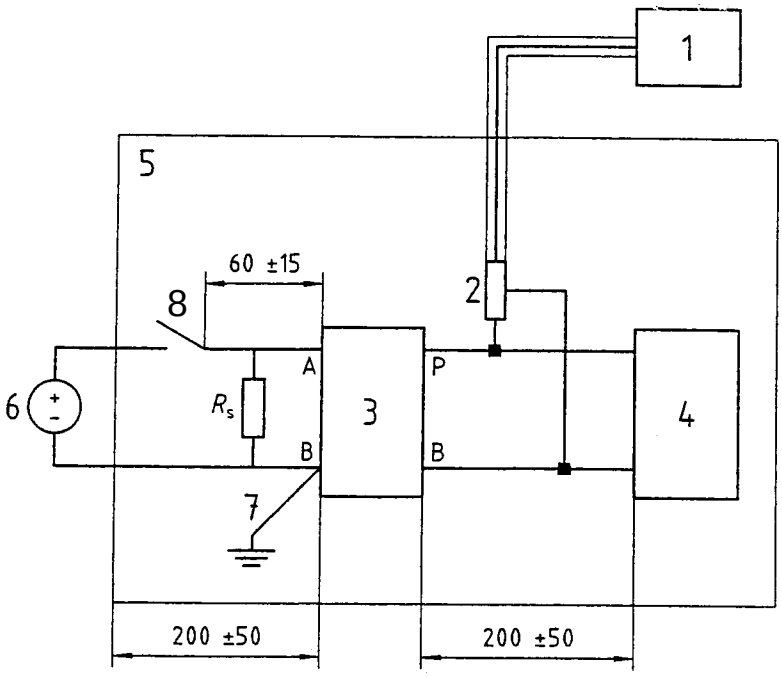
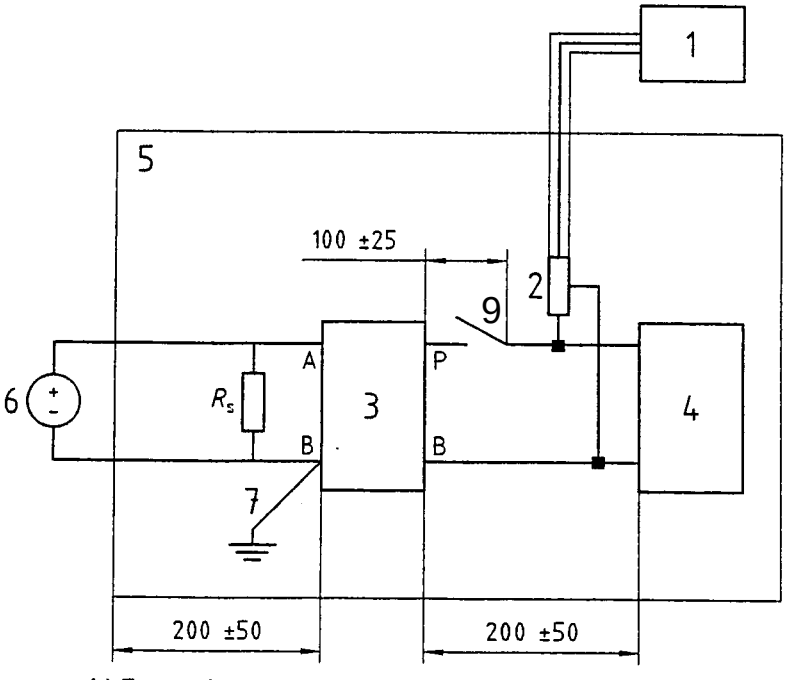


FIGURE 2 – IMPEDANCE MODULE BEHAVIOUR

FIGURE 3 – TRANSIENT EMISSION TEST SET–UP



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
8) Switch for slow pulses
9) Switch for fast pulses

5 DEVICE LOCATION

5.1 Place the devices on the test plane as indicated in **Figure 4**.

5.2 The device to be checked must be placed at the distance of 50 ± 5 mm from the ground plane and insulated from it, unless the direct ground connection on the frame is expressly provided; in this case, the connection with the ground plane must be as short as possible.

5.3 Prearrange the supply line (positive and negative) from the device to the impedance stabilization network with two wires whose section is 2.5 mm^2, 1000 ± 50 mm long and parallel one to the other at the distance of 20 ± 2 mm and spaced from the ground plane by 50 ± 5 mm.

5.4 The sensors must be stressed through the stimulating system mentioned in paragraph 4.7, if the system can be activated and/or deactivated in the vehicle through a switch or a remote control switch: this latter one must be present in the same configuration and of the same type provided on the vehicle.

5.5 The actuators must be the same ones provided on drawing to be installed on a vehicle.
If they are composed of electric motors, the mechanical load must be present or, eventually, simulated through a brake.

5.6 The battery's and the power supply's negatives must be connected to the ground plane.

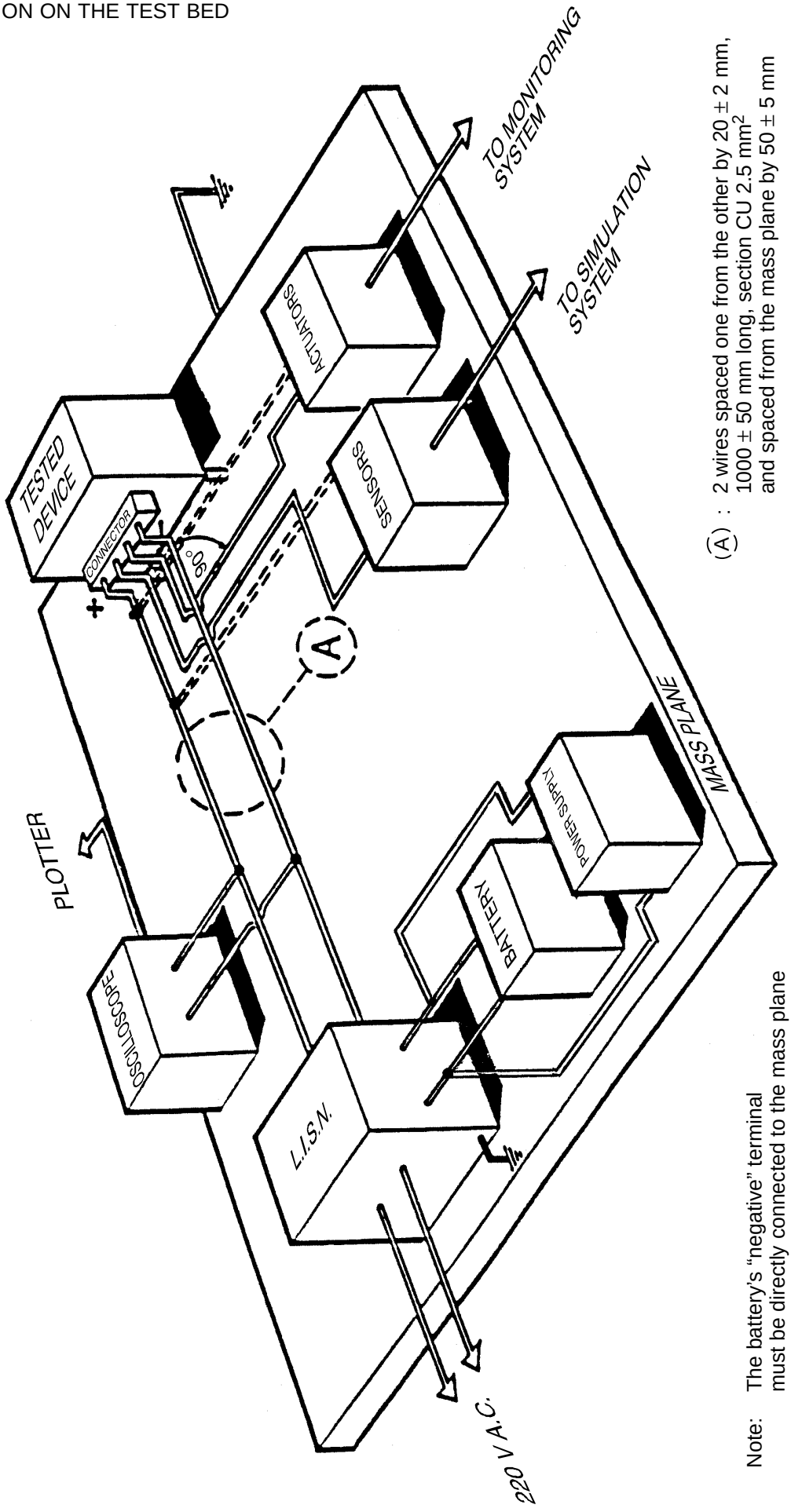
6 CARRYING OUT THE MEASUREMENTS

Supply and prearrange the tested device under the normal employment conditions, as provided by the Supplier or the related Specification.
In case of common connector for supply, signal and command lines, the wires related to this latter one must be placed at 90° ± 15° with respect to the supply ones, and as near as possible to the electrical terminals. Measurements of the following points must be carried out with the device operating according to what is required.
Find measuring point as near as possible to L.I.S.N. terminals for measurements performed at the bench; whereas for measurements on vehicle find it in the most accessible point to the device to be submitted to measurements.

DEVICE LOCATION ON THE TEST BED

INJECTION OF TRANSIENT NOISES ON THE SUPPLY LINE

Equipment location



(A) : 2 wires spaced one from the other by 20 ± 2 mm, 1000 ± 50 mm long, section CU 2.5 mm² and spaced from the mass plane by 50 ± 5 mm

Note: The battery's "negative" terminal must be directly connected to the mass plane

FIGURE 4

7 TRANSIENT MEASUREMENT ON SUPPLY LINES

Two series of measurements must be carried out:

a) L.I.S.N. electronic switch switching to simulate the key insertion and removal (stand by).

b) Integrated switch switching in the tested device (normal operation).

The measurements of the supply voltage at the device input and of the current on the positive supply wire are required for tests on vehicle, and as near as possible to L.I.S.N. for tests at the bench.
The initial transient time (envelope origin) must be placed at the moment when the transient reaches 10% of its maximum value.
In case two consecutive phenomena, whose frequency content is very different one from the other, occur in the same transient, it is necessary to separately compare the two phenomena with the limit.
Similarly, if more transients that are temporally spaced one from the other occur when switching, each transient must be separately compared with the limit.
The measurements must be carried out exploiting as much as possible the oscilloscope dynamics, to minimize the quantization noise.

8 ACCEPTABILITY LEVELS

Any measured transients must never exceed peak amplitudes higher than ± 60 V for systems powered with 12 V and ± 80 V for systems powered with 24 V.
Furthermore, the rise fronts of current transients must not show a speed greater than 1 A/µs; this parameter must be rated dividing the current variation between 10% and 90% of its maximum amplitude by the elapsed time.

STANDARDS QUOTED

IVECO STD.: 18–2252.