

<div>IVECO</div> <div>Standard</div> <div>TESTING STANDARD</div>		RESISTANCE OF ELECTRONIC DEVICES TO DISTURBANCES OF THE IRRADIATED TYPE “BULK CURRENT INJECTION” METHOD	16–2099
			Page 1/9 Date 25.11.2008
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1	SUBJECT		
	This standard is valid for equipment installed on vehicles with a 12–V and 24–V electric system, fitted with “OTTO” or “DIESEL” cycle internal combustion engines.		
2	PURPOSE		
	Definig methods and test procedures to measure the sensivity of the device to be tested against a radiofrequency current injected into the inlet cable set of the same device. The purpose of the measure is to verify on test bench the resistance of electronic devices against electromagnetic disturbances of the irradiated type.		
3	GENERAL TEST CONDITIONS		
3.1	Tests must be carried out on electronic devices that have already passed the functional checks mentioned in IVECO STD. 18–2252 and in the special specifications.		
3.2	Test environment (Unless otherwise required)		
	a) Rooms the dimensions of which can contain the instruments and the bench. b) Test environment must be free from noises that could affect the results of the test, and furthermore, should there be test frequencies generating ≥ 1 V/m, fields, a suitable shielding of test area must also be provided in order to obtain an adequate protection towards the outside. c) Environmental climatic requirements: – Temperature: 23 ± 5 °C. – Relative humidity: 45 – 70%. – Atmospheric pressure: 860 – 1060 mbar.		
Edition	Date	Description of modifications	Group
1	13.09.1993		PEL
4	12.09.2001	Point 9 “Presenting results” modified and point 8 “Acceptability limits” added.	
5	06.06.2002	Modified: points 2, 3.4, 5.1, 5.3, 5.4, 5.5, 5.6, 5.8, 7.2, 8, 9.	
6	03.03.2006	Added: Supervisor and Manager. Modified points: 4.2.2, 8 and 9. Editing modifications.	
7	25.11.2008	Supervisor changed, paras 7.1 and 8. Dept. Manager updated.	
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3.3 Test voltage

Refer to the values given in **Table I**.

TABLE I

VOLTAGE	FOR 12 V SYSTEMS (V)	FOR 24 V SYSTEMS (V)
UA	13.5 ± 0.5 V	27 ± 1 V
UB	12 ± 0.2 V	24 ± 0.4 V

Where

UA = System voltage (engine ON)

UB = Battery voltage (engine OFF)

3.4 Test levels

The test must be carried out within the frequency range and with the following limits:

- Frequency range: 1 MHz – 400 MHz
- (*) Modulation type: Amplitude (A.M.)
- (*) Modulation frequency: 400 Hz or 1000 Hz
- (*) Modulation index: 0 – 80 % (**)
- R.F. current intensity: 200 mA
- Frequency change: Logarithmic or linear
- Points per decade: 100, or with 1 MHz steps if linear
- Permanence time: Minimum 3 s for each frequency or the time necessary to check correct operation of the device being tested

(*) Only if required.

(**) If a test is required, use the module signal in amplitude instead of in CW conditions, peak to peak value of the electric field must in any case be:

$$E \text{ (CW peak)} = E \text{ (AM peak)}$$

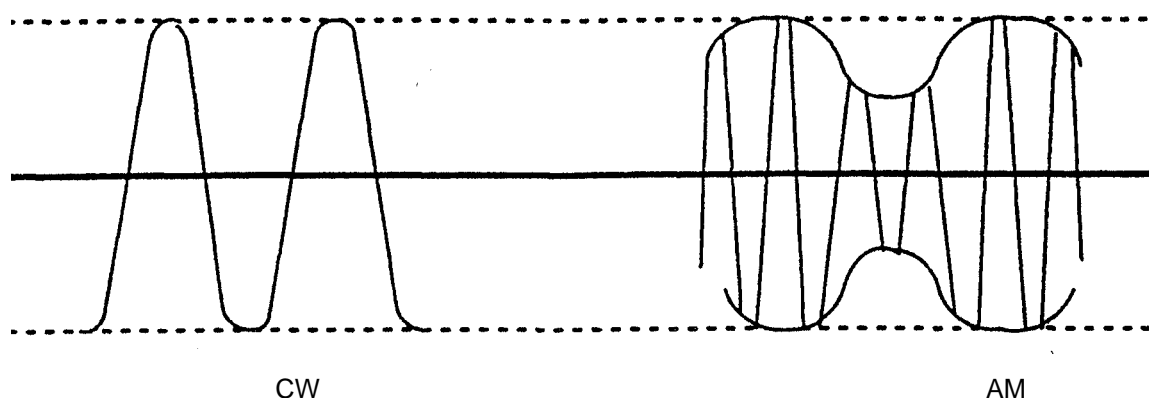


FIGURE 1

Relations between generated powers will be equal to:

$$\frac{P(AM)}{P(CW)} = \frac{((1 + m^2)E^2)}{2} = \frac{E^2}{2} = \frac{(1 + m^2)}{2} \cdot \frac{E^2}{E^2} = \frac{(1 + m^2)}{(1 + m)^2} \cdot 2$$

$$P(AM) = \frac{(2 + m^2)E^2}{(2(1 + m)^2)} P(CW)$$

for $m = 0.8$ (AM 1 KHz 80 %) the result will be:

$$P(AM) = 0.407 P(CW).$$

4 FUNCTIONAL CLASSES AND FAILURE CLASSIFICATIONS

4.1 Functional class classification

The functional states of electronic devices during tests can refer to the following classes:

- **CLASS A:** All device functions comply with requirements both during and after the test.
- **CLASS B:** All device functions comply with requirements both during and after the test; however, one or more of them can be out of tolerance. These functions however revert to their characteristic value at the end of the disturbance.
- **CLASS C:** A device function can be in failure, but it automatically reverts to its characteristic value at the end of the disturbance through an autoreset function that brings the device back to conditions complying with the present parameters.
- **CLASS D:** A device function can be in failure and it does not revert to its characteristics at the end of the disturbance, until a reset comes from the outside.
- **CLASS E:** One or more device functions can be in failure both during and after the test. These functions do not revert to their characteristic value at the end of the disturbance, so that the device is not repaired or replaced.

NOTE : Irreversible failures (FUNCTIONAL CLASS E) are not admissible on tested devices subjected to the maximum test level.

4.2 Failure classification and related test levels

4.2.1 Failure classification

- **P:** Priority failure that affects vehicle control, perceivable by the Driver or other road user, or that generates operation alterations which could cause confusion to other road users.
- **NP:** Non-priority failure that does not affect vehicle control or secondary functions for the examined system.

These classifications will be defined on the relevant product specifications.

4.2.2 Test levels

Carry out the test at 200 mA from 1 MHz to 400 MHz with amplitude modulation with 1 KHz frequency modulation and 80% modulation index.

5 TEST EQUIPMENT**5.1 Signal generator**

It must be able to supply sinusoidal signals from 10 KHz to 400 MHz which can be amplitude modulated with a depth varying from 0 to 80% with sinusoidal frequencies from 400 to 1000 Hz. The accuracy of the generated frequency (carrier) must be $\pm 1\%$ and the harmonics or spurious signals must be at least 25 dB less than the fundamental frequency.

5.2 Power amplifier

Frequency covering from 500 KHz to 400 MHz, generation of harmonics by at least 20 dB less than fundamental frequency.
Generated power of at least 50 W on 50 Ω resistive load on the whole frequency range.

5.3 Injection system

Injection gripper characteristics must be the following:

- Internal diameter: To guarantee cable harness internal positioning (≥ 32 mm).
- Insertion loss: ≤ 7 dB.
- Maximum power: Compatible with maximum power generated by R.F. amplifier
- Frequency band: 500 KHz – 400 MHz.
- Nominal impedance: 50 Ω .

5.4 Reading system

Reading characteristics of gripper must be as follows:

- Internal diameter: To guarantee cable harness internal positioning (≥ 32 mm).
- Frequency band: 500 KHz – 400 MHz.
- Nominal impedance: 50 Ω .

5.5 Directional coupler

Direct and reflected power measurement at the same time: frequency band from 10 KHz to 400 MHz. Input power compatible with R.F. amplifier maximum power.
Measurement accuracy ± 0.5 dB.

5.6 Radiofrequency wattmeter

Frequency band from 10 KHz to 400 MHz, input power compatible with maximum power generated by R.F. amplifier.
Measurement accuracy ± 0.5 dB.

5.7 Stimulating and monitoring system

Simulator capable of reproducing the operation of the sensors and actuators which make up the testing system.

The particular set of signals of this instrument must not vary, even in presence of disturbances circulating on the connecting cables of the system being tested.

5.8 Ground plane

Sheet of material with a high electrical conductivity (Cu, Al, brass) with minimum thickness 1.5 mm and minimum dimensions 2.5 x 1 m. The ground plane must be connected with the grounding line of the building through an appropriate braided wire soldered to the same plane.

5.9 Test bench

In insulating material (wood) with adequate dimensions for containing the ground plane.

5.10 Power supply

Power supply with adjustable voltage between 0 V and 40 V, 80 A, according to IVECO STD. 16–2108, with a 12 V, 70 Ah, 350 A battery as a backup (1 battery for 12 V tests, 2 batteries in series for 24 V tests).

5.11 Artificial impedance network (L.I.S.N.)

It must be realized according to the wiring diagram in **Figure 2a** and have the impedance characteristics varying with the frequency as indicated in **Figure 2b** (see next page).

It must also comply with the following requirements:

- The resistance measured between the P and B terminals, when A and B terminals are short-circuited must not deviate by more than 10% from the theoretical curve shown in **Figure 2b** (see next page) in the 100 KHz – 20 MHz frequency band.
- Capacity C must stand continuous voltages of at least 1500 V.
- Inductance L must stand a 40 A maximum current.

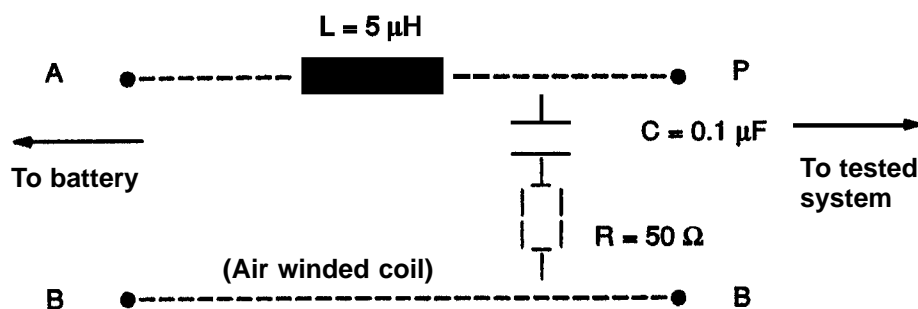


FIGURE 2a – IMPEDANCE STABILIZER LINE (L.I.S.N.) – WIRING DIAGRAM

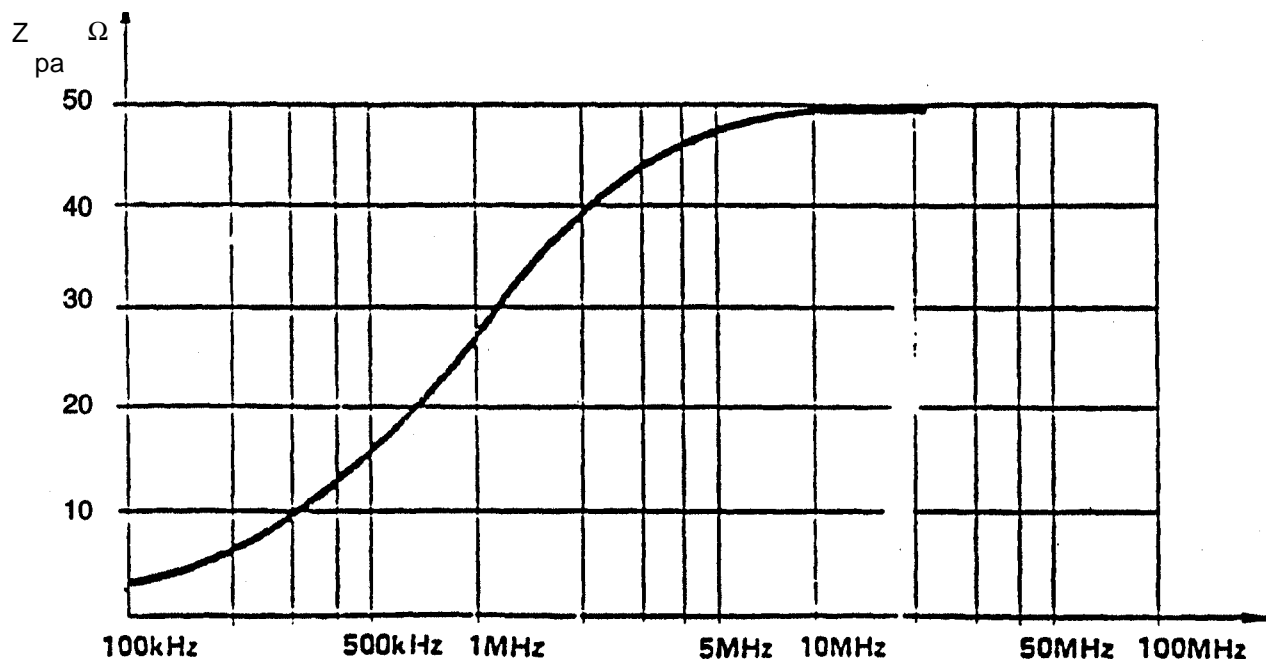


FIGURE 2b – IMPEDANCE MODULE BEHAVIOUR (A AND B TERMINALS ARE SHORT-CIRCUITED)

6 BENCH TEST CIRCUIT

- 6.1 Position: R.F. signal generator, power amplifier, grippers, directional coupler, wattmeter, power supply and stimulating and monitoring system as shown in **Figure 3** (see next page).
Test instruments such as: signal generator, power amplifier, wattmeter, signal coupler, power supply and stimulating and monitoring system must not be susceptible to the fields generated during the test.
For this reason the instrumentation must be positioned at a distance of at least 2 m from the radiant structure or else a screening (Faraday cage) containing the measurement area must be provided.
- 6.2 Position: the device being tested, the wiring, and the sensor and actuator test or the general-purpose simulator, as shown in **Figure 3** (see next page).
Take a special care when positioning the cable harness inside grippers because it must be centred with reference to the grippers by means of a suitable positioning.
- 6.3 Injection and reading grippers must be positioned as near as possible to the device being tested. Suggested distances are:
- measuring gripper centre-line at 10 cm from the device being tested;
 - injection gripper centre-line at 25 cm from the device being tested.
- 6.4 If the device being tested or any of the sensors/actuators is grounded in its normal installation on vehicle, this condition must be observed also in the bench test by realizing the shortest possible ground connection from the involved element to the ground plane.
- 6.5 Sensors must be stimulated through a suitable system or, if a general-purpose simulator is used, this must ensure actual sensors and actuators impedance characteristics.
During the test, fundamental signals for checking correct system operation must be monitored by means of optical links.
- 6.6 Supply and activate the device according to the test pattern indicated in the special Specification.

- 6.7 Adjust input signal characteristics of the radiant element in order to obtain the electrical field, test frequencies and modulation type required at point 3.4.
The extent of injected current will be kept constant, at test value, through the feedback obtained by the reading gripper suitably monitored by means of a specific optical link device (when using closed-loop method) or by using the net power data obtained at Jig calibration stage.

7 MEASUREMENT METHODS

7.1 Closed-loop method

Current required by specific test-plane, in any case not more than 25W direct power on a resistive load of 50 Omh at frequencies where it is not possible to match the required current.

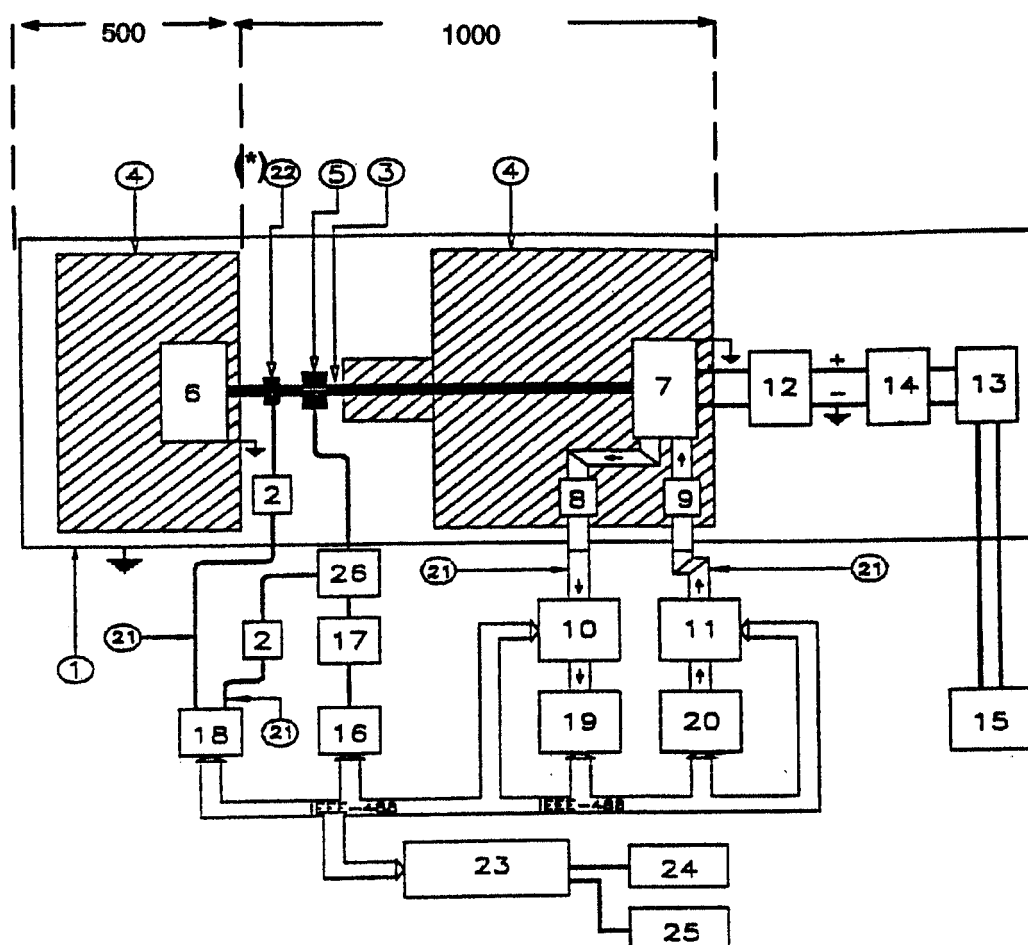


FIGURE 3 – Measure set-up (closed-loop)

Key for **Figure 3** on next page

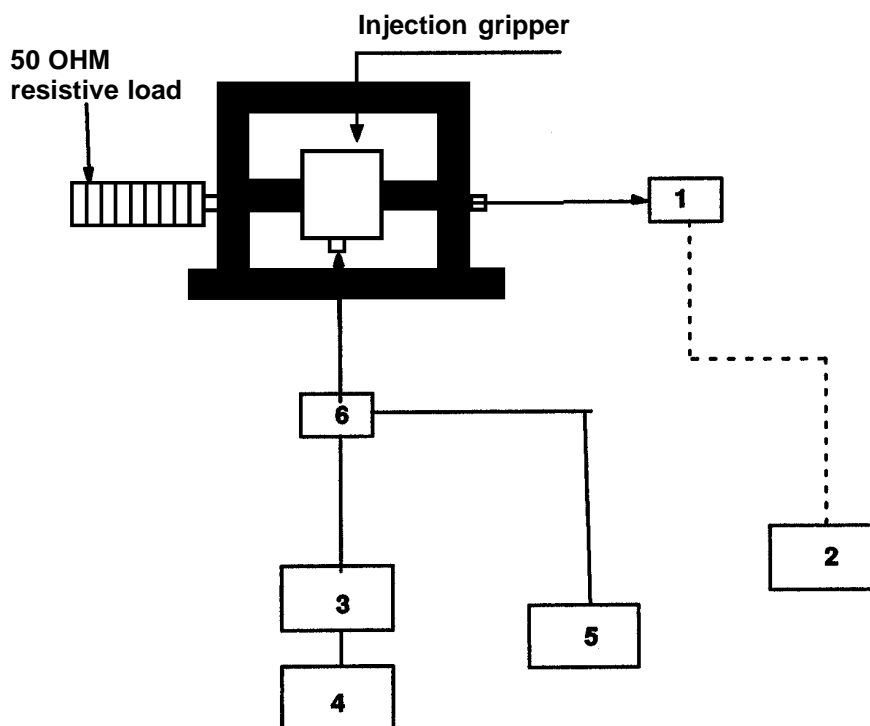
Key Figure 3 – Measure set-up

1	Ground metal plane	14	Battery
2	Electro-optical transmitter	15	Stabilized power supply
3	Cable harness	16	Signal generator
4	Support in dielectric material (wood) thickness ≥ 50 mm	17	Radiofrequency power amplifier
5	Radiofrequency current injection gripper	18	Radiofrequency current opto-electrical receiver (Wattmeter)
6	Device under test	19	Instrumentation for monitoring system operation condition
7	Sensors and actuators of device under test	20	Instrumentation for generating stimulation signals
8	Remote unit for measuring electro-optical signal/transmission	21	Optical fibers
9	Remote unit for receiving opto-electrical/injection and signals	(♦) 22	Radiofrequency current measuring gripper
10	Opto-electrical receiving base unit	23	Microcomputer
11	Opto-electrical transmitting base unit	24	Printer
12	Impedance stabilizer network (L.I.S.N.)	25	Plotter
13	Radiofrequency filter	26	Directional coupler

(♦) Optional only when gauging method through Jig is used (substitution method).

7.2 Substitution method

Use proper 50 Ω gauging Jig (**Figure 4**) in order to obtain net power values to be used in the test on device capable of guaranteeing R.F. values required by the specific test plane.


FIGURE 4 – GAUGING SET-UP

Key for **Figure 4** on next page

Key Figure 4 – Gauging set-up

1	Radiofrequency current electro–optical transmitter
2	Radiofrequency current opto–electrical receiver
3	Radiofrequency power amplifier
4	Signal generator
5	Radiofrequency wattmeter
6	Directional coupler

8 ACCEPTABILITY LIMITS

The relevant functional class (A – B – C – D – E) achieved by the product being examined during **radiofrequency current injection** shall be compliant with or higher than what specified for all the four test levels.

In case of device malfunctioning, carry out a manual detection of minimum levels **RF current** at which the device restarts regular operation (susceptibility limit detection).

- From 0 to 100 mA no defect tolerated.
- From 101 to 150 mA some non–priority functions can be out of tolerance but they shall return automatically to conformity levels as soon as disturbance disappears.
- From 151 to 200 mA some priority functions can be out of tolerance but they shall return automatically to conformity levels as soon as disturbance disappears.

If for certain frequencies it is not possible to obtain the required current, inject current equivalent to output power of 25W amplifier on a 50 Ohm load.

9 PRODUCTION OF RESULTS ACCORDING TO THE RELEVANT FUNCTIONAL CLASS ACHIEVED

Types of anomalies found must be shown for every system being verified, for every test condition and for every test level **radiofrequency/frequency current** diagrams representing the susceptibility curves and the achieved relevant functional class (A – B – C – D – E). Product functions being examined must comply with the tabulated prescriptions.

LEVEL	CLASS ACHIEVED	RESULTS/REMARKS
0 – 100 mA	A	No defects, both during and after disturbance
101 – 150 mA	B	Non–priority function defect that resets automatically as soon as Radio Frequency disappears
151 – 200 mA	B	Priority function defect that resets automatically as soon as Radio Frequency disappears

STANDARDS QUOTED

IVECO STD.: 16–2108, 18–2252.