

IVECO Standard	IMMUNITY TO ELECTROMAGNETIC FIELDS RADIATED BY RADIOTRANSMITTERS INSTALLED ON VEHICLES	16-2113	
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1 PURPOSE Defining test procedure and apparata adapted to verify on a vehicle, under all conditions of use, the immunity of electronic systems installed on a vehicle to electromagnetic fields radiated by radiotransmitters being present on board the vehicle itself.			
2 SUBJECT The present Standard is valid for apparata installed on vehicles with 12V or 24V system and equipped with internal combustion engine with "Otto" or "Diesel" cycle.			
3 GENERAL TEST CONDITIONS			
3.1 IN GENERAL The tests must be carried out on systems whose electronic components have already passed the functional checks recalled in the general specification IVECO STANDARD 18-2252 and in specific specifications.			
3.2 TEST ENVIRONMENT In a screened anechoic or semianechoic chamber, whose sizes are such as to contain the test vehicle and that must have the following characteristics: a) minimum screening attenuations with respect to the electromagnetic fields must be: for electric field 100dB from 100kHz to 10GHz; while for magnetic field di 60dB from 10kHz to 200kHz b) minimum reflection coefficients for anechoic material must be as follows: -35dB or better at 200MHz -50dB or better at 1GHz c) Environmental reference characteristics during the test must be: Temperature: 20 ± 2°C Relative humidity: 45-70% Atmospheric pressure: 860-1060 mbar			
3.3 VEHICLE POSITIONING The vehicle can be placed on rollers or, if a dynamometric bench is not available, must be lifted from the ground and supported by such an insulating support as to allow the driving axle rotation. Where adequate, transmission shafts can be disengaged.			
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1	16.07.2001	New.	PEL
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4 TEST INSTRUMENTS

4.1 RADIOFREQUENCY GENERATION/CONTROL SYSTEM

- Signal generators:
 - they must be able to generate sinusoidal signals in frequency bands covered by radioreceivers that are present on board the vehicle (1.8 MHz – 2.2 GHz), width-modulated with a modulation index varying between 0% (absence of modulation) and 80%, with 400Hz or 1000Hz (sinusoidal) modulating frequency. Moreover, the pulse modulation (rectangular wave) must also be possible, in the range of use of cellular phones, with a 200Hz modulation frequency, 100% modulation index, 1/8 duty cycle (Ton=577 uS, Toff=4.615 ms)
- Radiofrequency power amplifiers must have the following technical characteristics:
 - usable in the 1.8MHz – 2.2GHz range;
 - able to generate the maximum allowed power for radioreceivers (1500W)
 - possible output signal harmonics must be by at least 15 dB lower than the fundamental amplitude, for the whole operating band, while for other non-harmonic signals, by at least 20 dB lower than the fundamental frequency;
 - input power to obtain maximum output power (sensitivity): 1 mW on 50 ohms (0 dBm)
- Radiofrequency wattmeters must have the following technical characteristics:
 - minimum frequency bands: 1.8 MHz – 2.2 GHz
 - test frequency band measuring accuracy equal to at least ± 0.5 dB
 - accepted input power must be compatible with power output by directional couplers
- Directional couplers must satisfy the following technical requirements:
 - direct power measure (with optional chance of measuring the reflected power too)
 - accepted input power must be compatible with maximum generated power by radiofrequency power amplifiers
 - measuring accuracy: ± 0.5 dB in respective frequency bands
- Control and switching unit. It must drive signal and power switches and radiofrequency amplifiers, in compliance with required test frequency bands.
- Electric field repeater:
 - with optical fiber inlet and indication, through digital or analogue display, of measured quantity
- Isotropic electromagnetic field meters to carry out measures from 1.8 MHz to 2.2 GHz in the present field in order to safeguard the personnel responsible for the tests.
They must be supplied by internal batteries and equipped with optical fibers output for remote indication.

4.2 TEST DEVICES MONITORING SYSTEMS

- They must allow the correct test system operation under normal operating conditions, as provided by the supplier or related specification;
- They must be able to correctly interface themselves with system tested sensors and actuators, without changing functional electric characteristics (impedences) thereof;
- They must be insensitive to electromagnetic fields radiated during the test

In order to satisfy the above mentioned items, the systems must be composed of:

- signals transmission unit with electro-optical conversion for monitoring tested system functionality status
- receiving unit with signals electro-optical conversion for monitoring functionality status (in control room)
- optical fibers connecting transmission and reception units
- monitoring instruments (in control room)

A closed-circuit TV camera must also be installed on board the vehicle, with optical connection to receiving unit (monitor) placed in control rooms.

5 TESTED VEHICLE EQUIPMENT

The vehicle must be equipped in the following way:

Body:

it must be free from additional metallic masking, in order to avoid any modification to vehicle body screening power.

Maskings performed with non-metallic materials are allowed.

Vehicle electronic devices and electric wiring:

they must be in their final version or as near to it as possible, and anyway in compliance with what is required by the drawing or the related specification.

Pneumatic-type remote control for thermal engine starting and turning off:

Auxiliary stimulations of on-board systems through pneumatical and/or optical actuators.

Monitoring of electronic devices being checked:

for every electronic device being checked, signal cables must be identified and marked on wiring for checking the correct operation of the device being tested. On such cables, suitable quick-connection terminals must be inserted to which a signal detecting and transmitting electro-optical system must be connected.

6 TEST METHODS

6.1 TRANSMITTING ANTENNA POSITIONING

The antenna being used and its related coaxial cable must be of the same type (stylus antennae or tuned in $5/8$ lambda) as the one provided to be used on the vehicle.

They will have to be placed in the different points in which the customer can install its radioreceiver.

Normally the most frequent points are:

dashbopard area, windscreen center area, driver or passenger object-holder pocket area, driver or passenger head height area, immediately next to system under contact test and at a distance of 20 cm. Even if the range is much wider (1.8 MHz to 2.2 GHz), in applications on industrial vehicles, the radio-transmitters that are currently or in an immediate future most used are:

APPLICATION TYPE	FREQUENCY RANGE	POWER
CB	26 – 28 MHz	5 W
Amateur 2 meters	140 – 150 MHz	100 W
TACS (TIM) cellular phones	880 – 915 MHz	10 W
GSM cellular phones	925 – 960 MHz	10 W
DCS portable phones	1740 – 1785 / 1835 – 1900 MHz	25 W
UMTS	1885 – 2025 / 2100 – 2200 MHz	

6.2 TEST EXECUTION MODE

Automatic frequency scanning with power level according to prefixed frequency steps (1 to 5 MHz depending on the frequency), stay times (2 seconds or the necessary time to check the correct operation of the device being tested) and modulation types (AM, FM, GSM).

Manual search of susceptibility limits.

7 CLASSIFICATION OF FUNCTIONAL CLASSES

The operating states of the electronic devices during the conducted EMC tests refer to the following levels:

CLASS A: All the functions of the device meet the requirements, both during and after the test.

CLASS B: All the functions of the device meet the requirements both during and after the test, although one or more of these may be off tolerance limits within the limits set by specific Specification or by Product Specification. These functions, however, fall again within specifications when disturbance ceases.

CLASS C: A device function can be in failure, but automatically goes back to its characteristic value at the end of the disturbance through an autoreset function that brings back the device into conditions that are complying with present parameters.

CLASS D: A device function can be in failure and does not go back to its characteristic value at the end of the disturbance, until a reset from the outside occurs.

CLASS E: One or more functions of the device may fail, both during or after the test. These functions do not return back to specifications when disturbance ceases, unless device is repaired or replaced.

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

8 CLASSIFICATION OF COMPONENT/SYSTEM DEFECTS AND RELATED TEST LEVELS

8.1 CLASSIFICATION OF DEFECTS

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.

Such classifications will be defined on related product specifications.

8.2 TEST LEVELS AND RELATED FATIGUE TESTS

Test levels and related functional classes will be depending on the specific radioreceiver whose electronic system being examined has to be protected, as synthetically described in the table below, where the most frequent applications in industrial vehicles are pointed out in bold characters:

FREQUENCY BAND (MHz)	RATED TEST POWER FOR INSTALLED FIXED DEVICES AND REQUIRED FUNCTIONAL CLASS	MAXIMUM LEGAL ALLOWED TEST POWER AND REQUIRED FUNCTIONAL CLASS	PORTABLE DEVICES TEST POWER	TYPE OF USE
1.8 – 2	100 W (Class A)	1500 W (Class C)	5 W (Class A)	AMATEURS
3.5 – 4	100 W (Class A)	1500 W (Class C)	5 W (Class A)	AMATEURS
7 – 7.3	100 W (Class A)	1500 W (Class C)	5 W (Class A)	AMATEURS
10.1 – 10.15	100 W (Class A)	1500 W (Class C)	5 W (Class A)	AMATEURS
14 – 14.35	100 W (Class A)	1500 W (Class C)	5 W (Class A)	AMATEURS
18.1 – 18.15	100 W (Class A)	1500 W (Class C)	5 W (Class A)	AMATEURS
21 – 21.45	100 W (Class A)	1500 W (Class C)	5 W (Class A)	AMATEURS
24.89 – 24.99	100 W (Class A)	1500 W (Class C)	5 W (Class A)	AMATEURS
26.96 – 28	5 W (Class A)	5 W (ClasseA)	5 W (Class A)	CB
28 – 29.7	100 W (Class A)	1500 W (Class C)	5 W (Class A)	AMATEURS
30 – 50	120 W (Class A)	200 W (Class C)	5 W (Class A)	LAND MOBILE
50 – 54	150 W (Class A)	1500 W (Class C)	5 W (Class A)	AMATEURS
54 – 68	110 W (Class A)	200 W (Class C)	5 W (Class A)	LAND MOBILE
70 – 70.5	75 W (Class A)	75 W (Class A)	5 W (Class A)	AMATEURS
71 – 72.8	25 W (Class A)	25 W (Class A)	5 W (Class A)	LAND MOBILE
74.2 – 87.3	25 W (Class A)	25 W (Class A)	5 W (Class A)	LAND MOBILE
80 – 84	30 W (Class A)	30 W (Class A)	5 W (Class A)	LAND MOBILE
86.3 – 86.7	25 W (Class A)	25 W (Class A)	5 W (Class A)	LAND MOBILE
120 – 140	25 W (Class A)	25 W (Class A)	5 W (Class A)	LAND MOBILE
143 – 144	25 W (Class A)	25 W (Class A)	5 W (Class A)	LAND MOBILE
144 – 148	25 W (Class A)	1500 W (Class C)	5 W (Class A)	AMATEURS
148 – 149	25 W (Class A)	25 W (Class A)	5 W (Class A)	LAND MOBILE
150 – 174	110 W (Class A)	200 W (Class C)	7 W (Class A)	LAND MOBILE
184.5 – 191.5	10 W (Class A)	10 W (Class A)	5 W (Class A)	LAND MOBILE
200	10 W (Class A)	10 W (Class A)	5 W (Class A)	LAND MOBILE
220 – 225	100 W (Class A)	1500 W (Class C)	5 W (Class A)	AMATEURS
225 – 400	250 W (Class A)	250 W (Class A)		LAND MOBILE
420 – 450	100 W (Class A)	1500 W (Class C)	5 W (Class A)	AMATEURS
450 – 512	90 W (Class A)	200 W (Class C)	5 W (Class A)	LAND MOBILE
610 – 890	10 W (Class A)	10 W (Class A)		LAND MOBILE
890 – 960	20 W (Class A)	1500 W (Class C)	2 W (Class A)	LAND MOBILE
1240 – 1325	10 W (Class A)	1500 W (Class C)	5 W (Class A)	AMATEURS
1710 – 1785	25 W (Class A)	25 W (Class C)	1 W (Class A)	LAND MOBILE

9 ACCEPTABILITY LIMITS

When radiating through transmitter antenna that has to be simulated with power levels mentioned in paragraph 8.2, verify that the system correctly operates according to what is specified in the relate Product specification. In case of device malfunctions, a manual search must be carried out of minimum power levels at which the device starts again correctly operating (susceptibility limits search).

10 SHOWING THE RESULTS

For every system being checked, under any test condition and for every test level (\leq to the established one), Power / Frequency diagrams showing susceptibility curves and functional class must be included.

STANDARDS QUOTED:

IVECO STANDARD: [18-2252](#)