

IVECO Standard	MEASURE OF EMISSIONS CAPTURED BY VEHICLE ON-BOARD RECEIVER ANTENNA		16-2114
TESTING STANDARD			Page 1/8 Date 21.11.2003

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1 PURPOSE

Defining test procedure and apparatus adapted to verify on a vehicle, under all conditions of use, pulse and stationary disturbances emitted by electronic systems installed on the vehicle and captured by the radioreceiver antenna, in order to characterise the disturbances in the frequency domain and locate the most critical disturbing devices for on-board radioreceiver listening (automobile radio receiver, CBs, cellular phones or the like). In this case a device is disturbing when it emits such a disturbance as to impair signal reception quality useful on the radioreceiver. The test is divided into two phases. In the first phase, devices are characterised by detecting the frequency spectrum of emitted disturbances (in a semianechoic chamber), while in the second phase a sound evaluation of such disturbances is carried out in an open field.

2 SUBJECT

The present Standard is valid for apparatus 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 STD. [18-2252](#) and in specific specifications.

Edition	Date	Description of modifications	Group
1	16.07.2001	New.	PEL
2	21.11.2003	Supervisor and Manager added; Table 3, point 5.7, Table 4 and point 6.5 modified.	

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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 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: $20 \pm 2^{\circ}\text{C}$
 - Relative humidity: 45 – 70%
 - Atmospheric pressure: 860 – 1060 mbar

3.3 Vehicle positioning

The vehicle must be placed within a screened and semianechoic chamber.

4 TEST INSTRUMENTS

4.1 Signal generator

Signal generators: they must be able to generate sinusoidal signals, in the frequency bands covered by radioreceivers that are present on board the vehicle (150 kHz – 2.2 GHz).

4.2 Receiving antenna

It must be of the same type as the one provided to be installed on a vehicle.

4.3 Preamplifier

It must have the following characteristics:

- input impedance: >100 kohm
- frequency band: at least from 150 kHz to 30 MHz
- gain: greater than 0 dB and constant within $\pm 3\text{dB}$
- output impedance: 50 ohm
- input voltage: >1 Vpp

4.4 Receiver or spectrum analyser

It can be a measuring receiver or a spectrum analyser equipped with preselector; in any case, it must have the following characteristics:

- measuring frequency range: 150kHz to 2.2 GHz;
- sensitivity: at least 10 dBuV (equal to –97dBm) at 150 kHz, with bandwidth equal to 10 kHz and with peak detector;
- sensitivity: at least –5 dBuV (equal to –112dBm) at 150 kHz, with bandwidth equal to 9 kHz and with semi-peak detector;
- input impedance: 50 ohm;
- bandwidth: selectable at least between the following values: 10kHz and 100kHz; in case of use of semi-peak detector, 9kHz and 120kHz;
- detector: peak type, for spectrum analyser;
peak type, with mean value and possible semi-peak for measuring receiver.

The detector must have the following rated characteristics:

DETECTOR TIME	CHARGING TIME CONSTANT (tc)	DISCHARGING TIME CONSTANT (ts)	
		0.15 – 30 MHz	Over 30 MHz
SEMI-PEAK	1 ms	160 ms	550 ms
PEAK	<< 10 µs	1 s (*)	
MEAN VALUE	100 ms	100 ms	

(*) Not applicable in case a spectrum analyser is used.

5 TEST PREPARATION

5.1 Measuring system calibration

The insertion gain of preamplifier and coaxial cable connecting preamplifier and measuring instrument must be measured with the following procedure, in the sub-bands shown in **Table 1**.

- Connect the generator directly to measuring instrument inlet through an adapted coaxial cable (C1) whose length is less than or equal to 1 meter.
- Set on the generator a level of about 1 Vpp and take note or record the value read by the meter (U1) for each one of the frequency values shown in the first column of **Table 2**.
- For measuring the frequency band between 150 kHz and 30 MHz, connect the generator to the preamplifier inlet through the coaxial cable (C1); connect the preamplifier outlet to the measuring instrument through the same coaxial cable (C2) that will be used during the measure.
- For measuring the frequency band between 30 MHz and 2.2 GHz, connect the generator to the measuring instrument through the coaxial cable (C1) in cascade with the coaxial cable (C2) that will be used during the measure.
- Keeping the same width being set on the generator (about 1 Vpp), take note or record the value read by the meter (U2) for each one of the frequency values.

TABLE 1
Measuring frequency bands related to different types of antennae

ANTENNA TYPE	AFFECTED SERVICES	FREQUENCY BAND
Stylus antenna	OL, OM, FM automobile radio receiver, CB transceiver	150 kHz – 110 MHz
Antenna tuned in 5/8 lambda at 144 MHz	Taxi, Police, Fire Brigade, Radioamateurs, etc.	110 MHz – 200 MHz
Antenna tuned in 5/8 lambda at 450 MHz	Radiotelephones, TAC – S 450 MHz	200 MHz – 500 MHz
Antenna tuned in 5/8 lambda at 900 MHz	Radiotelephones, TAC – S 900 MHz – GSM	500 MHz – 1 GHz
Antenna tuned in 5/8 lambda at 1800 MHz	DECT	1.7 GHz – 1.8 GHz

TABLE 2
Frequency values and related sub-bands to be used for calibrating

CALIBRATION FREQUENCIES	OPERATING BAND
1 MHz	150 kHz – 0 MHz
100 MHz	30 MHz – 110 MHz
144 MHz	110 MHz – 200 MHz
450 MHz	200 MHz – 500 MHz
900 MHz	500 MHz – 1000 MHz
1750 MHz	1700 MHz – 1800 MHz

5.2 Tested vehicle equipment

- The vehicle must be equipped with a complete and operating automobile radio receiver system, eventually the one provided as optional. The same is true for different types of radio apparatus (Radiotelephones, Fire Brigade, Police, CB, GSM, etc.).
- 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 a vehicle.
- Place the vehicle in a screened chamber.

5.3 Exam of electric system on a vehicle

Carry out a significance check of vehicle systems and wirings and locate devices being present on board. This allows defining the list of possible disturbing devices. Verify the correct operation of tested devices.

5.4 Apparata arrangement

For measuring the frequency band from 150 kHz to 30 MHz, disconnect the antenna cable from automobile radio receiver and connect preamplifier to cable output connector connected to receiving antenna, installed on vehicle, taking care that the connection is as short as possible; connection between preamplifier and measuring instrument must be carried out by means of the calibrated coaxial cable. Carefully connect the antenna cable mass to the automobile radio receiver body, next to the preamplifier. It is necessary to verify, immediately before and after having carried out calibration and measures, that the supply voltage falls within the tolerance required by the Manufacturer.

In order to measure the frequency band from 30 MHz to 2.2 GHz, connect the antenna cable directly to the measuring instrument by means of the calibrated coaxial cable. Carefully connect the antenna cable ground to the automobile radio receiver body, next to the junction with the coaxial cable.

5.5 Measuring instrument setting

In case a measuring receiver is used, the whole measuring frequency band must be explored with a pitch that is always less than or equal to the bandwidth.

In case a spectrum analyser is used, the measuring frequency band scanning must be carried out by using sub-bands and scanning times shown in **Table 3**.

5.6 Arrangements for measuring broad band disturbances

The measure must be carried out by using peak detector and bandwidth shown in the appropriate column in **Table 3**. When a spectrum analyser is used, the video filter must be adjusted to a value that is equal to at least three times the bandwidth. Alternatively the measure can be carried out with semi-peak detector, in such case by using related bandwidths (**Table 3**).

TABLE 3

Bandwidth and video filter and scanning times for measuring broad band disturbances

SUB-BAND (MHz)	BANDWIDTH		SPECTRUM ANALYSER	
	Peak detector	Semi-peak detector	Video filter	Scanning time
0.15 – 2	9 kHz	9 kHz	30 kHz	100 ms/MHz
2 – 30	9 kHz	9 kHz	30 kHz	100 ms/MHz
30 – 110	120 kHz	120 kHz	300 kHz	1 ms/MHz
110 – 1800	120 kHz	120 kHz	300 kHz	1 ms/MHz

5.7 Arrangements for measuring narrow band disturbances

For measuring narrow band disturbances use the peak detector or the mean value one adopting the same limits.

The test must be carried out by using bandwidths shown in the appropriate column in **Table 4**. Moreover, in order to attenuate broad band disturbances, it is necessary to proceed as follows:

- when a spectrum analyser is used, insert video filter with values shown in the appropriate column in **Table 4**;
- when a measuring receiver is used, use mean value detector.
- set the scan time (if using the spectrum analyser) or the stay time at each frequency (if using the measure receiver) at value high enough to enable proper measurement of disturbance envelope.

It is recommended when using the receiver the stay time of 100 ms up to 200 MHz and 10 ms for frequencies higher than 200 MHz; if using the spectrum analyser the scan time is set automatically by the instrument.

During the measure, only activate those tested vehicle devices whose operation provides for the presence of a continuous and repeatable signal, for example units with a fixed frequency clock signal. Therefore, all devices are excluded that operate intermittently or for variable periods of a few seconds and all electromagnetic devices, whose disturbance must be deemed as broad band type.

TABLE 4

Bandwidth and video filter for measuring narrow band disturbances

SUB-BAND (MHZ)	BANDWIDTH	VIDEO FILTER (SPECTRUM ANALYSER)
0.15 – 2	9 kHz	100 Hz
2 – 30	9 kHz	100 Hz
30 – 110	120 kHz	300 Hz
110 – 1800	120 kHz	300 Hz

6 TEST EXECUTION MODES

6.1 Background noise

In order to guarantee that the measure is not altered by the ambient electromagnetic noise, it must be repeated with the same modes but deactivating all systems being tested; for every sub-band, the thereby-measured level must be by at least 10 dB lower than the corresponding limit shown in **Table 5**.

6.2 Tested device activation

Activate the device that has to be tested. In some cases the device must be activated by a person inside the cabin while the technician carries out the measure (unless an automation system is available).

6.3 Disturbance spectrum measure

Activate the measuring instrument to carry out the measure and store the results (if possible through automatic acquisition on PC). If possible, previously insert the correction of measured data in instrument or in managing software.

In all measures, the input attenuator of the measuring instrument must be adequately adjusted to correctly display the signal.

In order to check that there are no saturation phenomena on the instrument, repeat the measure after having increased by 10 dB the input attenuation: the absolute level of measured disturbances must remain unchanged within ± 1 dB; otherwise, increase the attenuation until this condition is satisfied and then use this new adjustment to carry out the real measure.

6.4 Acceptability limits for emissions

In each emissions measure, the detected disturbances must not exceed the limits shown in the following table (expressed in dBuV).

TABLE 5
Acceptability limits

FREQUENCY BAND (MHz)	NARROW BAND LIMITS (dBuV)	BROAD BAND LIMITS (dBuV)			
		Peak detectors		Semi-peak detectors	
		Components whose operation is continuous (ex.: windscreen wiper, electrofan, thermal engine, flash-light, etc.)	Components whose actuation is not constant (ex.: stop lights switch, screen-washer pump, etc.)	Components whose operation is continuous (ex.: windscreen wiper, electrofan, thermal engine, flash-light, etc.)	Components whose actuation is not constant (ex.: stop lights switch, screen-washer pump, etc.)
0.15 – 0.3	6	22	32	9	19
0.53 – 2	0	19	29	6	16
5.9 – 6.2	0	19	29	6	16
26.9 – 54	0	28	38	6 (15*)	16
70 – 87	0	28	38	6 (15*)	16
87 – 108	6	28	38	6 (15*)	16
117.9 – 172	0	28	38	6 (15*)	16
420 – 512	0	28	38	6 (15*)	16
800 – 1000	0	28	38	6 (15*)	16
1700 – 1800	0	28	38	6 (15*)	16

(*) Only for disturbances generated by the startup system.

6.5 Listening test

At the end of emission measures, restore the automobile radio receiver after having disconnected the measuring instrument. Take the vehicle in an open site and rotate it for the whole test at 360°, tune to a choosen channel and subjectively evaluate the reception in all vehicle positions during the activation of the different disturbing devices.

Emitting stations used for the tests, valid for tests carried out in Turin, are:

- Radio Montecarlo corresponding to the frequency of 216 kHz in OL and two additional stations in O.L. band; the first one to be chosen between frequencies tuning next to 150 kHz; the second one next to 300 kHz.
- Rai Uno Milano corresponding to the frequency of 900 kHz in OM and two additional stations in O.M. band; the first one to be chosen between frequencies tuning next to 530 kHz; the second one next to 2 MHz.
- Frequency of 104.7 MHz in FM and two additional stations in F.M. band; the first one to be chosen between frequencies tuning next to 88 MHz; the second one next to 108 MHz.

Obviously, the same philosophy is valid for other types of services (CB, taxi, police, fire brigade, GSM, etc.).

7 ACCEPTABILITY CRITERIA

It will be based on values measured in a screened chamber and the disturbance evaluation in an open field.

8 SHOWING THE RESULTS

For every system being checked, under any test condition, the measure of captured disturbances will have to be included in diagrams showing the amount of disturbances being present in the whole test spectrum (dBuV/Frequency).

STANDARDS QUOTED

IVECO STD.: 18-2252.