MEASURE OF RADIATED EMISSIONS IN SEMIANECHOIC CHAMBER BY ELECTRONIC DEVICES INSTALLED ON A BENCH

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1 PURPOSE

Defining test procedure and apparata adapted to verify in a bench, under all conditions of use, the radiated disturbances emitted by electronic systems installed on a bench to characterise whether the amount of such disturbances can be captured occasionally by the radioreceiver antenna or other electronic systems, to characterise in the frequency range the radiated disturbances.

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 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, points 1, 5.3, Table 1, point 5.4 and Table 2 modified.	
3	23.01.2006	Modified: Supervisor and Manager Dept.; point 5.1, Table 3, point 8. Point 7.1 added.	
4	21.04.2006	Point 7.1 modified.	
5	05.04.2007	Frequency band changed in Tables 1, 2 and 3 (previously was 1000–2200).	
6	15.01.2009	Supervisor, points 5.1, 6.4 “Acceptability limits – Table 3” changed; editorial changes made. Managing dept. updated.	

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3.2 Test environment

The test place must be free from disturbances that can affect the test results; otherwise, it is necessary to use a semianechoic screened chamber, whose sizes are such as to contain the test table and the antennae measuring the electromagnetic field: the approximate sizes of the inside volume to be used must be: length 6 m, width 4 m and height 3 m.

a) minimum screening attenuations with respect to the electromagnetic fields must be:
for electric field 100dB from 100kHz to 10GHz;
90dB from 10GHz to 18GHz
while
for magnetic field 60dB to 10kHz
80dB to 200kHz

b) minimum reflection coefficients for anechoic material must be as follows:

- 35dB or better at 200MHz
- 50dB or better at 1GHz
- 40dB at 18GHz

c) Environmental reference characteristics during the test must be:

- Temperature: 20 ± 2°C
- Relative humidity: 45–70%
- Atmospheric pressure: 860–1060 mbar

4 TEST INSTRUMENTS

4.1 Test table

It must be made of insulating material (for example wood), with sizes adapted to house the ground plane.

4.2 Ground plane

It must be made of sheet with high electric conductivity (copper, aluminium, brass, galvanized steel). Minimum thickness 1.5 mm, minimum sizes 2x1 m.
The ground plane will have to be connected to the building earth line through suitable copper braid welded to the plane itself.

4.3 Power supply

It must have an adjustable voltage between 0 and 40V, 50A, with 12V, 45Ah, 225A buffer batteries.

4.4 **Impedance stabilising network**

It must have the electric circuit and the impedance characteristic when frequency changes like in **Figure 1** and satisfy the following requirements:

– the resistance between terminals P and A must be less than 5 mOhm;

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

– the C2 capacity must withstand continuous voltages equal to at least 1500V;

– the inductance L must withstand the supply current of the tested device.

IMPEDANCE STABILISING LINE (L.I.S.N.)

Electric diagram

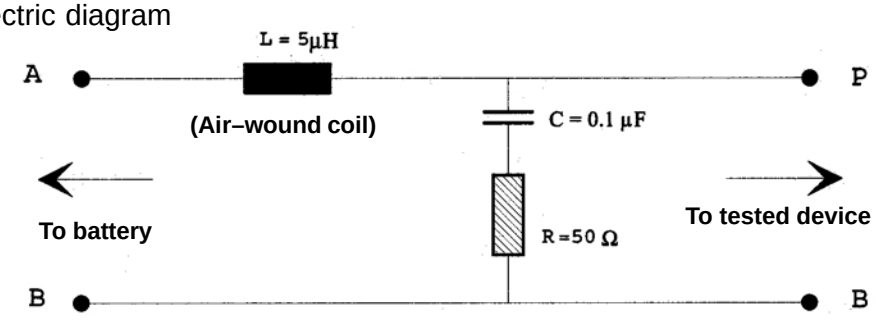


FIGURE 1

Impedance module

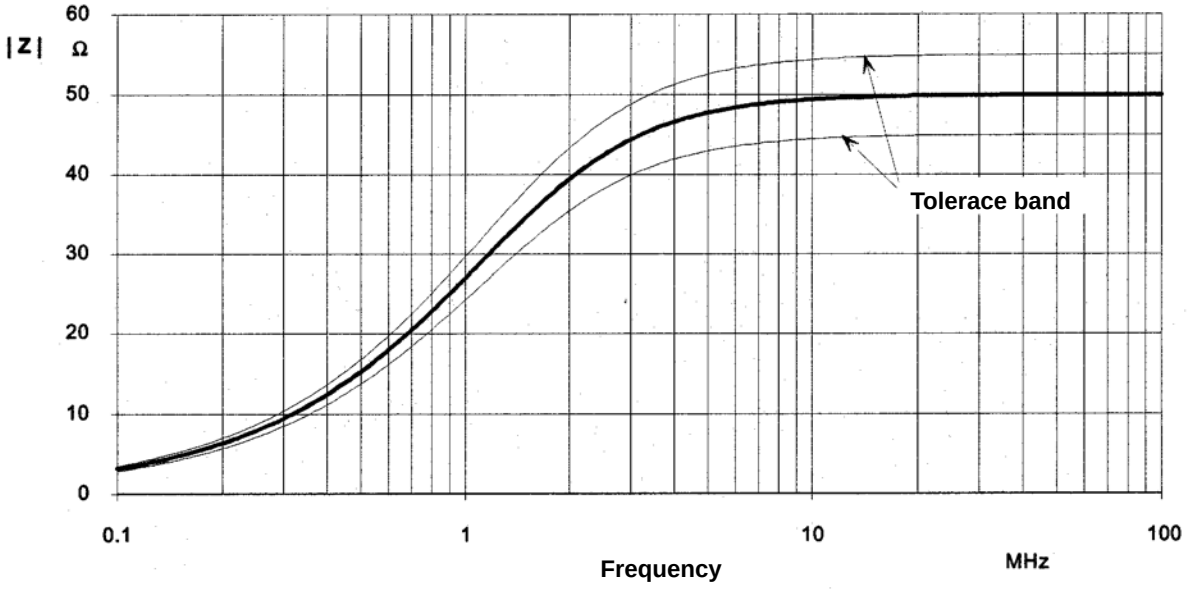


FIGURE 2

4.5 Tested device stimulating system

– It must allow the correct operation of the tested device under normal operating conditions, as provided in the drawing or the related specifications;

– It must be able to correctly interface system sensors and actuators being checked, without modifying their electric characteristics (impedances).

4.6 Receiving antenna

In the frequency band from 0.15 to 30 MHz a stylus antenna must be used.
In the frequency band from 30 MHz to 1 GHz, double–cone, log–periodic or double–ridge antennae must be used.
In any case the antenna must be calibrated, together with the used cable (and the adapter device to the measuring instrument, if used), in order to be able to compute the electric field actually measured in dBuV/m. Moreover, it must guarantee such a sensitivity as to allow, combined with measuring instrument performances, the measure of electromagnetic fields whose intensity is by at least 10 dB lower than the limits required in **Table 3**.

4.7 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;

– at least 15 dBuV (equal to –92dBm) at 100 MHz, with bandwidth equal to 100 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, 9 kHz and 120 kHz;

– 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 Equipment arrangement

Get through system people the necessary technical documentation to carry out the test, including:

– Tested system operating conditions.

– Stimulating system.

– System connection lay–out during the tests.

Arrange instruments on the test plane like in the set–up to be reproduced that is included as a diagram in **Figure 3**.

Arrange the tested system on the ground plane with related wiring and necessary instruments for its correct operation to be arranged inside the chamber (real sensors and actuators and/or stimulating system), trying to orient the tested device connectors towards the receiving antenna. The set–up to be reproduced is included as a diagram in **Figure 3**.

Place the system to be checked and its related wiring at a distance of 50 ± 7.5 mm from the test plane and insulated therefrom.
In case the ground connection is expressly provided for on the system body or on one of the sensors/actuators, such connection will have to be as short as possible.

Arrange the wiring so that it is lifted by 50 ± 7.5 mm from the ground plane, by means of a non–conductive material support with low relative permittivity ($E_r \leq 1.4$) and spaced by 100 ± 10 mm from the plane edge for at least 1500 ± 75 mm, arranging the possible branches (cable bundle lengths that connect sensors/actuators to main wiring and that due to their length do not allow arranging these latter ones outside 1.5 m of the wiring exposure length) at a right angle (90° ± 15°) with respect to the longitudinal cable bundle axis.

Sensors must be stressed through the stimulating system.

Actuators must be the same ones provided in the drawing to be installed on a car. If they are composed of electric motors, the mechanical load must be present or possibly stimulated by means of a brake.

Battery and supply negatives must be connected to the ground plane.

The receiving antenna must be at a distance of 1000+50 mm away from the ground plane edge, in compliance with what is required by the antenna manufacturer, i.e. from the antenna reference point, previousli calibrated that corresponds to the antenna center when the double–cone type is used, the nearest element when using the log–periodic type (including the biconilog ones), or from front opening for conical horn antenna.
The stylus antenna must be vertically arranged on metal plane point A with sizes of at least 1 m x 1.5m, on the same plane and adjacent to the ground plane on which the tested system lies and electrically connected thereto (as shown in **Figure 3**).
The other antennae must be arranged at a height of o ± 25 mm above the ground plane, with the maximum sensitivity direction perpendicular to the wiring and parallel to the ground plane.
Concerning > 1 GHz measurings, antenna shall be placed opposite the tested device.

EQUIPMENT ARRANGEMENT SET–UP

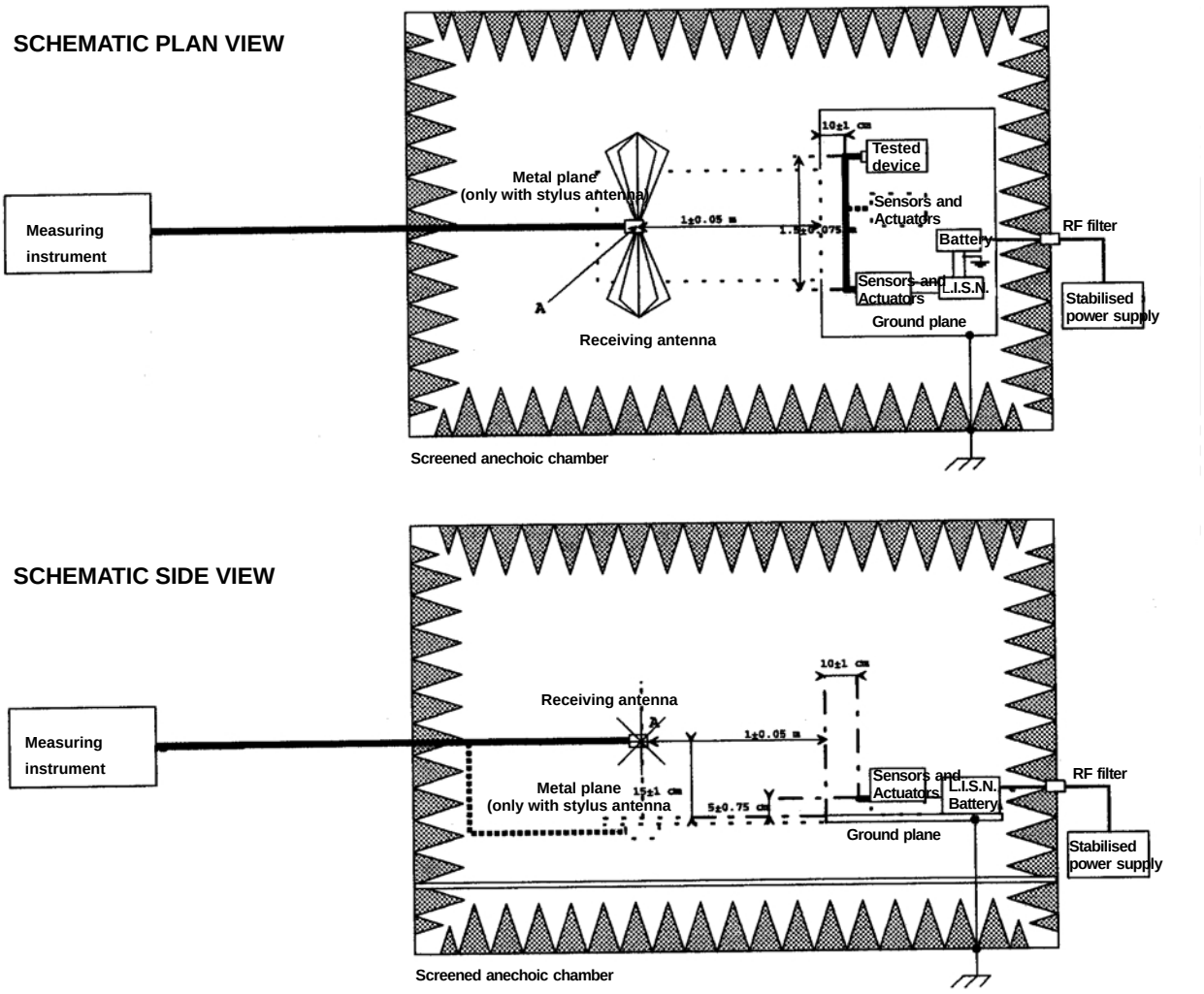


FIGURE 3

Concerning > 1 GHz measurings, antenna shall be placed opposite the tested device.

5.2 Test device activation

- Connect and supply the tested device as provided by the drawing or related specifications.
- Connect the measuring instrument to the antenna through a suitable coaxial screened calibrated cable.
- Arrange the system under operating conditions mentioned in the specification.
- Apply signals to all electric inputs or physical sensors.
- Activate the system.

5.3 **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 1**. 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 1**).

In case of intermittently–operating devices or anyway rarely–operating devices, operate as follows:

– using a measuring receiver, extend the stay time at every frequency to such a value as to allow proper measurement of disturbance envelope;

– using a spectrum analyser, extend the scanning time and/or insert the memory function (“MAX HOLD”) in such a way as to obtain the satisfactory coverage of the displayed spectrum.

TABLE 1

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 – 30	9 kHz	9 kHz	30 kHz	100 ms/ MHz
30 – 1000	120 kHz	120 kHz	300 kHz	1 ms/ MHz
1000 – 2500	120 kHz	120 kHz	300 kHz	1 ms/ MHz

5.4 **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 2**. 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 2**;

– when a measuring receiver is used, use mean value detector.

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 2

Bandwidth and video filter for measuring narrow band disturbances

Sub–band (MHz)	Bandwidth	Video filter (Spectrum analyser)
0.15 – 30	9 kHz	100 Hz
30 – 1000	120 kHz	300 Hz
1000 – 2500	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 6 dB lower than the corresponding limit shown in **Table 3**.

6.2 Test device activation

Activate the device that has to be tested in such a way as to maximise the emissions.

6.3 Disturbance spectrum measure

In case a measure receiver is used, the whole measuring frequency band must be explored with a pitch that is alway 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 minimum scanning times shown in **Table 1**, when measuring in broad band;

– according to such sub–bands as to guarantee a distance between samples shown on the instrument display that is lower than or equal to the bandwidth, when measuring narrow band disturbances.

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.

The measure must be carried out twice, apart from the stylus antenna case, arranging the receiving antenna under vertical and horizontal bias.

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 bench–radiated emissions by electronic systems**

Systems/components, installed on a bench, must not generate, during their normal operation, radio-frequency disturbances at higher levels than those shown in the following **Table 3**, expressed in dBuV/m:

TABLE 3

Acceptability limits

Frequency band (MHz) (*)	**Narrow band limits (dBμV/m)**	**Broad band limits (dBμV/m)**			
		Peak detector		**Semi–peak detector**	
	Peak or average detector	Components whose operation is continuous (ex.: windscreen wiper, electrofan, thermal engine, flash–light, etc.)	Components operating for a short time and with manual actuation (ex. stop lights switch, windscreen washer pump, etc.	Components whose operation is continuous (ex.: windscreen wiper, electrofan, thermal engine, flash–light, etc.	Components operating for a short time and with manual actuation (ex. stop lights switch, windscreen washer pump, etc.
0,15 – 0,3	31	66	76	53	63
0,3 – 0,53	31	76	86	63	73
0,53 – 2	26	59	69	46	56
2 – 5,9	26	67	77	54	64
5,9 – 6,2	34	48	58	35	45
6,2 – 26,9					
26,9 – 54	34	48	58	35	45
54 – 68					
68 – 87	24	37	47	24	34
87 – 108	30	37	47	24	34
108 – 175	24	37	47	24	34
175 – 300	31	44	54	41	51
300 – 330	24	37	47	24	34
330 – 420	31	44	54	41	51
420 – 512	24	37	47	24	34
512 – 820	45	68	78	53	63
820 – 1000	30	43	53	30	40
1000 – 2500 (**)	30 (***)	43	53	30	40

(*) With same–frequency conditions, the strictest request prevails.

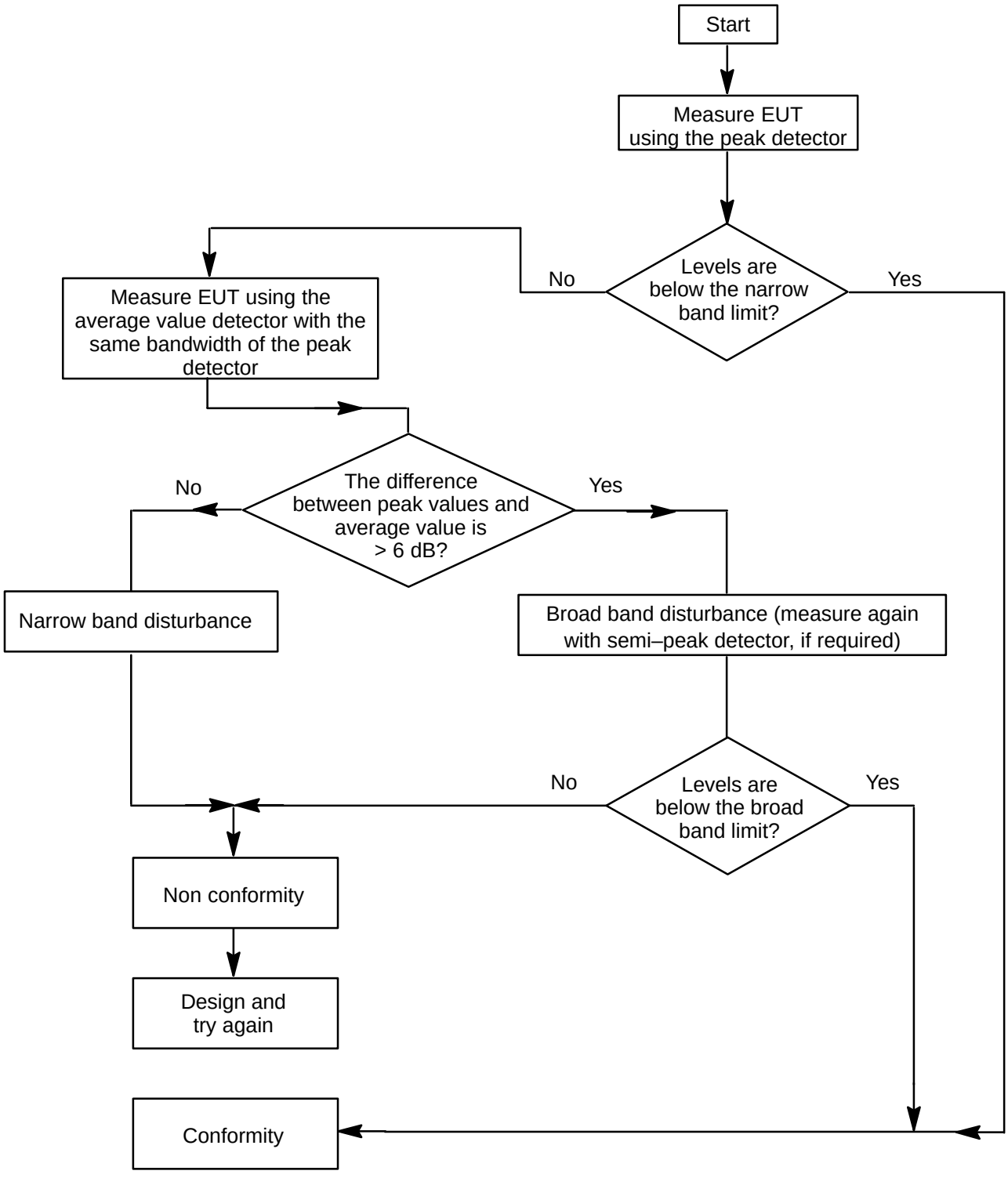
(**) Only if explicitly required by Product Specifications.

(***) The max allowed value within range 1570 – 1580 MHz, using the average detector, corresponds to 10 dB; with a band resolution equal to 10 kHz, 5 kHz–steps, stay time of 25 ms and scanning speed of 5 s/MHz.

7 ACCEPTABILITY CRITERIA

Operating conditions of the tested device must be chosen in order to maximise the emissions and must comply with the limits included in **Table 3**.

7.1 Method for determining conformity of irradiated disturbances and discrimination between narrow and wide band ones



8 SHOWING THE RESULTS

For every system being checked, under any test condition, the measure of radiated disturbances will have to be included in diagrams showing the amount of disturbances being present in the whole test spectrum from 150 kHz to 1 GHz (dBµV/m – Frequency).

STANDARDS QUOTED

IVECO STD.: 18–2252.