SUPERVISING DEPT.: E&D - Prototypes, Testing & Services - E/E Testing

MANAGING DEPT.: E&D - Prototypes, Testing & Services - E/E Testing

1

APPLICATION CRITERIA

This Standard is to measure radiated interference level at the frequency domain, as generated by the system and tested off-vehicle, which can be captured by the on-board receiver.

This standard is to be used at an Engineering Approval and Qualification stage.

Change	Date	Description		
-	Apr. 95	Issue 1 –	New; written in accordance with Technical Memorandum Procedure. This Standard supersedes para 3 of Std. 7.Z0890/01.	
-	Sept. 96	Issue 2 –	Updated.	(SS)
-	May 04	Issue 3 –	Supervisor changed (was Durando). “Test schedule” cancelled.	(SS)
-	Mar. 06	Issue 4 –	Completely revised.	(SS)

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Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ] | Job:
Component Type: | Drawing Number:
Supplier: | Last Change:

2

REFERENCES

7-G0030	Significance of items under test (PGE)
9.90110	Automotive electrical and electronic devices (CEL)

3

TEST EQUIPMENT

3.1

Shielded anechoic chamber

Chamber size to contain test table and EM field generator antennas positioned 1 meter away from table and 1.5 meter away from shielded sidewalls; internal clear dimensions to be: 6 m length, 4 m width and 3 m height

Minimum attenuation required within shielded chamber frequency range for EM field to be:

Electric fields:

10 kHz to 10 GHz : 100 dB

10 GHz to 18 GHz : 90 dB

Magnetic fields:

at 10 kHz : 60 dB

at 200 kHz : 80 dB

Minimum reflection coefficients required for anechoic material to be:

30 dB at 200 MHz

50 dB at 1GHz

40 dB at 18 GHz

3.2

Test instrument

Either a receiver or a spectrum analyzer with preselector; however, following requirements shall be met:

- test frequency field: min. 150 kHz to 1000 MHz 2.5 GHz
- sensitivity: - min. 10 dBμV (equivalent to -97 dBm) to 150 kHz, with 10 kHz band width and peak detector;
  - min. 15 dBμV (equivalent to -92 dBm) to 100 kHz, with 100 kHz band width;
  - min. 5 dBμV (equivalent to -112 dBm) to 150 kHz, with 9 kHz band width and peak-to-peak detector (if required);
- input impedance: 50 Ω;
- band width to be selected within following values:

  1 kHz, 10 kHz and 100 kHz; for peak-to-peak detector the last two values shall be replaced by the following ones: 9 kHz and 120 kHz.
- peak detector for spectrum/peak/average value analyzer and peak-to-peak analyzer for receiver as required;

Detector shall have the following characteristics:

TYPE OF DETECTOR	CONSTANT CHARGE TIME CURRENT (tc)	CONSTANT DISCHARGE TIME CURRENT (tc)	
		0,15 to 30 MHz	over 30 MHz
PEAK-TO-PEAK	1 ms	160 ms	550 ms
PEAK	≤ 10 μs	1 s (*)	
AVERAGE VALUE	100 ms	100 ms	

(*) not applicable if a spectrum analyzer is used

3.3

Impedance stabilizer network (L.I.S.N.)

Electric circuit and impedance characteristic with changing frequency to be as per help 1. Moreover, the following requirements shall be met:

- resistance across terminals P and A to be below 5 mΩ.
- impedance across terminals P and B, with terminals A and B shorted, not to exceed 20% of nominal curve shown on figure within 100 kHz to 20 MHz.
- capacitance C2 to withstand continuous voltage to 1500 V min.
- inductance L to withstand supply current of test specimen.

3.4

Grounded top

High electrical conductivity sheet metal (e.g. copper, aluminum, brass, galvanized steel), 1.5 mm min. thickness, 2.5 x 1 m min. dimensions.

Grounded top shall be connected to ground line of building thru copper braid welded to top.

3.5

Test table

Shall consist of insulating material (e.g. wood), of suitable size to adequately support grounded top.

Relative permeability of non-conductive material support where EUT (Equipment Under Test) and wiring are located to be ≤ 1.4.

3.6

Test specimen stimulating system

- Shall permit correct operation of test specimen in normal service conditions as per dwg or P.S.
- Shall interface with sensors and actuators of system under test without significant changes to electrical characteristics (impedance).

NOTE: *It is recommended to use a purely passive simulator to avoid affecting the test.*

Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ] | Job:
Component Type: | Drawing Number:
Supplier: | Last Change:

3.7

Supply unit

The unit must supply the voltage and the max current needed for correct operation of device under test.

Use supply unit with adjustable voltage 0 to 24V, 40 Amp, with 45 Ah, 225 Amp battery.

3.8

Receive antenna

A Rod antenna shall be used for 0.15 to 30 MHz frequency band, while for 30 MHz to 2.5 GHz frequency band biconical, log-periodic or double-ridged antennas can be used.

However, antennas and cable used (and adaptor to test equipment, if used) to be adjusted to calculate the electric field actually measured in dBµV/m.

Also, antenna sensitivity shall ensure detection of electromagnetic fields 6dB min. below P.S. 9.90110 requirements when combined with test instrument.

3.9

Data acquisition system

Data acquisition system to show readings from test instrument as electronic readings.

Above system to be constantly connected to test instrument.

Note: *Equivalent equipment may be substituted but must be equal or superior in performance.*

Date:..... Exemption: NO [ ] YES [ ]

Test Engineer:..... Signature:.....

Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ] Job:
Component Type: Drawing Number:
Supplier: Last Change:

4

DESCRIPTION OF ITEM UNDER TEST

4.1
Electronic Control Unit

Type	
Fiat Drawing No.	
Code	
ECU identification number	
Software release version	
Hardware release version	
Build level	A [ ]
	B [ ]
	C [ ]
	D [ ]
	E [ ]
Supplier	
Purpose	

4.2
Wiring harness

Type	
Fiat Drawing No.	
Build level	A [ ]
	B [ ]
	C [ ]
	D [ ]
	E [ ]
Supplier	

Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ] Job:
Component Type: Drawing Number:
Supplier: Last Change:

4.3

Sensors / Actuators

Type	
Fiat Drawing No.	
Build level	A [ ]
	B [ ]
	C [ ]
	D [ ]
	E [ ]
Supplier	

Type	
Fiat Drawing No.	
Build level	A [ ]
	B [ ]
	C [ ]
	D [ ]
	E [ ]
Supplier	

Type	
Fiat Drawing No.	
Build level	A [ ]
	B [ ]
	C [ ]
	D [ ]
	E [ ]
Supplier	

Date:.....

Test Engineer:..... Signature:.....

Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ] Job:
Component Type: Drawing Number:
Supplier: Last Change:

5

SIGNIFICANCE OF COMPONENTS UNDER TEST

COMPONENT WEIGHT AND CHARACTERISTICS FOR EVALUATING TEST SIGNIFICANCE					
Type of component	**% Significance (A)**	**Weight (B)**	**Component affecting test significance**	**Significant characteristics**	**Minimum build level**
Active		0.50	Electronic Control Unit	Printed circuit board Case if metal-type Software Release	B
Active		0.20	Wiring harness	Cable length and cross section	C
Active		0.30	Sensors and actuators	Impedance	C

Significance of item under test = Σ (A x B) =

Note: *For each component, evaluate % significance for the three distinct levels indicated in Standard 7-G0030, recording values in column A.*

Date:.....

Test Engineer:..... Signature:.....

Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ] | Job:
Component Type: | Drawing Number:
Supplier: | Last Change:

6

PRELIMINARY OPERATIONS

6.1

Procure engineering documentation needed to perform the test (hardware and functional specs, P.S., drawings, etc.) to get following information: [ ]

- classification of system under test, in accordance with Procurement Specification 9.90110;
- operating conditions of system under test and stimulation and monitoring system (as required);
- parameters monitored and tolerances;
- fault definition and action required.

6.2

Retrieve the specified limits stated in technical documentation and record data in "Data Processing" form tables. [ ]

6.3

Identify system components and fill in "Description of item under test" form tables. [ ]

6.4

Sistemazione delle apparecchiatureLayout of test apparatus

6.4.1

Organize test apparatus (as listed in "TEST EQUIPMENT" form) so as to produce setup as shown in help 2 according to the frequency range. [ ]

6.4.2

Place receiver antenna to get 1000 ± 10 mm distance between cable bundle and antenna reference point as required by the antenna manufacturer. [ ]

Antenna reference point is:

- Rod antenna – the vertical single pole
- Biconical antenna – the phase centre (mid point)
- Log-periodic Antenna – the antenna tip
- Horn Antenna – front opening.

Place rod antenna vertically on a 1 m x 1.5 m min. metal surface, level with and adjacent to the ground plane supporting system under test and wired to the latter (as shown in help 2).

Height of rod antenna grounded top to be ±10 mm to table grounded top.

Height of antenna phase centre (biconical / log-periodic / ridge types) to be 100 ± 10 mm above ground plate, with max. sensitivity direction perpendicular to wiring and parallel to grounded top.

6.4.3

Place receiver antenna perpendicular to and facing the cable bundle as described below: [ ]

- 0.15 - 1000 MHz frequency bands – Antenna to be in line to cable bundle mid point (cable length 1500 mm). The antenna is placed in front of the EUT cable bundle mid point (help 2-Figures 1 / 2 / 3)
- 1000 – 2500 MHz frequency bands – Antenna to be in line to EUT. The antenna is placed in front of the EUT cable bundle mid point (help 2-Figure 4).

6.4.4

Place system under test with wiring and auxiliary instrumentation needed for proper operation (i.e. real sensors and actuators and/or stimulation system inside anechoic chamber) on grounded top with connectors facing toward receiver antenna and parallel to metal surface front edge (side facing toward receiver antenna) at least 200±20 mm away (see set-up for reproduction shown as a diagram in help 2). [ ]

6.4.5

Place system under test and wiring raised 50±5 mm above grounded top ensuring total isolation. [ ]

***Note**: If ground connection is to be made on system frame or on a sensor/actuator keep it as short as possible.*

6.4.6

Arrange wiring parallel to front edge of metal surface for a length of 1500±75 mm min. about 100±10 mm away, with any branches (parts of harness connecting sensors/actuators to main harness which owing to their reduced length prevent sensor/actuator positioning outside the 1.5 m clearance specified for section of cable exposed to EM field) at right angles (90°±15°) to longitudinal centerline of cable harness. [ ]

***Note**: Any branches in excess of 60 cm shall have the first part parallel to main harness so that a 60 cm length will be at right angles to harness.*

If harness used it that installed on vehicle and supply lines (positive and negative) do not permit connection to impedance stabilization network (L.I.S.N.) keeping at least 1500±75 mm of harness parallel to front edge of metal surface, lines shall be extended using two cables parallel and close to one another 50±5 mm away from grounded top.

If harness used is not that of vehicle wiring harness type (i.e. cross section, shielding, twisting, ground paths, etc.) shall be equivalent to that of harness used on vehicle.

Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ] Job:
Component Type: Drawing Number:
Supplier: Last Change:

6.4.7

Connect test sensors and actuators which should be the same as those specified on drawing for installation on vehicle, to be loaded thru stimulation system. [ ]

Note: *If electric motors are used as actuators, an actual mechanical load shall be applied or simulated by a brake.*

6.4.8

Connect battery and alternator negative to grounded top and to the two supply lines of system under test to impedance stabilization network (L.I.S.N.). [ ]

Date:..... Exemption: NO [ ] YES [ ]

Test Engineer:..... Signature:.....

7

TEST PROCEDURE

The following tests must be carried out at an ambient temperature of 23 ± 5 °C with RH 45 to 70%.

7.1

Test setup activation

7.1.1

Connect and supply test specimen as specified on drawing or P.S. [ ]

7.1.2

Apply signals needed for system operation to all relevant electrical inputs or physical sensors. [ ]

7.1.3

Set system to static (no change in stimulation signals) or dynamic (sequence of given changes in stimulation signals to deliberately alter system status or behavior) operation specified on drawing or P.S. to test for correct operation. [ ]

7.1.4

Connect antenna test instrument using a shielded coaxial calibrated cable. [ ]

7.2

Narrowband interference measurement

7.2.1

Select subbands as appropriate for bandwidth shown in following **Table I**. [ ]

TABLE I: bandwidth and video filter width to measure narrowband interferences

SUBBAND	BAND WIDTH	VIDEO FILTER (spectrum analyzer)
0.15 - 2 MHz	10 kHz	100 Hz
2 - 26.9 MHz	10 kHz	100 Hz
26.9 - 110 MHz	100 kHz	300 Hz
110 - 2500 MHz	100 kHz	300 Hz

Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ] | Job:
Component Type: | Drawing Number:
Supplier: | Last Change:

7.2.2

If a spectrum analyzer is used as test equipment, follow the procedure below: [ ]

- Use a Peak Detector for reading
- Set video filters as shown in **Table I**
- Set sweep time to a value allowing correct reading of interference enveloping. Enter memory function ("MAX HOLD") and repeat sweep procedure (at least 2) on the same subband. Distance between samples displayed on equipment to be less than or equal to bandwidth for narrowband interference reading.

7.2.3

If a measurement receiver is used, follow the procedure below: [ ]

- Use an Average Detector for reading
- Use a pitch less than or equal to bandwdith to test the whole frequency band
- Set dwell time for each frequency to a value high enough to allow correct reading of interference enveloping.

7.2.4

Set measurement antenna to vertical polarization to read environmental electromagnetic interference through the receiver installed with test device off. [ ]

7.2.5

Switch on test device to read emissions spectrum for frequency tested as described in paras. 7.2.1 and 7.2.2 or 7.2.3. [ ]

7.2.6

Enter data obtained from test device in table of Data processing form. [ ]

7.2.7

Use data obtained to draw a graph showing level measured with reference to frequency (Frequency Spectrum). [ ]

Note 1: *Level measured to be at least 6 dB lower than corresponding admitted limit specified in P.S. 9.90110; if not, decrease receiver attenuation (measurement system) until above condition is met and use this new setting to carry our actual measurement.*

Note 2: *Within CATNET environment, the diagram is automatically generated by inserting data in relevant table.*

7.2.8

Repeat operations from paras. 7.2.1 to 7.2.7 with antenna in vertical polarization position. [ ]

Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ] Job:
Component Type: Drawing Number:
Supplier: Last Change:

7.2.9

Switch on test device as described in para. 7.1.3 and read spectrum level of radiated interferences in horizontal polarization using the measuring instrument and the automatic acquisition bench. [ ]

Note: *To check that no instrument saturation occurs, increase input attenuation of 10 dB and repeat measurement (para 7.2.1 and 7.2.2 or 7.2.3) according to the same procedure.*

Absolute interference level measured to be within ±1 dB; if not, increase attenuation until above condition is met and use this new setting to carry our actual measurement.

7.2.10

Enter data obtained from test device in table of Data processing form. [ ]

7.2.11

Use data obtained to draw a graph showing level measured with reference to frequency (Frequency Spectrum). [ ]

Note 2: *Within CATNET environment, the diagram is automatically generated by inserting data in relevant table.*

7.2.12

Repeat operations from paras. 7.2.9 to 7.2.11 with antenna in vertical polarization position. [ ]

Date:..... Exemption: NO [ ] YES [ ]

Test Engineer:..... Signature:.....

Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ] Job:
Component Type: Drawing Number:
Supplier: Last Change:

7.3

Broadband interference measurement [ ]

7.3.1

Select subbands as appropriate for bandwidth shown in following **Table II**. [ ]

TABLE II: bandwidth and video filter width, and sweep times to measure broadband interferences

SUBBAND	BAND WIDTH		VIDEO FILTER	MIN. SWEEP TIME
	PEAK DETECTOR	PEAK-TO-PEAK DETECTOR	SPECTRUM ANALYZER	
0.15 - 2 MHz	10 kHz	9 kHz	30 kHz	100 ms/MHz
2 - 26.9 MHz	10 kHz	9 kHz	30 kHz	100 ms/MHz
26.9 - 110 MHz	100 kHz	120 kHz	300 kHz	1 ms/MHz
110 - 2500 MHz	100 kHz	120 kHz	300 kHz	1 ms/MHz

7.3.2

If a spectrum analyzer is used as test equipment, follow the procedure below: [ ]

- Use a Peak Detector for reading.
- Set video filters as shown in **Table II**
- Set min. dwell time either as shown in **Table II** or to a value allowing to get a correct reading of interference enveloping. Enter memory function ("MAX HOLD") and repeat sweep procedure (at least 2) for the same subband.

7.3.3

If a measurement receiver is used, follow the procedure below: [ ]

- Use a Peak / Peak-to-Peak Detector for reading.
- Use a pitch less than or equal to bandwith to test the whole frequency band
- Set dwell time for each frequency to a value high enough to allow correct reading of interference enveloping.

7.3.4

Set measurement antenna to vertical polarization to read environmental electromagnetic interference through the receiver installed with test device off. [ ]

7.3.5

Switch on test device to read emissions spectrum for frequency tested as described in paras. 7.3.1 and 7.3.2 or 7.3.3. [ ]

7.3.6

Enter data obtained from test device in table of Data processing form. [ ]

7.3.7

Use data obtained to draw a graph showing level measured with reference to frequency (Frequency Spectrum). [ ]

Note 1: *Level measured to be at least 6 dB lower than corresponding admitted limit specified in P.S. 9.90110; if not, decrease receiver attenuation (measurement system) until above condition is met and use this new setting to carry our actual measurement.*

Note 2: *Within CATNET environment, the diagram is automatically generated by inserting data in relevant table.*

7.3.8

Repeat operations from paras. 7.3.1 to 7.3.7 with antenna in horizontal polarization position. [ ]

7.3.9

Switch on test device as described in para. 7.1.3 and read spectrum level of radiated interferences in horizontal polarization using the measuring instrument and the automatic acquisition bench. [ ]

Note: *To check that no instrument saturation occurs, increase input attenuation of 10 dB and repeat measurement (paras. 7.3.1 and 7.3.2 or 7.3.3) according to the same procedure.*

Absolute interference level measured to be within ±1 dB; if not, increase attenuation until above condition is met and use this new setting to carry our actual measurement.

7.3.10

Enter data obtained from test device in table of Data processing form. [ ]

7.3.11

Use data obtained to draw a graph showing level measured with reference to frequency (Frequency Spectrum). [ ]

Note 2: *Within CATNET environment, the diagram is automatically generated by inserting data in relevant table.*

7.3.12

Repeat operations from paras. 7.3.9 to 7.3.11 with antenna in vertical polarization position. [ ]

Date:..... Exemption: NO [ ] YES [ ]

Test Engineer:..... Signature:.....

Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ]
Component Type:
Supplier:

Job:
Drawing Number:
Last Change:

8

DATA PROCESSING

8.1

Narrowband interference measurement

"Banda stretta.xls"

8.2

Broadband interference measurement

"Banda larga.xls"

Date:.....

Exemption: NO [ ] YES [ ]

Test Engineer:.....

Signature:.....

Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ] Job:
Component Type: Drawing Number:
Supplier: Last Change:

9

POST-TESTING PROCEDURE

9.1

Disconnect instrumentation (sensors, actuators, etc.) not integral to system from system under test. [ ]

9.2

Reinstate any connections altered to permit testing. [ ]

9.3

Restore test setup to original conditions ready for further testing. [ ]

9.4

Archive the tested components for at least 10 years so they can easily be traced. Engineer [ ]

Note: *At the end of storage time, component shall be managed for demolition.*

Date:..... Exemption: NO [ ] YES [ ]

Test Engineer:..... Signature:.....

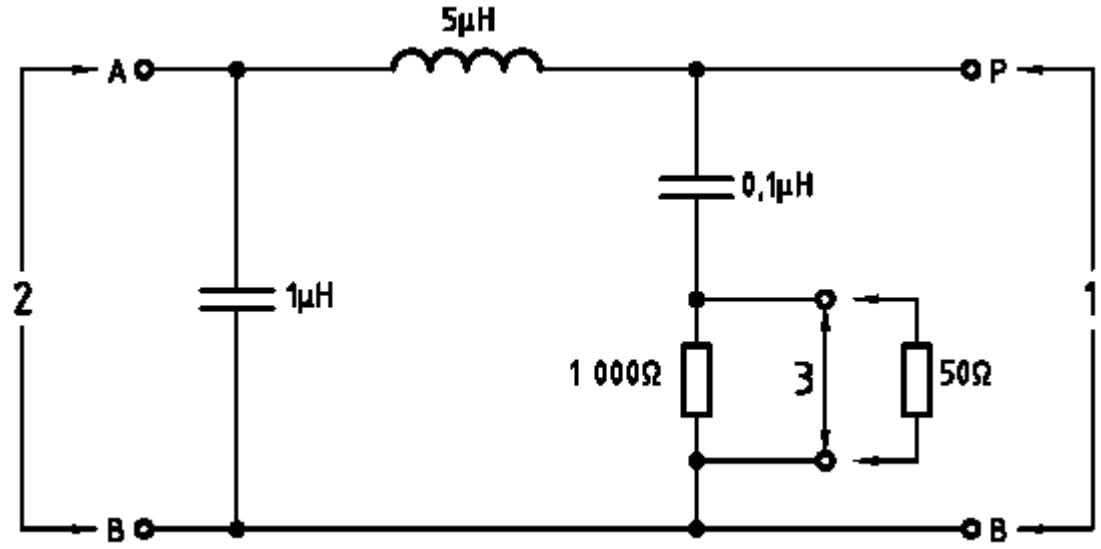
Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ] Job:
Component Type: Drawing Number:
Supplier: Last Change:

10

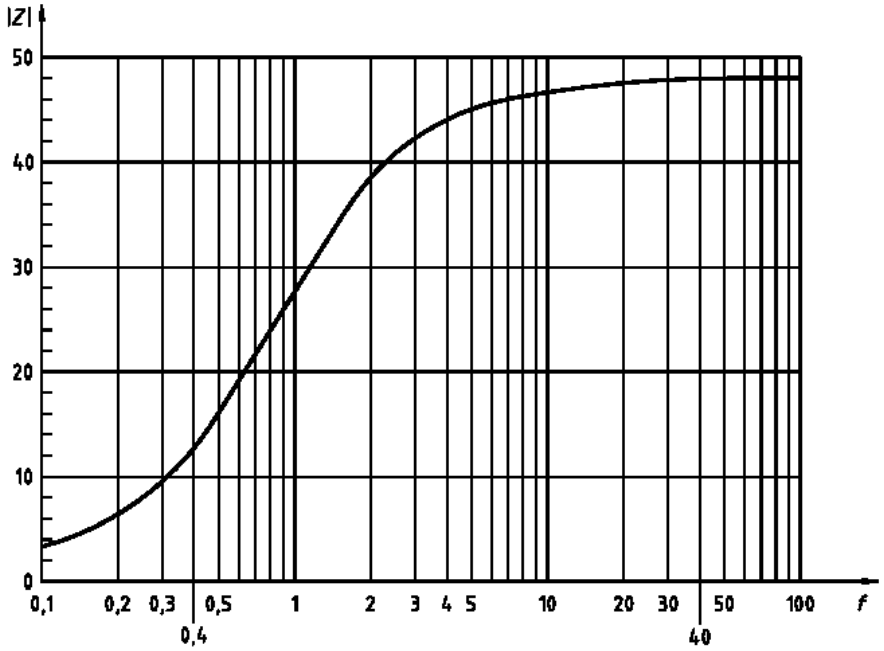
HELP

Help 1

IMPEDANCE STABILIZER NETWORK (L.I.S.N.)



1- EUT (Equipment Under Test) Port
2- Supply port
3- Measurement port

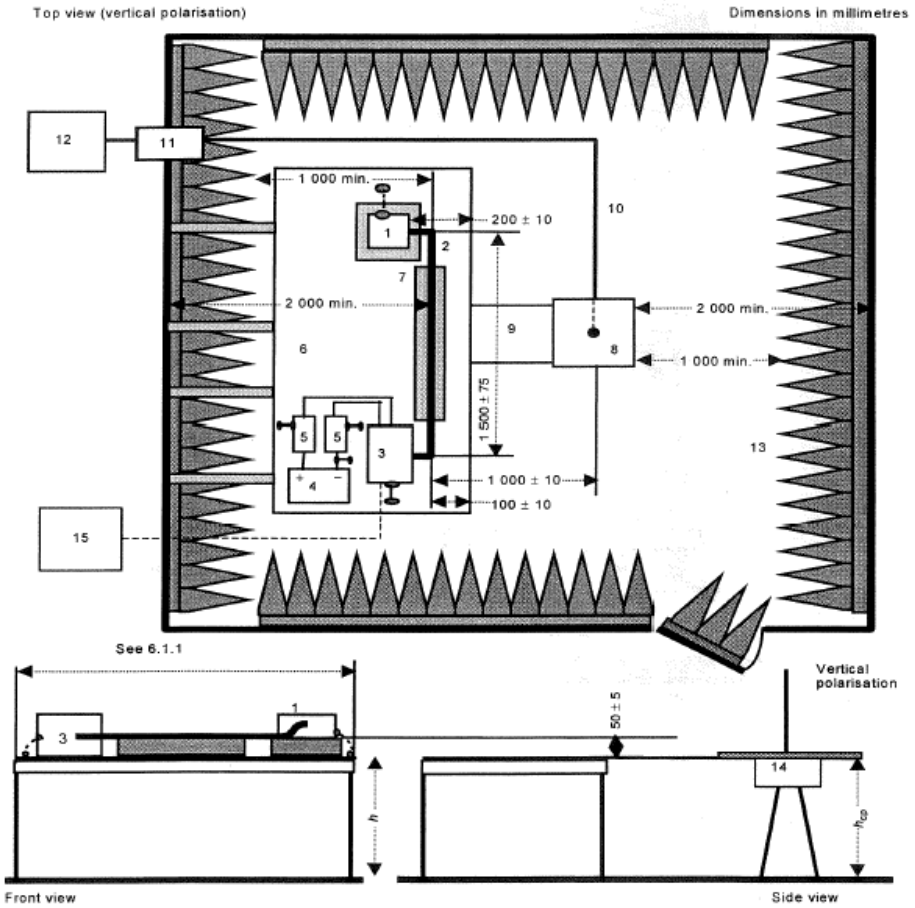


Help 2

EQUIPMMENT LAYOUT SETUP

FIGURE 1

0.15 –30 MHz Frequency Band Set-up

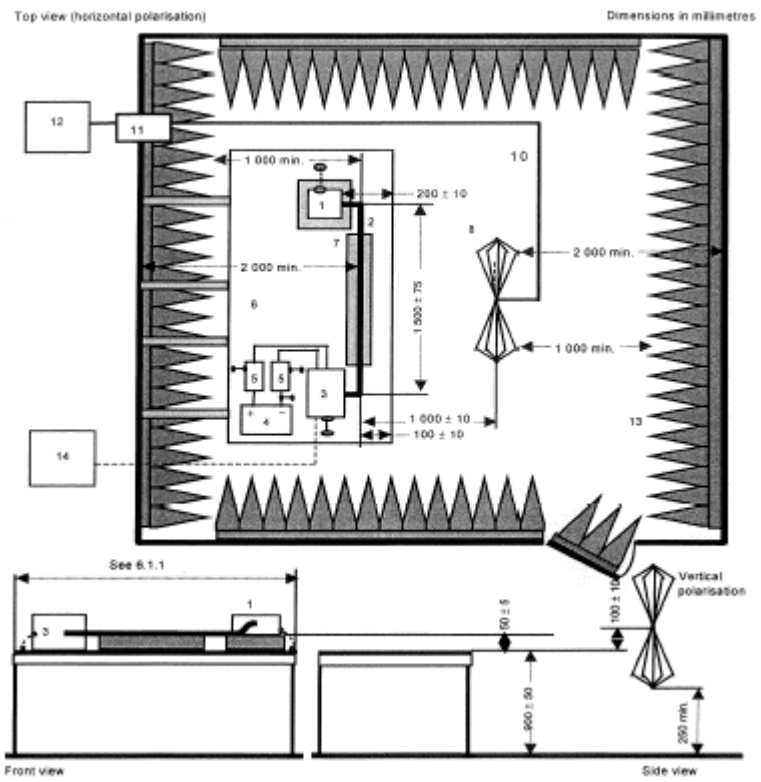


1 – EUT Equipment under test
2 – Cable bundle
3 – Simulator / load
4 – Power Supply (Battery)
5 – LISN
6 – Grounded top wired to anechoic test facility
7 – Low permittivity support
8 – Rod antenna
9 - Ground connection
10 – Double shielding coaxial cable (50 Ohm)
11 – Thru connectors
12 – Measuring receiver
13 – RF absorbing material
14 – Antenna unit
15 - Stimulating and monitoring system for equipment under test

Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ] Job:
Component Type: Drawing Number:
Supplier: Last Change:

FIGURE 2

30 –200 MHz Frequency Band Set-up

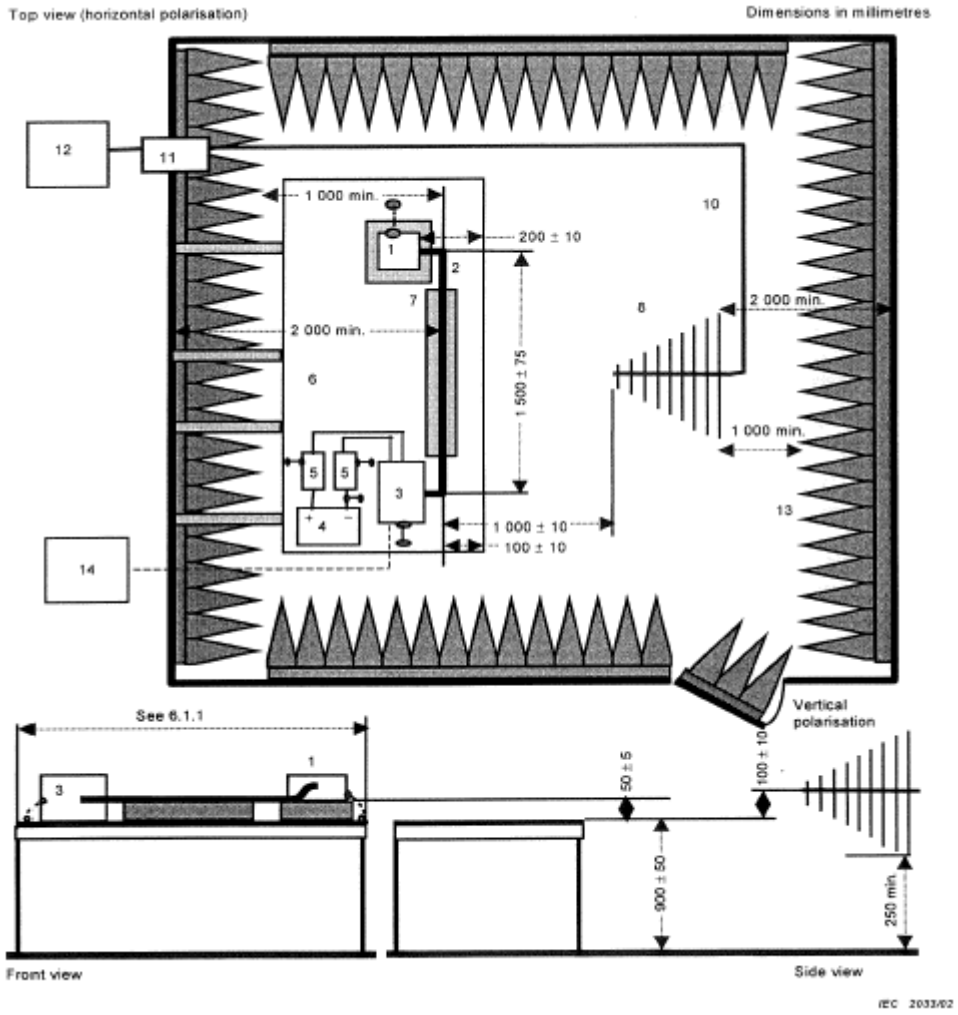


1 – EUT Equipment under test
2 – Cable bundle
3 – Load simulator for equipment under test
4 – Power Supply (Battery)
5 – LISN
6 – Grounded top wired to anechoic test facility
7 – Low permittivity support
8 – Biconical antenna
9 – /
10 – Double shielding coaxial cable (50 Ω)
11 – Thru connectors
12 – Measuring receiver
13 – RF absorbing material
14 - Stimulating and monitoring system for equipment under test

Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ] Job:
Component Type: Drawing Number:
Supplier: Last Change:

FIGURE 3

30 –1000 MHz Frequency Band Set-up

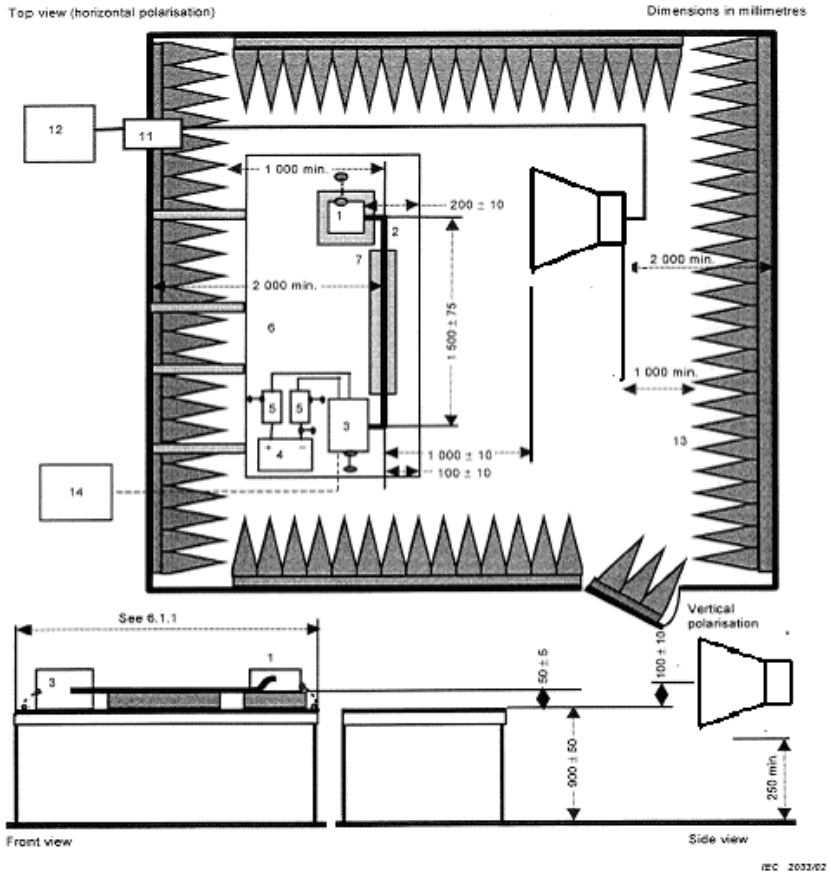


1 – EUT Equipment under test
2 – Cable bundle
3 – Load simulator for equipment under test
4 – Power Supply (Battery)
5 – LISN
6 – Grounded top wired to anechoic test facility
7 – Low permittivity support
8 – Log-periodic antenna for 30 – 1000 MHz or 200 -1000 MHz frequency bands
The antenna to be facing the cable bundle (para 2) as shown on figure.
9 – /
10 – Double shielding coaxial cable (50 Ω)
11 – Thru connectors
12 – Measuring receiver
13 – RF absorbing material
14 - Stimulating and monitoring system for equipment under test

Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ] Job:
Component Type: Drawing Number:
Supplier: Last Change:

FIGURE 4

1000 –2500 MHz Frequency Band Set-up



1 – EUT Equipment under test
2 – Cable bundle
3 – Load simulator for equipment under test
4 – Power Supply (Battery)
5 – LISN
6 – Grounded top wired to anechoic test facility
7 – Low permittivity support
8 – Log-periodic / Horn antenna for 1000 – 2500 MHz frequency band
The antenna to be placed as shown on figure and facing the EUT (para. 1)
9 – /
10 – Double shielding coaxial cable (50 Ω)
11 – Thru connectors
12 – Measuring receiver
13 – RF absorbing material
14 – Stimulating and monitoring system for equipment under test