BENCH TESTS FOR ELECTROMAGNETIC SUSCEPTIBILITY OF ELECTRONIC SYSTEM BY THE BULK CURRENT INJECTION METHOD (CURRENT INJECTION AT RADIO FREQUENCY ON CABLE HARNESS)

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PURPOSE

To define the equipment to be used and the test procedure to be followed for performing bench tests for electromagnetic susceptibility of electronic devices using the "BCI" method.

The aim of the tests is the correct application on the vehicle of the component tested, for the concession of Design Release, Final Design Release and Qualification.

Change	Date	
-	Apr. 95	Edition 1 – New; edited in accordance with the Technical Memory procedure; this standard superseded paragraph 6 of Std. 7.Z0890.
-	04/27/04	2nd Edition – Supervisor (was Durando) and Manager (was Cirio). Changed. Deleted paragraph "Test time requirements". (SS)

CRITERIA GOVERNING THE USE OF THE STANDARD

This document defines the methods and procedure for carrying out measurements of the susceptibility of the system tested to current at radio frequency on the device input cable harness.
The purpose of the measurement is to simulate the effect of an external interfering electromagnetic field on electric/electronic systems operating inside the vehicle.

EQUIPMENT REQUIRED FOR THE TEST

CAUTION:

The electric field radiated should not exceed the intensity of E= 1 V/m at a distance of 1 m from the test bench in the condition of maximum current injected in the cable harness. If this condition fails to be met, the set–up must be enclosed in a Faraday cage.

Make sure that the following instruments are available and indicate the date of last calibration: .

1 – SIGNAL GENERATOR

which must be capable of generating sinusoidal signals in the 1 MHz to 400 MHz frequency band, modulated in amplitude with modulation index variable between 0% and 80%, with a modulating frequency (sinusoidal) of 1000 Hz.

2 – POWER AMPLIFIER AT RADIO–FREQUENCY

Minimum frequency band	1 MHz to 400 MHz
Power generated	at least 10 W on a resistive load of 50 Ω, throughout the frequency band, for systems to be tested with nominal current of 100 or 200 mA at least 25 W on a resistive load of 50 Ω, throughout the frequency band, for systems to be tested with nominal current of 300 mA
Harmonics	at least 15 dB below the fundamental frequency, throughout the frequency band
Other non harmonic signals	at least 20 dB below the fundamental frequency, throughout the frequency band

3 – RADIO–FREQUENCY CURRENT INJECTION CLAMP

Inside diameter	≥ 32 mm
Max. power supply	compatible with the max. power generated by the R.F. amplifier
Frequency band	1 MHz to 400 MHz
Nominal impedance	50 Ω
Insertion loss	≤ 7 dB

3 – RADIO–FREQUENCY CURRENT MEASUREMENT CLAMP

Inside diameter	≥ 32 mm
Frequency band	1 MHz to 400 MHz
Nominal impedance	50 Ω

4 – RADIO–FREQUENCY CURRENT MEASUREMENT SYSTEM

This must comprise a transmission unit and a reception unit linked by fibre optics. The transmission unit must be able to be connected directly to the current measurement clamp specified in paragraph 3 and interfaced with the reception unit through electric–optic dialogue (via fibre optics). After optic–electric conversion of the signal leading from the transmission unit and suitable processing, this unit should give the measurement result directly in current intensity.

Electric specifications of transmission unit

Frequency band	1 MHz to 400 MHz
Nominal impedance	50 Ω
R.F. current intensity	measure from 2 mA to at least 300 mA

5 – TEST STIMULUS AND MONITORING SYSTEM FOR DEVICE UNDER TEST

This must allow correct operation of the device under test in normal conditions of use, as specified on the drawing or by the corresponding specification:

5a STIMULUS SYSTEM

Instrumentation for generating the sensor stimulus signals
Stimulus signal transmission unit with electric–optic conversion
Signal reception unit with electric–optic conversion
Stimulus signal injection devices
Fibre optic link between transmission and reception units

5b MONITORING SYSTEM

Transmission unit for device serviceability status monitoring signals with electric–optic conversion
Reception unit with electric–optic conversion of serviceability status monitoring signals
Fibre optic link between transmission and reception units
Monitoring instruments

6 – POWER SUPPLY

Voltage adjustable between 0 and 20 V, current output min. 60 A, as per Std. 7.Z0100
12 V, 45 Ah, 200 A buffer battery
A suitable filter for radio–frequency should be inserted on the battery output leads.

7 – IMPEDANCE STABILISER NETWORK (L.I.S.N.)

This must have the electric circuit and impedance characteristic to frequency variation as shown in Help 1 and meet the following requirements:

Resistance between terminals P and A below 5 mΩ

The impedance measured between terminals P and B, when terminals A and B are shorted, must not deviate more than 10% from the theoretical curve given in the figure in the 100 kHz to 20 MHz frequency band

The capacity C2 must withstand continuous voltages of at least 1500 V

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

8 – DOUBLE DIRECTIONAL COUPLER

Simultaneous measurement of incident and reflected power

Minimum frequency band	1 MHz to 400 MHz
Power accepted at input	compatible with the max. power generated by the R.F. amplifier
Measurement precision in test frequencies	at least ± 0.1 dB

9 – 2–CHANNEL RADIO–FREQUENCY WATTMETER

Minimum frequency band	1 MHz to 400 MHz
Power accepted at input	compatible with the max. power generated by the R.F. amplifier
Measurement precision in test frequencies	at least ± 0.1 dB

10 – EARTH PLATE

Highly conductive metal sheet (copper, aluminium, brass, galvanised steel).

Minimum thickness 1.5 mm, minimum dimensions 2.5 x 1 m.

The earth plate should be connected to the building's earth line by a special copper braid soldered to the earth plate.

11 – TEST BENCH

Of insulating material (e.g. wood), and of suitable dimensions to accommodate the earth plate.

12 – COMPUTER

With a specific management programme for performing Bulk Current Injection measurements

13 – GRAPHIC PLOTTER

For reproducing the test results

DESCRIPTION OF TEST SUBJECT

SYSTEM:

DRAWING No.:

CODE:

CONTROL UNIT IDENTIFICATION No.:

SUPPLIER:

PURPOSE:

Date: . . . . . .

Name of Engineer: . . . . . Signature: . . . . . .

SIGNIFICANCE OF TEST COMPONENTS

COMPONENT TYPE	SIGNIFICANCE VALUE % A	WEIGHT % B	COMPONENT INFLUECING SIGNIFICANCE OF TEST	SIGNIFICANT CHARACTERISTICS	MINIMUM MANUF. LEVEL

Significance of system tested = SUM (A x B) %

In the case of components not specified on the drawing write ”0” in the component significance and weight boxes.

Date: . . . . . .

Name of Engineer: . . . . . Signature: . . . . . .

PREPARATION FOR THE TEST

1 Through the competent RSC, procure the technical documents needed for performing the test:

1a Operating conditions of system under test

1b Stimulus system

1c Parameters monitored

1d Definition of fault

1e System connection layout during the tests

2 Position the device under test (and/or its actuators and sensors) at a distance of 50 ± 5 mm from the test bench and isolate it using a non–conductive spacer (wood, plastic); if the device is connected to the body when installed on the vehicle, make the earth connection directly on the metal container using a special conductive bus bar which should be as short as possible.

3 Connect the device to the power supply

4 Connect the device to the sensors

5 Connect the device to the actuators

6 Place the measurement clamp 5 cm (L1) from the device under test (see HELP 2)

7 Place the injection clamp 10 cm (L2) from the measurement clamp (see HELP 2)

8 Make sure that the axis of the wiring harness coincides with the axis of symmetry of the clamps

9 Stress the sensors through the fibre optic stimulus system

10 Connect the fibre optic acquisition instruments for monitoring the signals of the device

Date: . . . . . Violations: [YES] [NO]

Name of Test Technician: . . . . . .

Name of Engineer: . . . . . Signature: . . . . . .

VERIFICATION BY CALCULATION

To date, no tools exist within Electromagnetic Compatibility suitable for carrying out calculus checks.

TESTING

1 Set the device in one of the operating conditions given in point 1a of the previous paragraph

2 Operate the device

3 Check that the device is working properly, referring to points 1a, 1c and 1d of the previous paragraph

4 Start the automatic measurement bench management programme and set it to start measuring with the parameters given in paragraph 7.8 of the specification for electronic devices 9.90110.

Use the following frequency steps:

1 to 220 MHz	step 1 MHz
220 to 400 MHz	step 2.5 MHz

At each step, set a dwell time of at least 2 sec. at the test level, or enough time to check that the system under test is working properly

Should it be impossible to reach the required current rate for certain frequencies, inject the current corresponding to the amplifier output power of:

10 W	for test currents of 100 or 200 mA
25 W	for test currents of 300 mA

5 Start measurement

6 At each frequency check that the parameters listed under point 1c of the previous paragraph are within the tolerances specified under point 1d of the same paragraph

7 As faults occur, inform the computer of the fault using the procedures required by the programme

8 At the end of the test, print the susceptibility curve measured using the plotter

9 Attach the graph obtained in point 8 to this form, numbering it

10 Record the measurement data on a disk

11 Check the test results

Date: . . . . . Violations: [YES] [NO]

Name of Test Technician: . . . . . .

Name of Engineer: . . . . . Signature: . . . . . .

DATA PROCESSING

SPACE FOR ANY GRAPHS, TABLES, DIAGRAMS, ETC.

TEST OBJECT/BENCH RESTORING ACTIVITY

1 End execution of the measurement programme and switch off the power

2 Disconnect the injection and measurement clamps

3 Disconnect the power supply to the device under test

4 Disconnect the stimulus and monitoring instrumentation

5 Disconnect the wiring of the control unit tested

6 Restore any connections altered in order to perform the tests.

7 Prepare the bench ready to be used for a new test.

Date: . . . . . Violations: [YES] [NO]

Name of Test Technician: . . . . . .

Name of Engineer: . . . . . Signature: . . . . . .

HELP 1

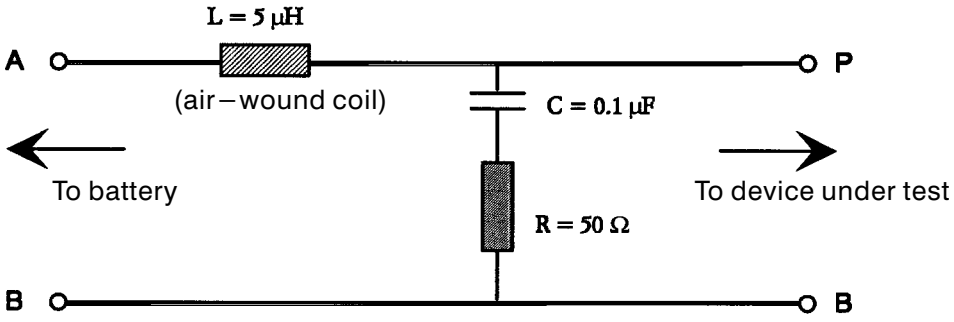


FIG. 1A: LINE IMPEDANCE STABILISER NETWORK (L.I.S.N.) LAYOUT

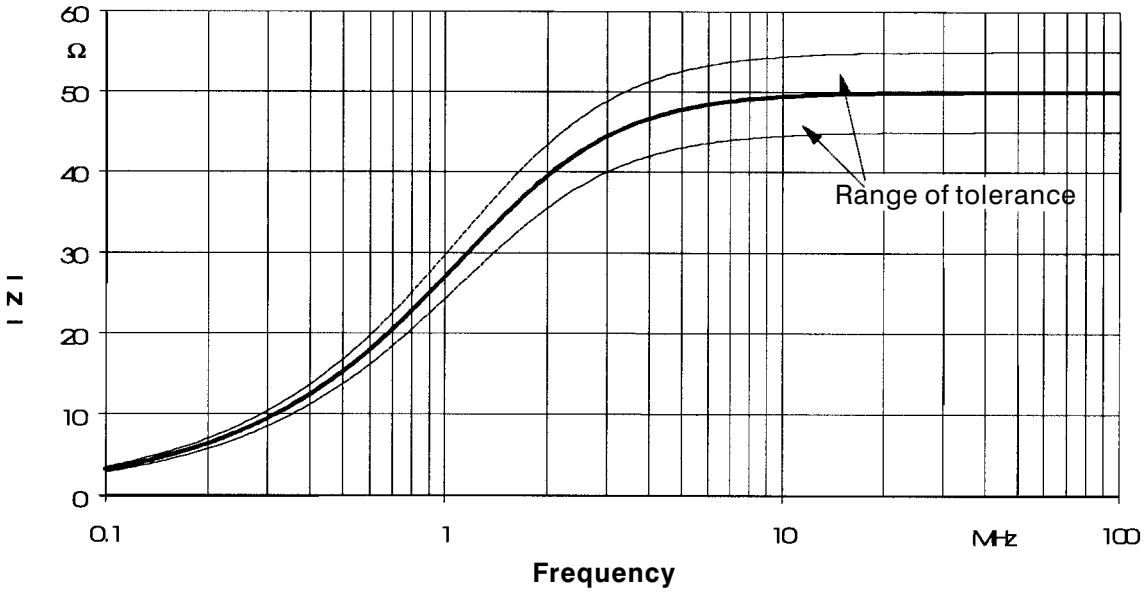
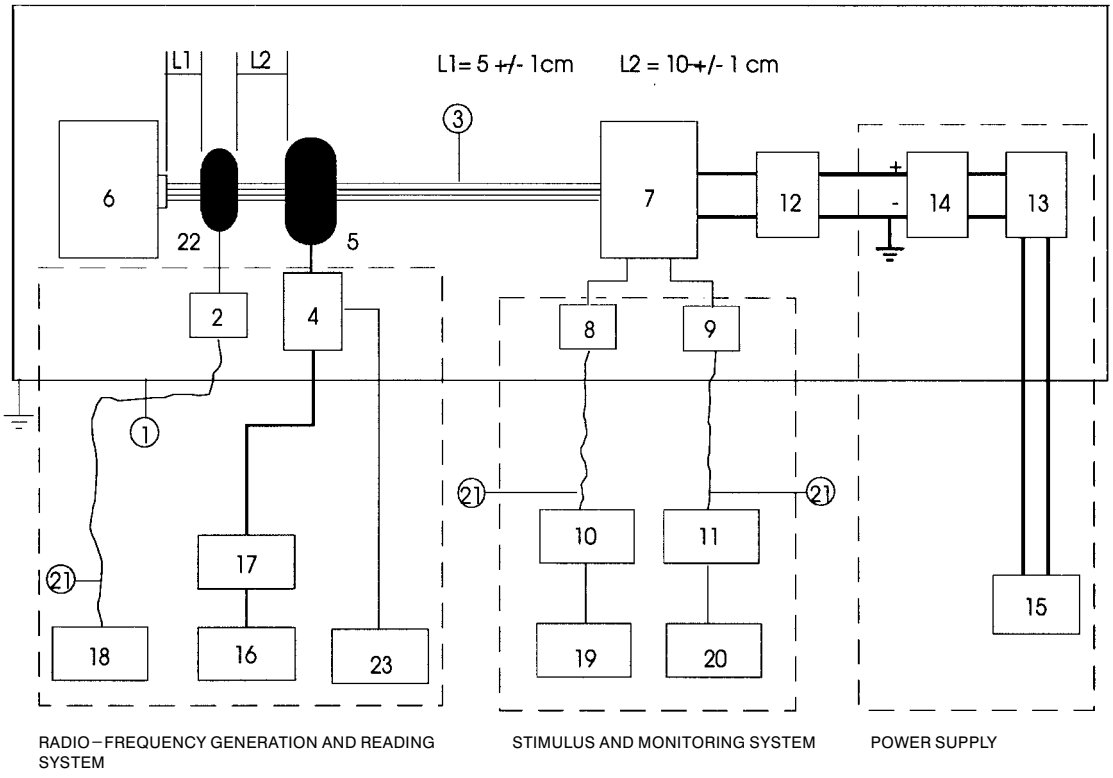


FIG. 1B: IMPEDANCE MODULUS OF LINE IMPEDANCE STABILISER NETWORK (L.I.S.N.)

HELP 2

TEST BENCH BLOCK DIAGRAM



1) metal earth plate
2) electric–optic radio–frequency current transmitter
3) cable harness
4) directional coupler
5) radio–frequency current injection clamp
6) device under test
7) sensors and actuators of device under test
8) remote electric–optic transmission signal measurement unit
9) remote optic–electric reception/signal injection unit
10) Base optic–electric reception unit
11) base optic–electric transmission unit
12) line impedance stabiliser network (L.I.S.N.)
13) radio–frequency filter
14) battery
15) stabilised power supply
16) signal generator
17) radio–frequency power amplifier
18) optic–electric radio–frequency current receiver
19) system serviceability status monitoring instruments
20) stimulus signal generation instruments
21) fibre optics
22) radio–frequency current measurement clamp
23) radio–frequency wattmeter