INTERNATIONAL STANDARD

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Road vehicles — Electrical disturbances by narrowband radiated electromagnetic energy — Vehicle test methods —

Part 4:
Bulk current injection (BCI)

Véhicules routiers — Perturbations électriques par rayonnement d'énergie électromagnétique en bande étroite — Méthodes d'essai du véhicule —

Partie 4: Méthode d'injection de courant (BCI)

Reference number
ISO 11451-4:1995(E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 11451-4 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

ISO 11451 consists of the following parts, under the general title *Road vehicles — Electrical disturbances by narrowband radiated electromagnetic energy — Vehicle test methods*:

— *Part 1: General and definitions*

— *Part 2: Off-vehicle radiation source*

— *Part 3: On-board transmitter simulation*

— *Part 4: Bulk current injection (BCI)*

Annexes A and B form an integral part of this part of ISO 11451. Annex C is for information only.

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Road vehicles — Electrical disturbances by narrowband radiated electromagnetic energy — Vehicle test methods —

Part 4:
Bulk current injection (BCI)

1 Scope

This part of ISO 11451 specifies bulk current injection (BCI) test methods and procedures for testing the electromagnetic immunity of electronic components for passenger cars and commercial vehicles regardless of the propulsion system (e.g. spark-ignition engine, diesel engine, electric motor). The electromagnetic disturbance considered in this part of ISO 11451 is limited to continuous narrowband electromagnetic fields.

Part 1 of ISO 11451 gives definitions, practical use and basic principles of the test procedure.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this part of ISO 11451. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this part of ISO 11451 are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 11451-1:1995, *Road vehicles — Electrical disturbances by narrowband radiated electromagnetic energy — Vehicle test methods — Part 1: General and definitions.*

3 Test conditions

3.1 Test temperature and supply voltage

Heat is generated in the test chamber when the vehicle is operated during the test. Sufficient cooling shall be provided to ensure that the engine does not overheat.

The ambient temperature in the test chamber shall be recorded if it is outside the range of (23 ± 5) °C.

For tests that require the vehicle engine to be running, the electrical charging system shall be functional. For tests where the vehicle engine is not required to be running, the battery voltage shall be maintained above 12,2 V and 24,4 V for 12 V and 24 V systems respectively.

3.2 Frequency range

To test automotive electronic systems, the applicable frequency range of the bulk current injection (BCI) test method is 1 MHz to 400 MHz.

The frequency range of the BCI test method is a direct function of the current probe characteristic. More than one type of current probe may be required.

3.3 Modulation

The device under test determines the type and frequency of modulation. If no values are agreed be-

tween the users of this part of ISO 11451, the following shall be used:

— no modulation (CW);

— 1 kHz sine-wave amplitude modulation (AM) of 80 %.

3.4 Dwell time

At each frequency, the device under test shall be exposed to the test level for the minimum response time needed to control it. In all cases, this minimum time of exposure shall not be less than 2 s.

3.5 Frequency steps

All tests in this part of ISO 11451 shall be conducted with frequency step sizes not greater than those specified in table 1.

Table 1 — Frequency step sizes

Frequency band MHz	Maximum frequency step size MHz
>1 to ⩽10	1
>10 to ⩽200	2
>200 to ⩽400	20

Alternatively, logarithmic frequency steps, with the same minimum number of frequency steps in each frequency band, may be used. The values as agreed by the users of this part of ISO 11451 shall be documented in the test report.

If it appears that the susceptibility thresholds of the device under test are very near the chosen test level, these frequency step sizes should be reduced in the frequency range concerned in order to find the minimum susceptibility thresholds.

3.6 Test severity levels

The user should specify the test severity level(s) over the frequency bands. Suggested test severity levels are given in annex C.

These test severity levels are expressed in terms of the equivalent root-mean-square value of the unmodulated wave.

4 Test instrument description and specification

4.1 BCI system

BCI is a method of carrying out immunity tests by inducing disturbance signals directly into the wiring harness by means of a current injection probe. The injection probe is a current transformer through which the wires of the device under test are passed. Immunity tests are then carried out by varying the test severity level and frequency of the induced disturbance.

BCI shall be conducted on each individual system fitted to the vehicle.

4.2 Instrumentation

Figure 1 shows an example of a BCI test configuration.

An injection probe or set of probes capable of operating over the test frequency range is required to interface the test equipment to the device under test. The probe shall be capable of withstanding a continuous input power over the test frequency range regardless of the system loading.

The monitoring probe or set of probes shall be capable of operating over the test frequency range. The monitoring probe(s) shall be terminated in the load impedance at which they were calibrated.

4.3 Test set-up

The vehicle should be tested as built; no additional grounding connections are allowed. Tests should be performed inside a shielded room.

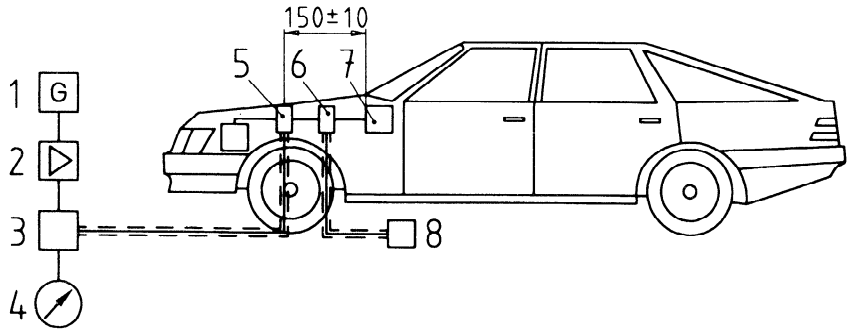
The distance between the vehicle and all other conductive structures, such as the walls of a shielded room (with the exception of the ground plane underneath the vehicle) shall be a minimum of 0,5 m.

5 Test procedure

5.1 Test plan

Prior to performing the tests, a test plan shall be prepared; it shall include interface test points, mode of operation for the device under test, acceptance criteria for the device under test, and any special instructions and changes from the standard test. Each device under test shall be verified under the most

Dimensions in millimetres



Key

1 Signal generator
2 Broadband amplifier
3 RF 50 Ω directional coupler
4 RF power level measuring device or equivalent
5 RF injection probe
6 RF monitoring probe (required for current monitoring probe method, optional for calibrated injection probe method)
7 Device under test
8 Spectrum analyser or equivalent (required for current monitoring probe method, optional for calibrated injection probe method)

Figure 1 — Example of BCI test configuration

significant conditions, i.e. at least in stand-by mode and in a mode where all the actuators can be excited.

5.2 Test methods

CAUTION — Hazardous voltages and fields may exist within the test area. Take care to ensure that the requirements for limiting the exposure of humans to RF energy are met.

There are two test methods for the BCI test: the calibrated injection probe method and the current monitoring probe method (see 5.2.1 and 5.2.2 respectively).

For both tests, the test euipment shall be connected in a similar manner to that shown in figure 1.

5.2.1 Calibrated injection probe method

This method is based upon the use of net power as the reference parameter for calibration and test.

In this method, the specific test level (current, voltage or power) shall be calibrated prior to the actual testing.

The test with the device under test is then conducted by subjecting it to the test signals based on the calibrated values as predetermined in the test plan.

Measurements using this method can be affected by coupling between the injection probe and the wiring harness as well as by reflected energy. During the test, the net power shall be maintained relative to the calibration point up to a limit of 2 dB increase in forward power. If the forward power has to be increased by 2 dB or more, this shall be indicated in the test report.

NOTE 1 If the standing wave ratio (SWR) in the test system can be demonstrated to be less than 1,2:1, then forward power may be used as the reference parameter to establish the test level.

Mount the current injection probe around the harness (150 ± 10) mm from the connector or the outlet aperture of the device under test being tested on the vehicle.

Where the harness contains a number of branches to a device under test, the test should be repeated with the current probe(s) clamped around each of the branches (150 ± 10) mm from the branch termination. Under these test conditions, the measuring probe, if used, shall be left at its previous distance from the device under test.

Using either the pre-calibrated level of net power (see annex A) or a relatively high level of fixed net power, conduct a search for events over the frequency range of the injection probe.

For each event, record the lowest net power to the probe as the threshold of immunity even if this is

found with the injection probe in different positions at different frequencies.

A current monitoring probe may optionally be mounted between the current injection probe and the device under test. It may provide extra useful information but it may also modify the test conditions. Where this probe is used, the measured current cannot be used to determine the performance of the device under test, but should be retained and used during investigative work for the causes of events and the variances in test conditions after system modifications.

5.2.2 Current monitoring probe method

The RF power to the current injection probe shall be increased until

— the predetermined maximum test current level, measured using the monitoring probe, is reached, or,

— the maximum net power (defined in the test plan) to the injection probe is achieved.

The current monitoring probe shall be calibrated using the method in annex B.

Record the threshold of susceptibility as a function of frequency.

5.3 Test report

When required in the test plan, a test report shall be submitted detailing information regarding the test equipment, test site, systems tested, frequencies, power levels, system interactions and any other relevant information regarding the test.

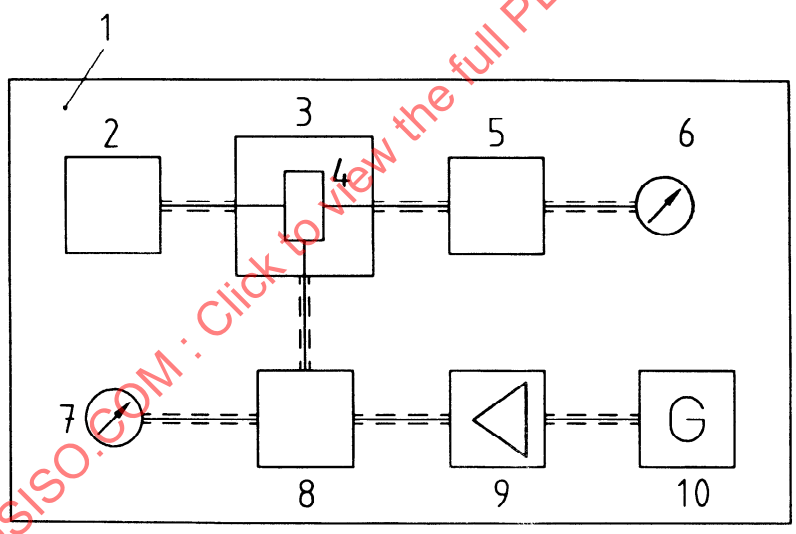
Annex A
(normative)

Current injection probe calibration method

To determine the injected current flowing, the net power measurement across a calibration fixture is used. Figure A.1 shows an example of a test equipment configuration for the current injection probe calibration.

Mount the current injection probe centred in the calibration fixture (see figure A.2) and, while sweeping the test frequency range, monitor the net power required to achieve the current at which testing is to be conducted.

As an alternative method, once testing of the system is complete, and all data has been recorded, mount the current injection probe in the calibration fixture. At each frequency showing an event, the recorded net power levels are applied to the probe. The currents then observed in the calibration fixture are those at which events within the system occurred.

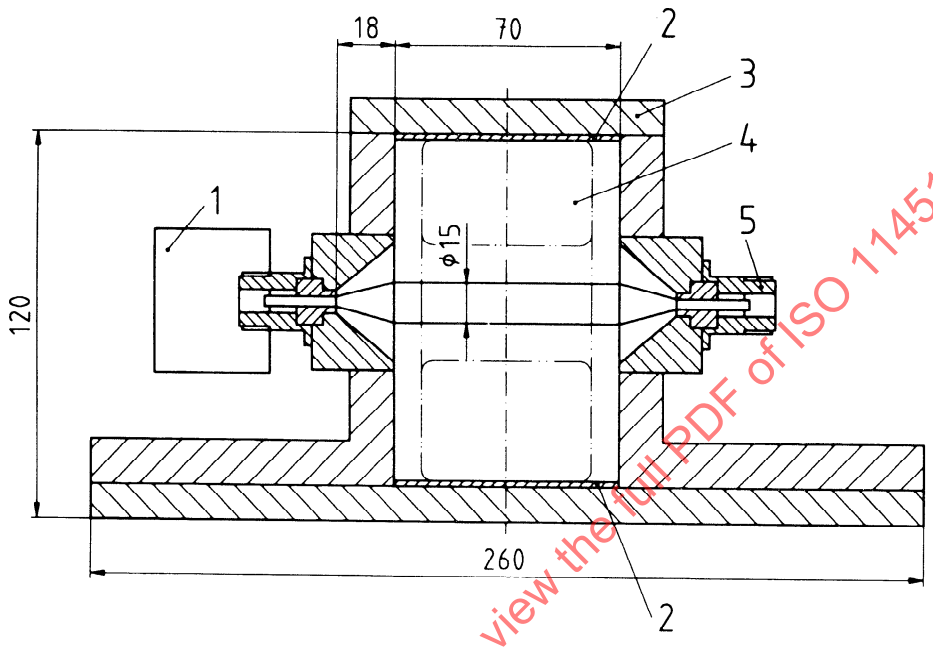


Key

1 Shielded enclosure
2 50 Ω coaxial load, SWR 1,2 : 1 max.
3 Calibration fixture
4 Current injection probe 50 Ω
5 50 Ω attenuator
6 Spectrum analyser or equivalent
7 RF power level measuring device or equivalent
8 RF 50 Ω directional decoupler (with 30 dB minimum decoupling coefficient)
9 Broadband amplifier with 50 Ω output impedance
10 RF signal generator

Figure A.1 — Example of current injection probe calibration configuration

Dimensions in millimetres



Key

1 50 Ω load
2 Insulation
3 Detachable metallic cover plate
4 Current injection probe
5 Connected directly to 50 Ω receiver

Figure A.2 — Current injection probe calibration fixture

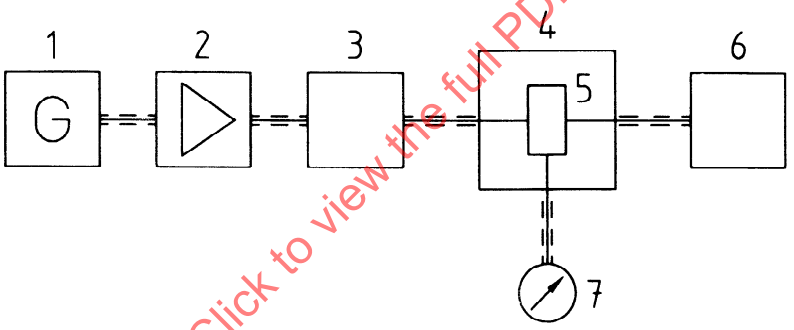
Annex B
(normative)

Current monitoring probe calibration method

Mount the monitor probe in the proper size calibration fixture with the probe concentric about the centre conductor of the fixture: see figure B.1.

Record the output of the monitor probe as a function of frequency while maintaining a constant RF calibration signal power.

Based on a known termination impedance, the output voltage versus input current can be determined.



Key
1 RF signal generator
2 Broadband amplifier with 50 Ω output impedance
3 Directional coupler with power meters
4 Calibration fixture
5 Monitor probe being calibrated
6 RF termination 50 Ω
7 Spectrum analyser or equivalent

Figure B.1 — Example of current monitoring probe calibration configuration

Annex C
(informative)

Function performance status classification (FPSC)

NOTE 2 A detailed explanation of the application of function performance status classification is given in ISO 11451-1:1995, annex A.

Table C.1 — Suggested test severity levels

Test severity level	Value mA
I	25
II	50
III	75
IV	100
V	Specific value agreed between the users of this part of ISO 11451 if necessary

Table C.2 — Frequency bands

Frequency band	Frequency range MHz
F1	>1 to ⩽10
F2	>10 to ⩽30
F3	>30 to ⩽80
F4	>80 to ⩽200
F5	>200 to ⩽400