INTERNATIONAL STANDARD

ISO 11452-4

First edition
1995-12-01

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

Part 4:
Bulk current injection (BCI)

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

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

Reference number
ISO 11452-4:1995(E)

Contents

International Organization for Standardization
Case Postale 56 • CH-1211 Genève 20 • Switzerland
Printed in Switzerland

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 11452-4 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

ISO 11452 consists of the following parts, under the general title *Road vehicles — Electrical disturbances by narrowband radiated electromagnetic energy — Component test methods*:

— *Part 1: General and definitions*

— *Part 2: Absorber-lined chamber*

— *Part 3: Transverse electromagnetic mode (TEM) cell*

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

— *Part 5: Stripline*

— *Part 6: Parallel plate antenna*

— *Part 7: Direct radio frequency (RF) power injection*

Annexes A and B form an integral part of this part of ISO 11452. Annex C is for information only.

This page intentionally left blank

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

Part 4:
Bulk current injection (BCI)

1 Scope

This part of ISO 11452 specifies bulk current injection (BCI) tests for the electromagnetic immunity of electronic components of 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 11452 is limited to continuous narrowband electromagnetic fields.

Immunity measurements of complete vehicles are generally only possible by the vehicle manufacturer, because, for example, of the high costs of an absorber-lined chamber, preserving the secrecy of prototypes or the large number of different vehicle models. Therefore, for research, development and quality control, a laboratory measuring method is used by the manufacturer.

ISO 11452-1 specifies general test methods, definitions, practical use and basic principles of the test procedure.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 11452. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 11452 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 7637-1:1990, *Road vehicles — Electrical disturbance by conduction and coupling — Part 1: Passenger cars and light commercial vehicles with nominal 12 V supply voltage — Electrical transient conduction along supply lines only.*

ISO 7637-2:1990, *Road vehicles — Electrical disturbance by conduction and coupling — Part 2: Commercial vehicles with nominal 24 V supply voltage — Electrical transient conduction along supply lines only.*

ISO 11452-1:1995, *Road vehicles — Electrical disturbances by narrowband radiated electromagnetic energy — Component test methods — Part 1: General and definitions.*

3 Test conditions

3.1 Test temperature and supply voltage

The ambient temperature during the test shall be (23 ± 5) °C.

The supply voltage during the test shall be (13,5 ± 0,5) V for 12 V electrical systems and (27 ± 1) V for 24 V electrical systems.

If other values are agreed by the users of this part of ISO 11452, the values shall be documented in the test report.

3.2 Frequency range

To test automotive electronic systems, the applicable frequency range of the 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 test determines the type and frequency of modulation. If no values are agreed between the users of this part of ISO 11452, 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 step sizes

All tests in this part of ISO 11452 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 11452, 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 to find the minimum susceptibility thresholds.

3.6 Test severity levels

The user should specify the test severity level(s) over the frequency range. Suggested severity levels are included 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

Bulk current injection 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 carried out by varying the test severity level and frequency of the induced disturbance.

4.2 Instrumentation

Figure 1 shows an example of a set-up of the BCI measurement system.

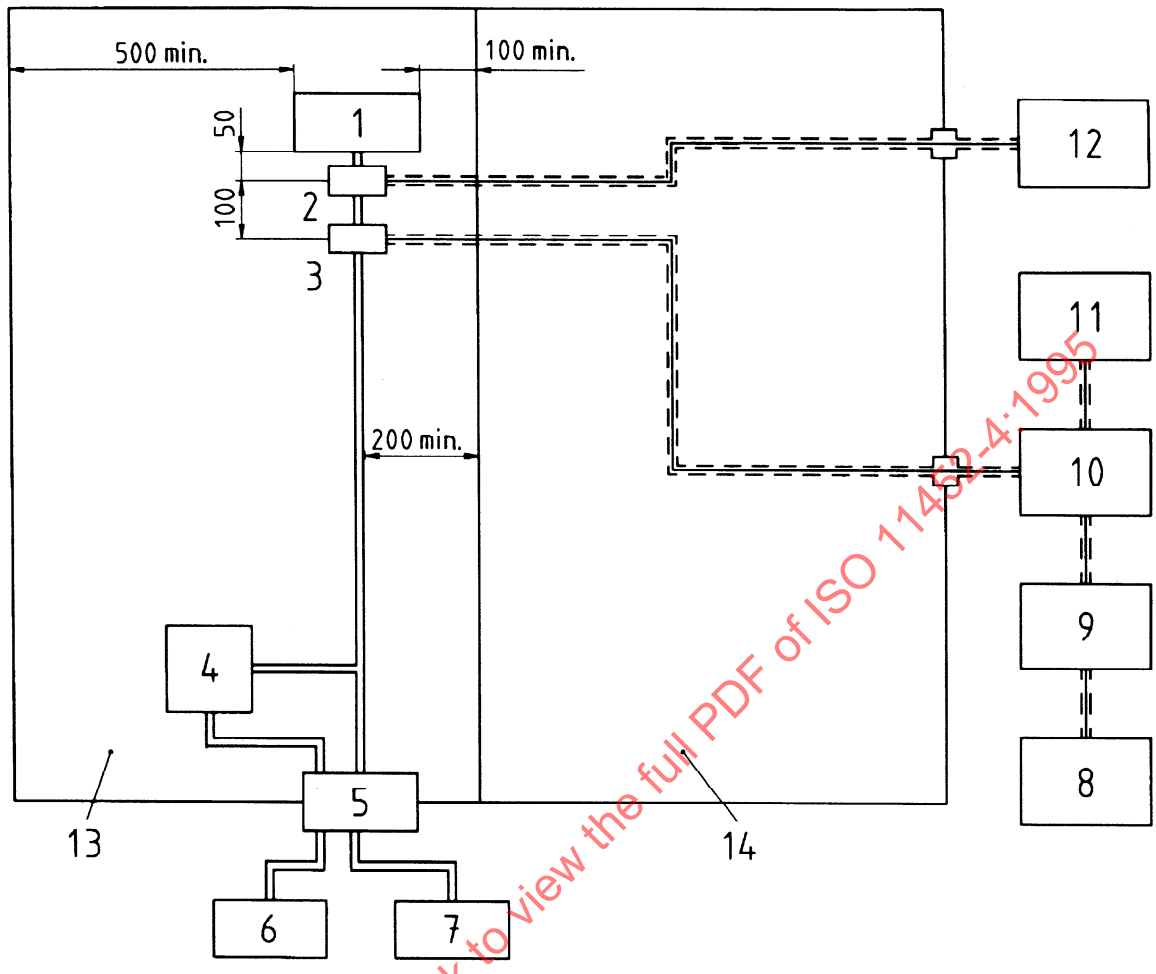
If a regulated power supply is used, then an artificial network (AN) should be used in the supply lines to the device under test to define the RF impedance. This network is specified in ISO 7637-1 and ISO 7637-2.

When a battery is used, a charging source is required to achieve the specified test voltage.

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 terminate in the load impedance at which it was calibrated.

Dimensions in millimetres



Key

1 Device under test
2 RF monitoring probe (required for current monitoring probe method, optional for calibrated injection probe method)
3 RF injection probe
4 Artificial network
5 Shielded room filter network
6 Power source
7 Interface (stimulation and monitoring equipment for the device under test)
8 Signal generator
9 Broadband amplifier
10 RF 50 Ω directional coupler
11 RF power level measuring device or equivalent
12 Spectrum analyser or equivalent (required for current monitoring probe method, optional for calibrated injection probe method)
13 Ground plane
14 Shielded enclosure

Figure 1 — Example of BCI test configuration

4.3 Test set-up

The device under test shall be connected to the ground plane according to the manufacturer's installation specifications; no additional grounding connections are allowed.

If no specific requirements are made, the device under test and its associated harness shall be placed on a ground plane and shall be insulated from it by an insulating support of ($50\ ^{+10}_{0}$) mm thickness. The harness shall pass concentrically through the centre of the current injection probe.

The ground plane shall be constructed from copper, brass or galvanized steel.

The minimum thickness of the metal ground plane is 0,5 mm. Its area is 2,25 m^2 or larger, with the smaller side not less than 0,75 m.

The ground plane shall be bonded to the chamber with bonding straps such that the DC bonding resistance does not exceed 2,5 mΩ. In addition, the bond straps shall be placed at distances no greater than 0,9 m apart. The minimum size of the ground plane depends upon the size of the system under test and shall allow for complete harness and system component placement.

The device under test shall be arranged and connected according to its requirements. The distance between the device under test and all other conductive structures, such as walls of a shielded room (with the exception of the ground plane underneath the device under test) shall be a minimum of 0,5 m.

All individual units shall be connected to the ground plane as intended. When the device under test is connected to the vehicle chassis and is thereby in contact with the negative polarity of the power supply by its metal casing, this condition shall be reproduced in the test.

If the negative terminal of the battery is connected to the device under test, this line shall be included in the coupling harness.

Unless otherwise specified, a 1 m long test harness shall be used. All wires of the harness shall be terminated. When possible the actual loads and actuators shall be used.

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 significant situations, 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 (substitution) and the current monitoring probe method (closed-loop).

For both tests, the test equipment shall be connected as 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 used 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.

Where the harness contains a number of branches, 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 or a relatively high level of fixed net power (see annex A), a search for events shall be conducted over the frequency range of the injection probe.

For each event, the lowest net power to the probe shall be recorded 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 be mounted between the current injection probe and the device under test.

The use of a current monitoring probe is optional: 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 injection probe shall be increased until

— the predetermined maximum test current level is reached (this induced current is measured using the monitor probe); or

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

The monitor probe shall be calibrated using the annex B method.

Record the threshold of susceptibility as a function of frequency.

5.3 Test report

When required in the test plan, a test report should 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.

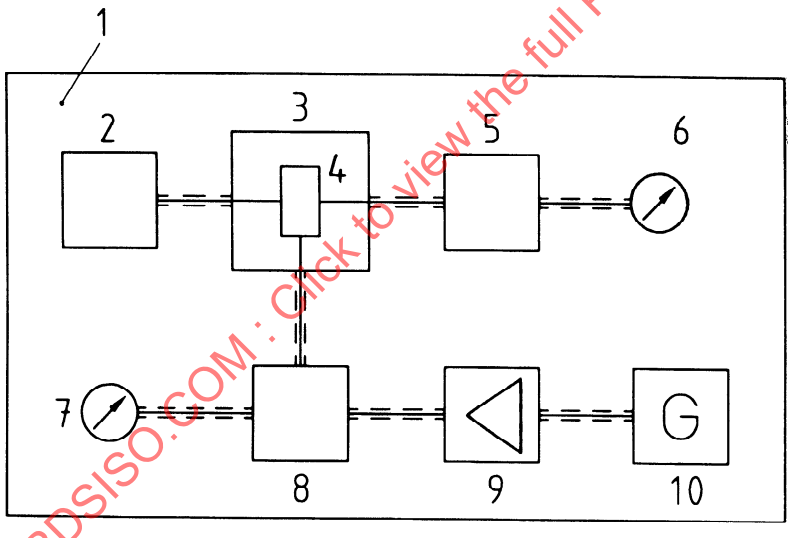
Annex A
(normative)

Current injection probe calibration procedure

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 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 have 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.

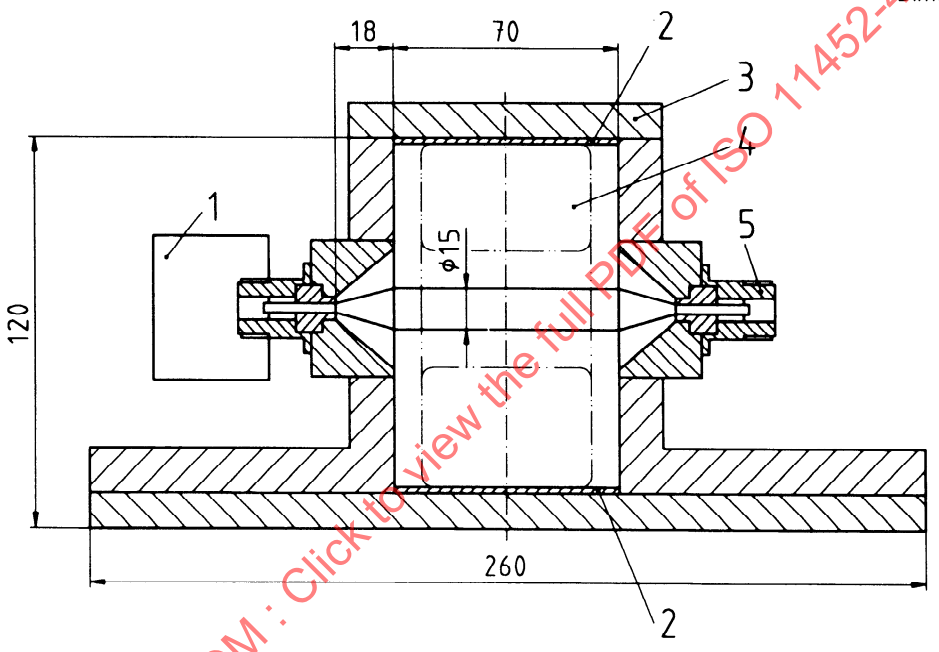


Key

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 coupler (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

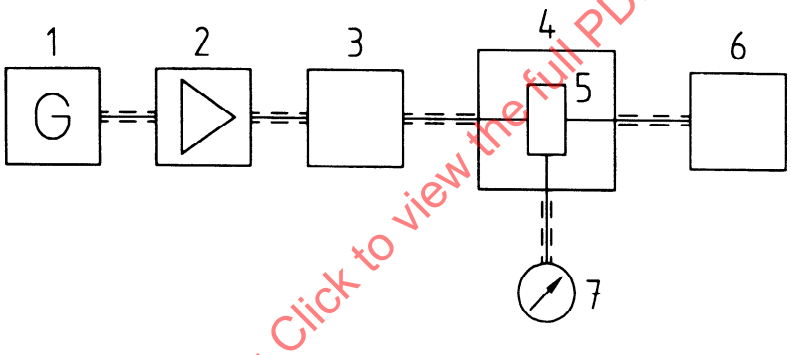
Annex B
(normative)

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