INTERNATIONAL ELECTROTECHNICAL COMMISSION

CISPR 16-1-2

2003

AMENDMENT 1
2004-04

INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

Amendment 1

Specification for radio disturbance and immunity measuring apparatus and methods –

Part 1-2: Radio disturbance and immunity measuring apparatus – Ancillary equipment – Conducted disturbances

*This **English-language** version is derived from the original **bilingual** publication by leaving out all French-language pages. Missing page numbers correspond to the French-language pages.*

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FOREWORD

This amendment has been prepared by CISPR subcommittee A: Radio-interference measurements and statistical methods.

The text of this amendment is based on the following documents:

FDIS	Report on voting
CIS/A/503/FDIS	CIS/A/521/RVD

Full information on the voting for the approval of this amendment can be found in the report on voting indicated in the above table.

The committee has decided that the contents of the base publication and its amendments will remain unchanged until 2006. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

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5.2 Voltage probe

Add the title of new subclause 5.2.1 as follows:

5.2.1 High impedance voltage probe

Insert, immediately after the title of new subclause 5.2.1, the existing text of subclause 5.2.

Add the following new subclause:

5.2.2 Capacitive voltage probe

The asymmetrical disturbance voltages of cables can be measured without making direct conductive contact with the source conductor and without modification of its circuit by the use of a clamp-on capacitive coupling device. The usefulness of this method is self-evident; complex wiring systems, electronic circuits, etc. may be measured without interruption of the normal operation or configuration of the EUT or the need to cut the cable to insert a measuring device. The capacitive voltage probe is constructed so that it may be conveniently clamped around the conductor to be measured.

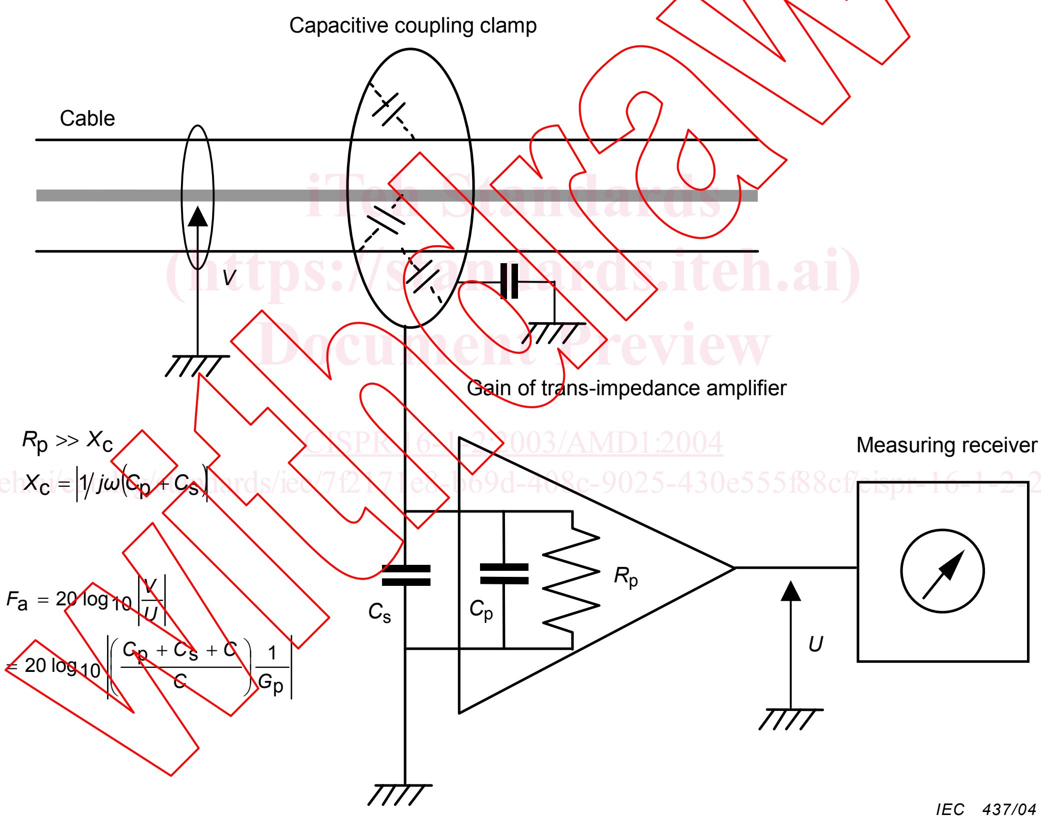
The capacitive voltage probe is used for measurements of conducted disturbances in the frequency range 150 kHz to 30 MHz with an almost flat frequency response in the frequency range of interest. The voltage division factor, which is defined as the ratio of the disturbance voltage on the cable to the input voltage at the measuring receiver, depends on the type of cable. This parameter should be calibrated over a specified frequency range for each cable type, using the method described in Annex G.

The capacitive voltage probe may need additional shielding to provide sufficient isolation from the asymmetrical (common mode) signal around the cable (see "Influence of electric field" in 5.2.2.2). Annex G contains an example of the construction and a method of measurement for the isolation.

This capacitive voltage probe can be used to measure the disturbances at telecommunication ports. The minimum measurable level is typically up to 44 dB(μV).

5.2.2.1 Construction

The capacitive voltage probe shall be constructed so as to enable the measurement of the voltage without disconnecting the cable under measurement. Figure 11 shows a circuit that is used to make voltage measurements between a cable and a reference ground. The probe consists of a capacitive coupling clamp which is connected to a trans-impedance amplifier. The input resistance R_p of this amplifier shall be large enough compared to the reactance X_c to obtain a flat frequency response.



Key

G_p Gain of trans-impedance amplifier
C Capacitance between the cable and the clamp
C_s Capacitance between probe and ground
C_p Capacitance of trans-impedance amplifier
R_p Resistance of trans-impedance amplifier
V Disturbance voltage
U Voltage at the input of the measuring receiver

Figure 11 – Circuit used to make voltage measurement between a cable and a reference ground

Annex G provides instructions for the typical construction and verification of the capacitive voltage probe.

5.2.2.2 Requirements

Added shunt capacitance:	Less than 10 pF between the grounding terminal of capacitive voltage probe and the cable under test.
Frequency response:	Voltage division factor, $F_a = 20 \log_{10}\lvert V/U\rvert$ in dB (see Figure 11), is calibrated over a specified frequency range.
Pulse response:	Maintain linearity for the pulse determined by the method in Annexes B and C of CISPR 16-1-1 for band B.
Influence of electric field: (influence caused by electrostatic coupling with other cables near the probe)	The voltage indication is reduced by more than 20 dB when a cable is removed from the capacitive voltage probe. The measurement method is described in Annex G.
Capacitive voltage probe aperture or opening: (aperture when the two coaxial electrodes open at the slot (see Figure G.1))	At least 30 mm

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Figure 6 – Circuit for RF voltage measurement on supply mains

Change the existing title of Figure 6 to read as follows:

Figure 6 – Circuit for RF voltage measurement on supply mains (see 5.2.1)

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Add, after Annex F, the new Annex G as follows:

Annex G
(informative)

Construction and evaluation of capacitive voltage probe (subclause 5.2.2)

G.0 Introduction

This annex provides an example of a method for the calibration of the capacitive voltage probe (CVP). Other calibration methods can be used if their uncertainty is considered to be equivalent to that of the method shown in this annex.

G.1 Physical and electrical considerations for capacitive voltage probe

Figure G.1 shows the configuration of a capacitive voltage probe. It is made up of two coaxial electrodes, a grounding terminal, a cable fixture, and a trans-impedance amplifier. The outer electrode is used as an electrostatic shield to reduce the measurement error caused by electrostatic coupling from cables running alongside.

The equivalent circuit of the probe is shown in Figure G.2. When a voltage exists between the cable and the ground, an induced voltage occurs between the inner electrode and the outer electrode as a result of electrostatic induction. This voltage is detected by a high impedance input amplifier and converted to low impedance by a trans-impedance amplifier. The output is measured by a measuring receiver.

G.2 Determination of the frequency response of the voltage division factor

Figure G.3 shows the test set-up used to determine the frequency response of the capacitive voltage probe. The probe is verified according to the following procedures.

a) Prepare the same type of cable which is used with the equipment under test (EUT).

   NOTE If several types of cable are used with the probe, a representative variety of cable types shall be used in the calibration and the spread of results determined. The voltage division factor (F_a) can be estimated by using equation (G.3), however, it is recommended to measure the F_a for each cable.

b) Place the calibration fixture on the reference ground plane, as shown in Figure G.3.

c) Connect both ends of the cable to the inner ports of the calibration fixture (port-1, port-2) (see Figure G.3).

d) Place the probe in the calibration unit and adjust the position of the cable to pass through the centre.

   Caution: If the end of plates of the calibration fixture are too close to the ends of the voltage probe, the stray capacitance is increased, which can adversely affect the calibration at higher frequencies. If the end plates of the calibration fixture get too far from the ends of the voltage probe, a standing wave may be formed within the calibration fixture at higher frequencies. These standing waves can adversely affect the calibration.

e) Connect the grounding port of the probe to the inner grounding port of the calibration fixture. Connect the outer grounding port of the calibration fixture to the reference ground plane. The grounding strip should have low inductance, be as short as possible and kept away from the voltage probe aperture.

f) Connect a signal generator, with an output impedance of 50 Ω, to the outer port of the port-1 through a 10 dB attenuator.

g) Connect a level meter, with an input impedance of 50 Ω, to the outer port of port-2 and terminate the output port of the probe in 50 Ω. Measure the level V over a specified frequency range.

h) Connect the level meter to the output port of the probe and terminate the outer port of the port-2 by 50 Ω. Measure the level U over a specified frequency range.

i) Calculate the voltage division factor $F_a = 20 \log_{10}|V/U|$ in dB from the measured values.

G.3 Method of measurement to determine the influence of external electric fields

G.3.1 Influence of external electric field

The influence of the external electric field appears via electrostatic coupling with other cables close to the probe. Figure G.4 shows the electrostatic coupling models and their equivalent circuits. Both the common-mode voltage V_x on cable #2 and the voltage V on cable #1 appear at the input terminal of the high impedance voltage probe through the capacitance C_x and C as shown in Figure G.4 (a). An electrostatic shield shall be used to reduce the coupling due to C_x. However, the influence of the external electric field due to the electrostatic coupling between the outer electrode and other cable (C_x') still remains because of the imperfection of the electrostatic shield, as shown in Figure G.4 (b). Subclause G.3.2 shows the measurement procedure for evaluating the influence of the electrostatic coupling between outer electrode and other cable. Furthermore, it should be noted that the voltage V is affected by the V_x unless $|Z_s| << |1/(j\omega C_c)|$.

G.3.2 Method of measurement to determine the influence of the external electric field

The influence of an external electric field caused by electrostatic coupling due to limited electrostatic shielding is measured using the test set-up shown in Figure G.5. The measurement procedure is as follows;

a) Measure the voltage division factor, $F_a = 20 \log_{10}|V/U|$, using the method in Clause G.2.

b) Place the capacitive voltage probe beside the cable, at a distance "*s*" equal to 1 cm (see Figure G.5).

c) Connect the grounding port of the probe to the inner grounding port of the unit. Connect the outer grounding port of the unit to the reference ground plane.

d) Connect a signal generator with a 50 Ω output impedance to the outer port of the port-1 through a 10 dB attenuator.

e) Connect a measuring receiver with a 50 Ω input impedance to the outer port of the port-2 and terminate the output port of the probe by 50 Ω. Measure the level V_s over a specified frequency range.

f) Connect the measuring receiver to the output port of the probe and terminate the outer port of the port-2 by 50 Ω. Measure the level U_s over a specified frequency range.

g) The reduction of the influence is defined as $F_s = F_a/(V_s/U_s)$ from the measured values.