

INTERNATIONAL STANDARD

NORME INTERNATIONALE

INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE
COMITÉ INTERNATIONAL SPÉCIAL DES PERTURBATIONS RADIOÉLECTRIQUES

BASIC EMC PUBLICATION
PUBLICATION FONDAMENTALE EN CEM

AMENDMENT 2
AMENDEMENT 2

**Specification for radio disturbance and immunity measuring apparatus and methods –
Part 2-3: Methods of measurement of disturbances and immunity – Radiated disturbance measurements**

**Spécifications des méthodes et des appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques –
Partie 2-3: Méthodes de mesure des perturbations et de l'immunité – Mesures des perturbations rayonnées**



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FOREWORD

This amendment has been prepared by subcommittee A: Radio-interference measurements and statistical methods, of IEC technical committee CISPR: International special committee on radio interference.

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

FDIS	Report on voting
CISPR/A/1054/FDIS	CISPR/A/1063/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 this amendment and the base publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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- withdrawn,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

3 Terms and definitions

Replace the existing title by the following new title:

3 Terms, definitions and abbreviations

Add, after the existing definition 3.26, added by Amendment 1, the following new terms and definitions:

3.27

highest internal frequency

highest frequency generated or used within the EUT or the highest frequency at which the EUT operates or tunes

3.28

module

part of an EUT that provides a function and may contain radio-frequency sources

3.29 Abbreviations¹

The following abbreviations, not already provided in 3.1 through 3.28, are used in this standard.

AM	Amplitude modulation
APD	Amplitude probability distribution
AV	Average
BB	Broadband
CW	Continuous wave
FFT	Fast-Fourier transform
FM	Frequency modulation
IF	Intermediate frequency
ISM	Industrial, scientific or medical
LPDA	Log-periodic dipole array
NB	Narrowband
NSA	Normalized site attenuation
PRF	Pulse repetition frequency
RBW	Resolution bandwidth
RF	Radio frequency
RGP	Reference ground plane
QP	Quasi-peak
TEM	Transverse electromagnetic
UFA	Uniform field area
VBW	Video bandwidth

6.2.2 Compliance (conformity assessment) testing

Replace, in the second existing paragraph of this subclause, “In the case of compliance measurement according to a limit” by “When evaluating compliance with a limit”.

Replace the last existing sentence of the second paragraph by the following new sentence:

Further guidance on measurement of disturbances in the presence of ambient emissions is provided in Annex A.

Delete the existing note of this subclause.

6.4 Operating conditions of the EUT

Replace the existing title by the following new title:

6.4 EUT arrangement and measurement conditions

¹ At the next maintenance, when a new edition is published, terms and definitions will be placed in a new subclause 3.1 and renumbered, and abbreviations will be re-located to a new subclause 3.2.

6.4.1 Normal load conditions

Replace the existing title and text of this subclause by the following new titles and new text:

6.4.1 General arrangement of the EUT

6.4.1.1 General

Where not specified in the product standard, the EUT shall be configured as described below.

The EUT shall be installed, arranged and operated in a manner consistent with typical applications. Where the manufacturer has specified or recommended an installation practice, that practice shall be used in the test arrangement, where possible. This arrangement shall be typical of normal installation practice. Interface cables, loads, and devices shall be connected to at least one of each type of interface port of the EUT and, where practical, each cable shall be terminated in a device typical of actual usage.

Where there are multiple interface ports of the same type, additional interconnecting cables, loads and devices may have to be added to the EUT depending upon the results of preliminary tests. Connecting a cable or wire to just one of that type of port may be sufficient. The actual number of additional cables or wires may be limited to the condition where the addition of another cable or wire does not significantly affect the emission level, i.e. varies less than 2 dB, provided that the EUT remains compliant. The rationale for the selection of the configuration and loading of ports shall be included in the test report.

Interconnecting cables should be of the type and length specified in the individual equipment requirements. If the length can be varied, the length shall be selected to produce maximum disturbance.

If shielded or special cables are used during the tests to achieve compliance, then a note shall be included in the instruction manual advising of the need to use such cables.

Excess lengths of cables shall be bundled at the approximate centre of the cable with the bundles 30 cm to 40 cm in length. If it is impractical to do so because of cable bulk or stiffness, the disposition of the excess cable shall be precisely noted in the test report.

The results of an evaluation of EUTs having one of each type of module can be applied to configurations having more than one of each of those modules. This is permissible because it has been found that disturbances from identical modules are generally not additive in practice. However the 2 dB criteria defined in this clause shall be applied.

Any set of results shall be accompanied by a complete description of the cable and equipment orientation so that results can be reproduced. If specific conditions of use are required to meet the limits, those conditions shall be specified and documented; for example cable length, cable type, shielding and grounding. These conditions shall be included in the instructions to the user.

Equipment that is populated with multiple modules (drawer, plug-in card, board, etc.) shall be tested with a mix and number representative of that used in a typical installation. The number of additional boards or plug-in cards of the same type may be limited to the condition where the addition of another board or plug-in card does not significantly affect the emission level, i.e. varies less than 2 dB, provided that the EUT remains compliant. The rationale used for selecting the number and type of modules shall be stated in the test report.

A system that consists of a number of separate units shall be configured to form a minimum representative configuration. The number and mix of units included in the test configuration shall be representative of that used in a typical installation. The rationale used for selecting units shall be stated in the test report.

At least one module of each type shall be operative in each equipment evaluated in an EUT. For a system EUT, at least one of each type of equipment that can be included in the possible system configuration shall be included in the EUT.

The EUT position relative to the RGP shall be equivalent to that occurring in use. Therefore, floor-standing equipment is placed on, but insulated from, a RGP, and tabletop equipment is placed on a non-conductive table.

Equipment designed for wall-mounted or ceiling mounted operation shall be tested as tabletop EUT. The orientation of the equipment shall be consistent with normal installation practice.

Combinations of the equipment types identified above shall also be arranged in a manner consistent with normal installation practice. Equipment designed for both tabletop and floor standing operation shall be tested as tabletop equipment unless the usual installation is floor standing, then that arrangement shall be used.

The ends of signal cables attached to the EUT that are not connected to another unit or auxiliary equipment shall be terminated using the correct terminating impedance defined in the product standard.

Cables or other connections to associated equipment located outside the test area shall drape to the floor, and then be routed to the place where they leave the test volume.

Auxiliary equipment shall be installed in accordance with normal installation practice. Where this means that the auxiliary equipment is located on the test site, it shall be arranged using the same conditions applicable for the EUT (e.g distance from ground plane and insulation from the ground plane if floor standing, and layout of cabling).

6.4.1.2 Tabletop arrangement

Equipment intended for tabletop use shall be placed on a non-conductive table. The size of the table will nominally be 1,5 m by 1,0 m, but may ultimately be dependent on the horizontal dimensions of the EUT.

All units forming the system under test (including the EUT, connected peripherals and auxiliary equipment or devices) shall be arranged according to normal use. Where not defined in the normal use, a nominal 0,1 m separation distance between the neighbouring units shall be defined for the test arrangement.

Intra-unit cables shall be draped over the back of the table. If a cable hangs closer than 0,4 m to the horizontal ground plane (or floor), the excess shall be folded at the cable centre into a bundle no longer than 0,4 m, such that the bundle is at least 0,4 m above the horizontal RGP.

Cables shall be positioned as for normal usage.

If the mains port input cable is less than 0,8 m long, (including power supplies integrated in the mains plug) an extension cable shall be used such that the external power supply unit is placed on the tabletop. The extension cable shall have characteristics similar to the mains cable (including the number of conductors and the presence of a ground connection). The extension cable shall be treated as part of the mains cable.

In the above arrangements, the cable between the EUT and the power accessory shall be arranged on the tabletop in the same manner as other cables connecting components of the EUT.

6.4.1.3 Floor-standing arrangement

The EUT shall be placed on the horizontal RGP, orientated for normal use, but separated from metallic contact with the RGP by up to 15 cm of insulation.

The cables shall be insulated (by up to 15 cm) from the horizontal RGP. If the equipment requires a dedicated ground connection, then this shall be provided and bonded to the horizontal ground plane.

Intra-unit cables (between units forming the EUT or between the EUT and auxiliary equipment) shall drape to, but remain insulated from, the horizontal RGP. Any excess shall either be folded at the cable centre into a bundle no longer than 0,4 m or arranged in a serpentine fashion. If an intra-unit cable length is not long enough to drape to the horizontal RGP but drapes closer than 0,4 m, then the excess shall be folded at the cable centre into a bundle no longer than 0,4 m. The bundle shall be positioned such that it is either 0,4 m above the horizontal RGP or at the height of the cable entry or connection point if this is within 0,4 m of the horizontal RGP.

For equipment with a vertical cable riser, the number of risers shall be typical of installation practice. Where the riser is made of non-conductive material, a minimum spacing of at least 0,2 m shall be maintained between the closest part of the equipment and the nearest vertical cable. Where the riser structure is conductive, the minimum spacing of 0,2 m shall be between the closest parts of the equipment and riser structure.

6.4.1.4 Combinations of tabletop and floor-standing equipment arrangement

Intra-unit cables between a tabletop unit and a floor standing unit shall have the excess folded into a bundle no longer than 0,4 m. The bundle shall be positioned such that it is either 0,4 m above the horizontal RGP or at the height of the cable entry or connection point if this is within 0,4 m of the horizontal RGP.

6.4.2 The time of operation

Replace the existing title and text of this subclause by the following new title and new text:

6.4.2 Operation of the EUT

The operating conditions of the EUT shall be determined by the manufacturer according to the typical use of the EUT with respect to the expected highest level of emission. The determined operational mode and the rationale for the selected operating conditions shall be stated in the test report.

The EUT shall be operated within the rated (nominal) operating voltage range and typical load conditions (mechanical or electrical) for which it is designed. Actual loads should be used whenever possible. If a simulator is used, it shall represent the actual load with respect to its radio frequency and functional characteristics.

The test programmes or other means of exercising the equipment should ensure that various parts of a system are exercised in a manner that permits detection of all system disturbances.

6.4.3 Running-in time

Replace the existing title and text of this subclause by the following new title and new text:

6.4.3 EUT time of operation

The time of operation shall be, in the case of EUTs with a given rated operating time, in accordance with the marking; in all other cases, the EUT shall be continuously operated throughout the test.

6.4.4 Supply

Replace the existing title and text of this subclause by the following new title and new text:

6.4.4 EUT running-in time

No specific running-in time, prior to testing, is given, but the EUT shall be operated for a sufficient period to ensure that the modes and conditions of operation are typical of those during the life of the equipment. For some EUTs, special test conditions may be prescribed in the relevant product standards.

6.4.5 Mode of operation

Replace the existing title and text of this subclause by the following new title and new text:

6.4.5 EUT supply

The EUT shall be operated from a supply having the rated voltage of the EUT. If the level of disturbance varies considerably with the supply voltage, the measurements shall be repeated for supply voltages over the range of 0,9 to 1,1 times the rated voltage. EUTs with more than one rated voltage shall be tested at the rated voltage that causes maximum disturbance.

Add, after the 6.4.5, the following new subclauses:

6.4.6 EUT mode of operation

The EUT shall be operated under practical conditions that cause the maximum disturbance at the measurement frequency.

6.4.7 Operation of multifunction equipment

Multifunction equipment which is subjected simultaneously to different clauses of a product standard, and/or different standards, shall be tested with each function operated in isolation, if this can be achieved without modifying the equipment internally. The equipment thus tested shall be deemed to have complied with the requirements of all clauses and/or standards when each function has satisfied the requirements of the relevant clause and/or standard.

For equipment where it is not practical to test with each function operated in isolation, or where the isolation of a particular function would result in the equipment being unable to fulfil its primary function, or where the simultaneous operation of several functions would result in saving measurement time, the equipment shall be deemed to have complied if it meets the provisions of the relevant clause and/or standard with the necessary functions operated.

6.4.8 Determination of arrangement(s) causing maximum emissions

Initial testing shall identify the frequency that has the highest disturbance relative to the limit. This identification shall be performed while operating the EUT in typical modes of operation and with cable positions in a test arrangement that is representative of typical installation practice.

The frequency of highest disturbance with respect to the limit shall be found by investigating disturbances at a number of significant frequencies. This provides confidence that the probable frequency of maximum disturbance has been found and that the associated cable, EUT arrangement and mode of operation has been identified.

For initial testing, the EUT should be arranged in accordance with the product standards as appropriate.

6.4.9 Recording of measurements

Of those disturbances above ($L - 20$ dB), where L is the limit level in logarithmic units, the disturbance levels and the frequencies of at least the six highest disturbances shall be recorded.

For radiated disturbances, the antenna polarization and height for each reported disturbance shall be recorded.

6.6.2 Minimum measurement times

Replace the existing text in the first paragraph of this subclause, modified by Amendment 1, by the following new text:

The minimum measurement (dwell) times are given in Table 7. From Table 7, the minimum scan times for measurements over a complete CISPR band have been derived in Table 1. These minimum measurement (dwell) times for scanning receivers and FFT-based measuring instruments in Table 7 and the scan times for spectrum analyzers in Table 1 apply to CW signals.

In addition, the test report shall include the value of the measurement instrumentation uncertainty corresponding to the used test setup, calculated as per the requirements of CISPR 16-4-2.

In the existing second paragraph, delete the first sentence (beginning with “The scan times”).

6.6.6 Timing considerations using FFT-based instruments

Replace the existing Note 2 and footnote 3, added by Amendment 1, by the following new note:

NOTE 2 Additional background information on the definition of the FFT-based receiver can be found in CISPR 16-3 [2].

7.3.6.2 Test environment

Replace the introducing text of the existing list by the following new introducing text:

If the ambient field-strength level at frequencies within the specified measurement ranges, at the specified measurement distance, exceeds the limit(s), the following alternatives may be used to show compliance of the EUT:

Replace the existing item a) of the list by the following new items a) and b):

- a) Perform measurements at a closer distance and extrapolate results to the distance at which the limit is specified. Extrapolate the results using one of the following methods:
 - 1) determine L_2 corresponding to the close-in distance d_2 by applying the relation $L_2 = L_1(d_1/d_2)$, where L_1 is the specified limit in $\mu\text{V}/\text{m}$ at the distance d_1 ;

NOTE This extrapolation method can only be used when both d_1 and d_2 are in the far-field zone of the EUT at all frequencies of measurement.
 - 2) use the formula as recommended by the product standard;
 - 3) determine the limit L_2 at a distance d_2 applying an extrapolation formula verified by measurements at no less than three different distances.
- b) In the frequency bands where the ambient noise values are exceeded (measured values higher than 6 dB below the limit), the disturbance values of the EUT may be interpolated from the adjacent disturbance values. The interpolated value shall lie on the curve describing a continuous function of the disturbance values adjacent to the ambient noise.

Renumber the existing items b) to e) of the list as items c) to f) respectively.

Replace, in the existing item d), which is now renumbered e), the words “open field area test site” by the abbreviation “OATS”.

7.3.6.3 Configuration of equipment under test

Replace, in the existing title, “equipment under test” by “EUT”.

Replace the entire text of this subclause by the following new text and figure:

The EUT operating conditions and arrangement are detailed in 6.4.

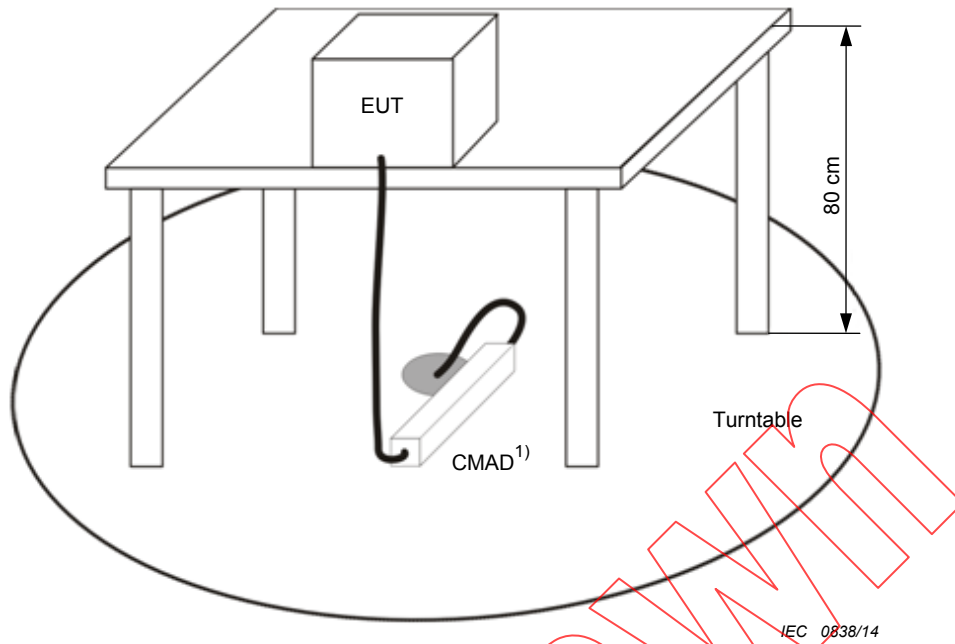
Ferrite clamp type CMADs are used to reduce the influence of cables outside the test volume on radiated disturbance measurement results. If CMADs are used, the cable leaving the test volume shall enter the CMAD at the point where it reaches the ground plane as shown in Figure 22. The CMAD shall always be placed flat on the ground plane. The part of the cable between the exit point of the CMAD and the exit point of the turntable shall be kept as short as possible. Each cable shall be treated with a separate CMAD. Cables with diameters larger than the cable openings of commercially available CMADs do not have to be treated with CMADs.

NOTE 1 In order to avoid saturation, high common mode current power cables (e.g. the output port of inverters) should not be treated with CMADs unless the CMADs in use are specifically designed for high common mode currents.

For EUTs with up to three cables leaving the test volume, each cable shall be treated with a CMAD during radiated disturbance measurements. This requirement applies to any type of cable (e.g. power, telecommunication, and control). For a test set-up with more than three cables leaving the test volume, only the three cables from which the highest emission is expected need to be equipped with CMADs. The cables on which the CMADs have been applied shall be documented in the test report.

NOTE 2 The limitation of the number of CMADs is discussed in [10]. In comparing large versus small size EUTs, as well as EUTs with one versus two cables, the author concluded that a small EUT with only one cable leaving the test volume is worst case. The author's investigation covered application of CMADs to tabletop equipment with three cables or less.

General information on the purpose and application of ferrite-type CMADs is provided in 4.9.1 of CISPR/TR 16-3 [2].



¹⁾ CMADs shall comply with the relevant specifications of CISPR 16-1-4; their use shall be documented in the test report.

Figure 22 – Position of CMAD for table-top equipment on OATS or in SAC

Figure 7 – Typical FAR site geometry, where a, b, c, e depend on the room performance

Replace the existing footnote 2) of this figure by the following new footnote:

²⁾ CMADs shall comply with the relevant specifications of CISPR 16-1-4; their use shall be documented in the test report.

Figure 8 – Typical test set-up for table-top equipment within the test volume of a FAR

Replace the existing footnote 2) of this figure by the following new footnote:

²⁾ CMADs shall comply with the relevant specifications of CISPR 16-1-4; their use shall be documented in the test report.

Figure 9 – Typical test set-up for floor-standing equipment within the test volume of a FAR

Replace the existing footnote 3) of this figure by the following new footnote:

³⁾ CMADs shall comply with the relevant specifications of CISPR 16-1-4; their use shall be documented in the test report.

7.4.3 Cable layout and termination

Replace the existing item e) by the following new item, and add a new item f) as follows: