SLOVENSKI STANDARD
SIST EN 55016-1-6:2015/A2:2022

01-julij-2022

Specifikacija za merilne naprave in metode za merjenje radijskih motenj in odpornosti - 1-6. del: Merilne naprave za merjenje radijskih motenj in odpornosti - Umerjanje EMC antene - Dopolnilo A2

Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-6: Radio disturbance and immunity measuring appratus - EMC antenna calibration

Ta slovenski standard je istoveten z: EN 55016-1-6:2015/A2:2022

ICS:

17.220.20	Merjenje električnih in magnetnih veličin	Measurement of electrical and magnetic quantities
33.100.20	Imunost	Immunity

SIST EN 55016-1-6:2015/A2:2022 en

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 55016-1-6:2015/A2

April 2022

ICS 33.100.10; 33.100.20

English Version

Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-6: Radio disturbance and immunity measuring apparatus - EMC antenna calibration (CISPR 16-1-6:2014/AMD2:2022)

Spécification des méthodes et des appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques - Partie 1-6: Appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques - Étalonnage des antennes CEM (CISPR 16-1-6:2014/AMD2:2022)

Anforderungen an Geräte und Einrichtungen sowie Festlegung der Verfahren zur Messung der hochfrequenten Störaussendung (Funkstörungen) und Störfestigkeit - Teil 1-6: Geräte und Einrichtungen zur Messung der hochfrequenten Störaussendung (Funkstörungen) und Störfestigkeit - Kalibrierung von Antennen für EMV-Messungen (CISPR 16-1-6:2014/AMD2:2022)

This amendment A2 modifies the European Standard EN 55016-1-6:2015; it was approved by CENELEC on 2022-04-07. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this amendment the status of a national standard without any alteration.

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This amendment exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

European foreword

The text of document CIS/A/1362/FDIS, future CISPR 16-1-6/AMD2, prepared by CISPR SC A "Radio-interference measurements and statistical methods" of CISPR "International special committee on radio interference" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 55016-1-6:2015/A2:2022.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2023-01-07
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2025-04-07

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a Standardization Request given to CENELEC by the European Commission and the European Free Trade Association.

Any feedback and questions on this document should be directed to the users' national committee. A complete listing of these bodies can be found on the CENELEC website.

Endorsement notice

The text of the International Standard CISPR 16-1-6:2014/AMD2:2022 was approved by CENELEC as a European Standard without any modification.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Add the following references:

Publication	Year	Title	EN/HD	Year
CISPR 16-1-2	-	Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-2: Radio disturbance and immunity measuring apparatus - Coupling devices for conducted disturbance measurements	EN 55016-1-2	-
CISPR 16-1-4	2019	Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-4: Radio disturbance and immunity measuring apparatus - Antennas and test sites for radiated disturbance measurements	EN IEC 55016-1-4	2019

CISPR 16-1-6

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INTERNATIONAL STANDARD

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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 1-6: Radio disturbance and immunity measuring apparatus – EMC antenna calibration

Spécification des méthodes et des appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques –
Partie 1-6: Appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques – Étalonnage des antennes CEM

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SPECIFICATION FOR RADIO DISTURBANCE AND IMMUNITY MEASURING APPARATUS AND METHODS –

Part 1-6: Radio disturbance and immunity measuring apparatus – EMC antenna calibration

AMENDMENT 2

FOREWORD

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Amendment 2 to CISPR 16-1-6:2014 has been prepared by subcommittee CISPR 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:

Draft	Report on voting
CIS/A/1362/FDIS	CIS/A/1365/RVD

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

The language used for the development of this Amendment is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications/.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

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

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

2 Normative references

Add to the existing list the following new references:

CISPR 16-1-2, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-2: Radio disturbance and immunity measuring apparatus – Coupling devices for conducted disturbance measurements*

CISPR 16-1-4:2019, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-4: Radio disturbance and immunity measuring apparatus – Antennas and test sites for radiated disturbance measurements*

3.1.2.5
magnetic field antenna factor

Replace the existing Note 1 to entry and Note 2 to entry as follows:

Note 1 to entry: The symbol F_{aH} is used only when antenna factor is expressed in dB. The quantity F_{aH} is expressed in dB(S/m) or dB(Ω^{-1}m^{-1}).

Note 2 to entry: The unit dB(pT/µV) is used in some standards (but not in CISPR 16-1-6), which can be converted to dB(S/m) by subtracting 2 dB.

Add Note 3 to entry:

Note 3 to entry: CISPR 16-1-4 specifies loop antennas for magnetic field strength measurements in the frequency range of 9 kHz to 30 MHz.

3.2 Abbreviations

Add to the existing list the following new abbreviations:

CPM current probe method

SFM standard field method

5.2.1 General

Replace the second and third paragraphs by the following five new paragraphs:

Several techniques have been developed for calibrating loop antennas or measuring magnetic field antenna factors [74]. Reference [18] provides a useful overview. Reference [15] provides a simplified version of the standard field method (SFM) ([32] and [16]), and the TAM is described in [35]. This subclause and Annex H specify acceptable calibration methods for loop antennas.

The TAM and the TEM cell method yield a standard uncertainty of measured antenna factor of approximately ± 0,5 dB, while application of the TEM cell method is restricted to the frequency range below the first resonant frequency of the TEM cell.

The current probe method (CPM) [15] is an improved SFM based on IEEE Std 291 [32]. In the original method, the current flowing in the transmit loop antenna was measured using an RF vacuum thermocouple built into the loop element; however, a thermocouple is typically small and fragile, and therefore is not suitable for use in routine calibration measurements.

The Helmholtz coil method [34], categorized as a SFM, is accurate to 0,7 % (0,06 dB) up to 150 kHz, and better than ± 0,5 dB up to 10 MHz (see Annex H), but its applicable frequency range depends on the coil size.

A sufficient signal-to-{receiver noise} ratio of at least 34 dB is necessary to obtain low measurement uncertainties, if using a VNA as described in 6.2.4. In addition, it is important to attach attenuators to the transmit loop antenna and the receive loop antenna, to reduce mismatch uncertainties if using a signal generator and a receiver. When calibrating a loop antenna in free-space conditions, the distance between the transmit antenna or the receive antenna and any nearby reflecting objects, including any metallic ground plane, should be greater than 1,3 m; the clearance required also depends on the spacing between the antennas.

Add, at the end of the existing 5.2.2.2, the following new subclauses:

5.2.3 Three antenna method (TAM)

5.2.3.1 General

Antenna calibration using the TAM requires three antennas (numbered as 1, 2, and 3) to form three antenna pairs. Prior knowledge of the AF of any of the three antennas is not needed with the TAM (see also 4.3.3 about the TAM).

SIL for antenna calibration is usually measured with a calibrated network analyzer, to reduce mismatch errors that may occur between the signal output port and the transmit loop antenna, as well as between the signal receiving port and the receive loop antenna. Alternatively, a combination of signal/tracking-generator and measuring receiver can be used; in this case, padding attenuators are required to reduce standing waves on the cables.

Different from TAM calibrations above 30 MHz, which are based on the Friis transmission equation, the TAM method for loop antenna calibrations is based on a modified Neumann mutual inductance formula [75], which is approximately expressed by the so-called Greene's formula [70].

The separation distance between the transmit antenna and the receive antenna shall be small compared to the distance to the surroundings. Therefore, coupling between the antennas is maximized, while coupling to the surroundings is minimized. A specific site validation criterion is not required, but the influences from the site on the magnetic field antenna factor results shall be estimated; see the discussion in 5.2.3.2.

5.2.3.2 Calibration procedure

For antenna pairs coaxially aligned as shown in Figure 21, the site insertion loss, $A_\mathrm{i}(i,j)$, between antenna i and antenna j is measured in a free-space environment [35], and is described by Equation (61).

$$A_\mathrm{i}(i,j) = F_\mathrm{aH}(i) + F_\mathrm{aH}(j) + 45{,}9 + 20\lg(f_\mathrm{MHz}) - 20\lg[K(i,j)] \text{ in dB} \qquad (61)$$

From data on the $A_\mathrm{i}(i,j)$ for the three antenna pairs, the magnetic field antenna factors F_aH of each antenna can be determined using Equations (62).

$$F_{\mathrm{aH}}(1)=\frac{1}{2}\left[-45{,}9-20\lg f_{\mathrm{MHz}}+A_{\mathrm{i}}(1{,}2)+A_{\mathrm{i}}(1{,}3)-A_{\mathrm{i}}(2{,}3)+K(1{,}2)+K(1{,}3)-K(2{,}3)\right]$$
$$F_{\mathrm{aH}}(2)=\frac{1}{2}\left[-45{,}9-20\lg f_{\mathrm{MHz}}+A_{\mathrm{i}}(1{,}2)-A_{\mathrm{i}}(1{,}3)+A_{\mathrm{i}}(2{,}3)+K(1{,}2)-K(1{,}3)+K(2{,}3)\right] \text{ in dB(S/m)} \qquad (62)$$
$$F_{\mathrm{aH}}(3)=\frac{1}{2}\left[-45{,}9-20\lg f_{\mathrm{MHz}}-A_{\mathrm{i}}(1{,}2)+A_{\mathrm{i}}(1{,}3)+A_{\mathrm{i}}(2{,}3)-K(1{,}2)+K(1{,}3)+K(2{,}3)\right]$$

where

f_{MHz} is the frequency in MHz;

$A_{\mathrm{i}}(i,j)$ is the SIL between antenna i and antenna j; when it is measured using a network analyzer, the site insertion loss is given by Equation (63).

$$A_{\mathrm{i}}(i,j)=-20\lg\left|S_{21}(i,j)\right| \text{ in dB;} \qquad (63)$$

$K(i,j)$ is the function shown in Equation (64), based on a modified Neumann equation for antenna pair (i,j)

$$K(i,j)=20\lg\left(\frac{1}{4\pi S_i S_j}\left|\oint_{C_j}\oint_{C_i}\frac{\mathrm{e}^{-\mathrm{j}\beta R}}{R}d\mathbf{s}_i\cdot d\mathbf{s}_j\right|\right) \text{ in dB(m}^{-3}\text{)} \qquad (64)$$

and

S_i,S_j are the geometric areas ($r^2\pi$) in m^2 of antennas i and j, respectively;

C_i,C_j are the closed curves encircling the loop element of antennas i and j, respectively;

$d\mathbf{s}_i,d\mathbf{s}_j$ are infinitesimal segment vectors of the loop elements of antennas i and j, respectively;

R is the distance in m between the segments $d\mathbf{s}_i$ and $d\mathbf{s}_j$.

If the three loop antennas are true circles and a homogeneous current distribution along each loop is assumed, Equation (64) can be expressed approximately by the following form:

$$K(i,j)=20\lg\left(\frac{\sqrt{1+\beta^2R_0^2(i,j)}}{2\pi R_0^3(i,j)}\left[1+\frac{15}{8}\left(\frac{r_ir_j}{R_0^2(i,j)}\right)^2+\frac{315}{64}\left(\frac{r_ir_j}{R_0^2(i,j)}\right)^4\right]\right) \text{ in dB(m}^{-3}\text{)} \qquad (65)$$