SLOVENSKI STANDARD
SIST EN 50715:2022

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Elektromagnetna združljivost - Radiofrekvenčno sevanje - Statistični vidiki ugotavljanja skladnosti množično proizvedenih izdelkov z zahtevami za neželena radiofrekvenčna sevanja

Electromagnetic compatibility - Radio frequency emission - Statistical considerations in the determination of compliance for mass-produced products with requirements for unwanted radio frequency emission

Elektromagnetische Verträglichkeit - Hochfrequente Störaussendungen - Statistische Betrachtungen bei der Bestimmung der Übereinstimmung von seriengefertigten Produkten mit Anforderungen zur unerwünschten hochfrequenten Störaussendung

Compatibilité électromagnétique - Emissions radiofréquences - Considérations statistiques pour la détermination de la conformité des produits de série aux exigences en matière d'émissions radiofréquences indésirablesCompatibilité électromagnétique - Emissions radiofréquences - Considérations statistiques pour la détermination de la conformité des produits de série aux exigences en matière d'émissions radiofréquences indésirables

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European Committee for Electrotechnical Standardization
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European foreword

This document (EN 50715:2022) has been prepared by CLC/TC 210 “Electromagnetic Compatibility (EMC)”.

The following dates are fixed:

- latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2023-06-06
- latest date by which the national standards conflicting with this document have to be withdrawn (dow) 2025-06-06

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1 Scope

This document specifies statistical considerations for the evaluation of unwanted radio frequency emissions of mass-produced products.

NOTE 1 It is based on CISPR TR 16-4-3.

The reasons for such statistical considerations are:

a) that the abatement of interference aims that the majority of the products to be approved shall not cause interference;

b) that the CISPR limits should be suitable for the purpose of type approval of mass-produced products as well as approval of single-produced products;

c) that to ensure compliance of mass-produced products with the CISPR limits, statistical techniques have to be applied;

d) that it is important for international trade that the limits shall be interpreted in the same way in every country.

Therefore, this document specifies requirements and provides guidance based on statistical techniques. EMC compliance of mass-produced products with the requirements of this document are based on the application of statistical techniques that reassure the consumer, with an 80 % degree of confidence, that 80 % of the products of a type being investigated comply with the limits for unintended radio frequency emission.

This document does not define limits or measuring methods. It can be used only after measurements of unwanted radio frequency emissions have been performed according to the applicable standard for the unwanted radio frequency emissions.

NOTE 2 Clause 4 gives some general requirements on the interpretation of CISPR radio disturbance limits and specifies different methods, which can be used alternatively. Clause 5 gives some specific requirements for certain product groups.

NOTE 3 This document does not give a calculation method about the manufacturer's risk, whether a type of products will be accepted during a second statistical evaluation. More information on the acceptance probability for a repeated measurement is given in CISPR TR 16-4-3, Edition 2.1, Annex D.

2 Normative references

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.

EN 55011, *Industrial, scientific and medical equipment — Radio-frequency disturbance characteristics — Limits and methods of measurement*

EN 55014-1, *Electromagnetic compatibility — Requirements for household appliances, electric tools and similar apparatus — Part 1: Emission*

EN 55015, *Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment*

CISPR TR 16-4-3:2004+AMD1:2006, *Specification for radio disturbance and immunity measuring apparatus and methods — Part 4-3: Uncertainties, statistics and limit modelling — Statistical considerations in the determination of EMC compliance of mass-produced products*

IEC 60050-161, *International Electrotechnical Vocabulary (IEV) — Chapter 161: Electromagnetic compatibility*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-161 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at https://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

4 Interpretation of CISPR radio disturbance limits

4.1 Significance of a CISPR limit

A CISPR limit is a limit recommended to national authorities for incorporation in national standards, relevant legal regulations and official specifications. It is also recommended that international organizations use these limits.

The significance of the limits for type approved equipment shall be that on a statistical basis at least 80 % of the mass-produced equipment complies with the limits with at least 80 % confidence.

4.2 General

4.2.1 Equipment producing continuous disturbance

Evaluations shall be made either:

a) on a sample of equipment of the type using the statistical method of evaluation in accordance with 4.3, or

b) for simplicity's sake, on one unit only.

Subsequent tests are recommended from time to time on equipment taken at random from the production, especially if option b) above has been followed.

4.2.2 Equipment producing discontinuous disturbance (clicks)

Evaluations shall be made on one unit only.

NOTE The evaluation of discontinuous disturbance (clicks) is described in EN 55014-1.

Subsequent tests are recommended from time to time on units taken at random from the production. In the case of controversy with regard to the result of an evaluation, the following shortened procedure is applied:

If the first unit is tested and fails, three additional units shall be tested at the same frequency or frequencies at which the first unit failed. The three additional units are judged according to the same requirements as applied to the first unit. If all three additional units comply with all relevant requirements, the final result of the evaluation is PASS. If one or more units do not comply with all relevant requirements, the final result of the evaluation is FAIL.

4.3 Compliance with limits for equipment in large-scale production

4.3.1 General

Statistically assessed compliance with the limits shall be made according to one of the three methods described below or to some other test which ensures compliance with the requirements of 4.1.

The test according to 4.3.2 or 4.3.3 should be performed on a sample of not less than 5 items of the type, but if, in exceptional circumstances, 5 items are not available, then a sample of at least 3 shall be used.

The test according to 4.3.4 should be performed on a sample of not less than 7 items.

It is recommended to start the evaluation with the method described in 4.3.2 and only in case the test has not been passed to continue with the more extensive methods described in 4.3.3 and 4.3.4.

4.3.2 Method based on a general margin to the limit

Compliance with this document is given when the measured values from all items of the sample are under the limit and the margin to the limit is not less than the general margin, given in Table 1 below.

Table 1 — General margin to the limit for statistical evaluation

Sample size (n)	3	4	5	6
General margin to the limit (dB)	3,8	2,5	1,5	0,7

This method shall not be used to consider a product as non-compliant with the requirements of this document.

NOTE The general margin to the limit has been calculated using the conservative value σ_{max} = 6,0 dB for the standard deviation in a product group. For further information on this method see CISPR TR 16-4-3.

In Table 1, values are given only for a sample size up to *n* = 6 because for *n* = 7 or higher the method given in 4.3.4 can be applied, where the binomial distribution without an additional margin is used.

4.3.3 Test based on the non-central t-distribution

Compliance with this document is judged from the following relationship:

$$\bar{x} + kS_n \leq 0 \quad (1)$$

where

$\bar{x}$ is the arithmetic mean of the values x_n of n items in the sample;

S_n is the standard deviation of the sample with

$$S_n^2 = \sum (x - \bar{x}_n)^2 / (n-1) \quad (2)$$

The quantities x_n, $\bar{x}$ and S_n are expressed logarithmically (dB(µV), dB(pW) or dB(µV/m).

k is the factor, derived from tables of the non-central t-distribution, which ensures with 80 % confidence that 80 % or more of the type is below the limit; the value of k depends on the sample size n and is given in Table 2 below.

Table 2 — Factor k for the application of the non-central t-distribution

n	3	4	5	6	7	8	9	10	11	12
k	2,04	1,69	1,52	1,42	1,35	1,3	1,27	1,24	1,21	1,2

x_n is determined as follows:

— for each of the frequency ranges specified in Clause 5, the differences between the measured values and the limit are calculated. The difference is negative where the measured value is below the limit and positive where it is higher than the limit.

For the nth individual unit, x_n is the difference value at the frequency where the difference curve is at maximum.

NOTE 1 If all measured values are below the limit, x_n is the shortest distance to the limit. If some of the measured values are above the limit, x_n is highest value by which the limit is exceeded.

The statistical evaluation shall be carried out separately for the frequency sub-ranges, given in Clause 5.

If all measured values are under the limit and the test is failed only due to a high standard deviation, it shall be investigated whether this high standard deviation has been caused by a maximum of x_n at the borderline between two frequency sub-ranges. In this case the evaluation shall be done according to 4.3.4.

NOTE 2 Figure 1 illustrates the possible difficulties if a maximum of the measured disturbances occurs near the borderline between two frequency sub-ranges. “U” is the measured disturbance voltage; “f” is the frequency. Here two units with different characteristics out of a sample are shown. For broadband disturbances the value of the maximum as well as the frequency of the maximum can change from unit to unit, differences as between unit 1 and unit 2 in a sample are typical. An average value and standard deviation is calculated for all units (of which two are shown) for each sub-range. In this example the calculated standard deviation is much higher for subrange 1 than subrange 2 (e.g. consider how different the values of x1 and x2 are at the borderline). Even though the average for subrange 1 is much lower than subrange 2, after taking into consideration the high value of S_n multiplied by the factor out of Table 2, in rare cases this could lead to the sample set failing the given criteria. Since this is simply a consequence of the way in which the frequency sub-ranges have been defined, no statistically meaningful conclusion can be drawn regarding compliance with standard.

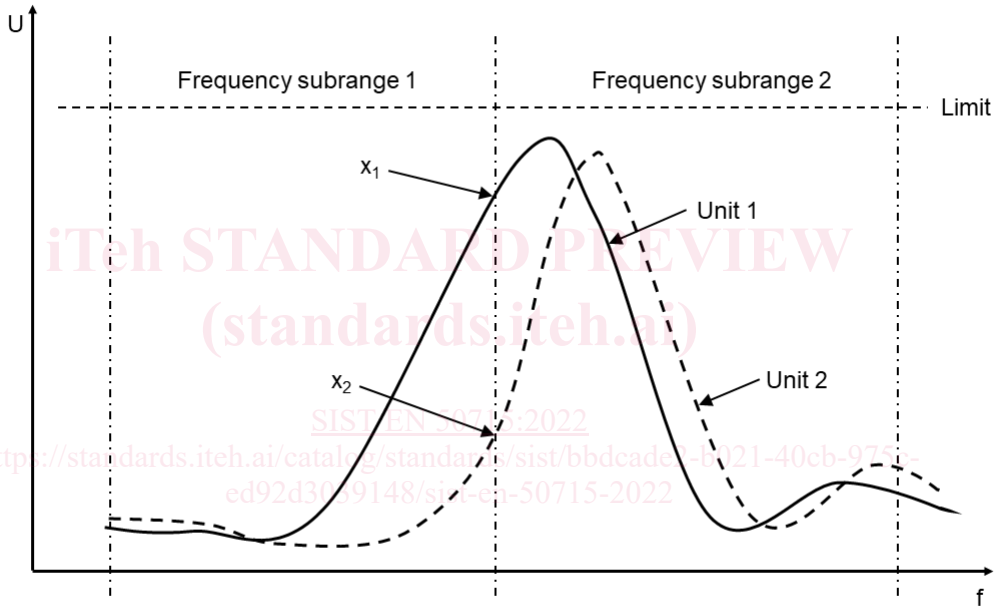

Figure 1 — Unit-to-unit variation of the sub-range maximum

NOTE 3 This Figure is taken from CISPR 14-1, Ed. 7.

4.3.4 Test based on the binomial distribution

Compliance with this document is judged from the condition that, from a sample of size n, the number of units that generate an interference level above the applicable limit shall not exceed c, as given in Table 3.

Table 3 — Application of the binomial distribution

n	7	14	20	26	32
c	0	1	2	3	4

4.3.5 Larger sample size

Should the test on the sample result in non-compliance with this document, then a second sample may be tested and the result may be combined with those from the first sample. In this case compliance with this document is checked for the larger sample size.

NOTE For general information see CISPR TR 16-4-3.

5 Definition of sub-ranges for the test based on the non-central t-distribution

5.1 General

At CISPR level, some product standards define specific sub-ranges, which are not given in CISPR 16-4-3. They have therefore been transferred to this document.

If a product falls in the scope of one of the following subclauses, the sub-ranges defined there shall be applied. Otherwise, the provisions of CISPR TR 16-4-3:2004+AMD1:2006, 5.1.1 shall be applied.

5.2 Definition of subranges for products in the scope of EN 55011

The statistical evaluation according to the method in 4.3.3 shall be carried out separately in the following frequency sub-ranges:

Conducted disturbances:

— 150 kHz to 500 kHz

— 500 kHz to 5 MHz

— 5 MHz to 30 MHz

Radiated disturbances below 1 GHz:

— 30 MHz to 230 MHz

— 230 MHz to 500 MHz

— 500 MHz to 1 000 MHz

Radiated disturbances above 1 GHz:

— 1,0 GHz to 4,5 GHz

— 4,5 GHz to 18 GHz

NOTE For group 2 equipment, there may be no need to fully or continuously cover the frequency subranges defined above, see respective information in CISPR 11, Clause 6.3.2.4, Table 13.

5.3 Definition of subranges for products in the scope of EN 55014-1

The statistical evaluation according to the method in 4.3.3 shall be carried out separately in the following frequency sub-ranges:

Disturbance voltage and disturbance current:

— 150 kHz to 500 kHz

— 500 kHz to 5 MHz

— 5 MHz to 30 MHz