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INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE (CISPR)

Sub-Committee A: Radio Interference Measurements and Statistical Methods

Working Group 1: EMC Instrumentation Specifications

Subject: Uncertainty of calibration of absorbing clamps

References: a) CISPR 16-4-1:2009-02 (Ed. 2)
b) CISPR 16-1-3:2013-03 (Ed. 2, Amd.1)

At the CISPR/A meeting in Frankfurt, Germany it was agreed to develop measurement instrumentation uncertainty estimates for absorbing clamp calibrations (CISPR/A/1103/RM, AI 14-04).

CISPR 16-1-3 (Ed.2, Amd.1) describes two calibration methods for absorbing clamps in Annex B:

1. Original calibration method
2. Jig calibration method

1) A detailed uncertainty estimate for the Original calibration method does exist in CISPR 16-4-1 (Ed.2) in clause 7.2. Therefore, it is suggested to include a reference to CISPR 16-4-1 clause 7.2 in CISPR 16-1-3 (Ed.2) clause B.2.4. In addition, a statement is to be included that the measurement uncertainty for the absorbing clamp calibration using the original method is to be calculated based on CISPR 16-4-1 (Ed.2) Table E.1 for the frequency range 30 MHz to 300 MHz and based on Table E.2 for calibrations of the clamp in the frequency range 300 MHz to 1 GHz. The following wording is suggested:

B.2.4 Measurement uncertainty of the absorbing clamp calibration
The calibration uncertainty is to be mentioned in every calibration report. ~~The calibration report shall consider the following uncertainty factors.~~

~~– The original calibration method:~~

~~• the uncertainty of the measurement equipment,~~
~~• the mismatch between the output of the absorbing clamp (with a 6 dB attenuator and receiver cable) and the measurement equipment, and • the repeatability of the calibrations, which includes factors such as centring the lead under test in the current transformer and guidance of the receiver cable to the network analyzer.~~

The guidance in clause 7.2 of CISPR 16-4-1 (Ed.2) shall be followed when determining the calibration uncertainty of absorbing clamps using the original calibration method. The expanded uncertainty shall be calculated in accordance with CISPR 16-4-1 (Ed.2) Table E.1 for the frequency range 30 MHz to 300 MHz and Table E.2 for the frequency range 300 MHz to 1 GHz.

The absorbing clamp is to fulfill the minimum requirement of the decoupling factors DF and DR.

2) For the jig calibration method the following uncertainty estimate is suggested to be added to CISPR 16-1-3 (Ed.2) clause B.2.4:

Source of uncertainty (Uncertainty factors/influence quantities)	Uncertainty value (± dB)	Probability distribution	Divisor	Standard uncertainty
Measuring instrument accuracy [1)]	0.1 dB	Rectangular	1.73	0.06
Uncertainty of JTF [2)]	0.3 dB	Rectangular	1.73	0.17
Mismatch Receiver - absorbing clamp [3)]	0.15 dB	U-shaped	1.41	0.11
Distance between the clamp reference point (CRP) and the jig [4)]	0.15 dB	Rectangular	1.73	0.09
Influence of measurement cable connection [5)]	0.1 dB	Rectangular	1.73	0.06
Influence of different measurement environments [6)]	0.2 dB	Rectangular	1.73	0.12
Repeatability of calibration process [7)]	0.2 dB	Normal	1	0.2
Combined standard uncertainty				0.27
Expanded uncertainty (k=2)				0.54

Rationale for the estimates of input quantities specific to the absorbing clamp jig calibration method:

1) Measuring instrument accuracy
The network analyser is to be calibrated using a calibration kit to reduce the systematic errors. A requirement for the linearity of the network analyser is included in CISPR 16-1-3 (Ed.2) clause B.2.2.2

2) Uncertainty of JTF (Jig Transfer Factor)
The correlation of the determined clamp factor to CF_{act} to the clamp factor of the original calibration method CF_{orig} is required in order to provide a useful clamp factor to the test house. This correlation is accomplished through the use of a JTF. The uncertainty of the JTF is expected to be available from the jig manufacturer.

3) Mismatch Receiver - absorbing clamp
The mismatch of the cable connecting the receiver input to the absorbin clamp via a 6 db attenuator is to be determined.

4) Distance between the clamp reference point (CRP) and the jig
The distance of the CRP to the jig is specified as 30 mm. If this distance is within 25 mm and 35 mm, the deviations are less than 0.15 dB.

5) Influence at the measurement cable connection
A secondary absorption device is to be used on the receiver cable and be positioned per Figure B4 of CISPR 16-1-3 (Ed.2, Amd.1). This setup significantly reduces the influence of the receiver cable orientation relative to the absorbing clamp under calibration.

6) Influence of different measurement environments
Per CISPR 16-1-3 (Ed.2, Amd.1) the jig must be equipped with vertical flanges per Figure B.5 to significantly reduce the influence of the calibration environment on the results.

7) Repeatability of calibration process

Further investigations are required to verify the suggested magnitudes the jig transfer factor JTF (item #2 above) and the impact of different calibration requirements (item #6) above.