CISPR News 2017

New developments in CISPR product standards for emission measurements

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Overview

- CISPR – Purpose and publication levels
- CISPR 16 – Normative references
- CISPR product standards for emission measurements
  - CISPR 11 – Industrial, scientific and medical equipment
  - CISPR 14-1 – Household appliances and electric tools
  - CISPR 15 – Lighting equipment
  - CISPR 32 – Multimedia equipment
CISPR

Purpose

I CISPR = International Special Committee on Radio Interference ¹

I Technical committee within the International Electrotechnical Commission (IEC)

I The committee is constituted of 7 sub-committees that fulfil both product (vertical) and basic (horizontal) standardisation roles

I CISPR was established in 1933 and had its first meeting in June 1934 in Paris, with representatives of 6 national committees of the IEC (Belgium, The Netherlands, Luxembourg, France, Germany and UK)

I Today CISPR is one of the 104 technical committees of the IEC

I Members of CISPR are 41 National Committees (23 participate/18 observer), EBU, ETSI, CIGRE, IARU and both ITU-R and ITU-T

I CISPR was established to consider the protection of radio reception from interference

¹) “Comité International Spécial des Perturbations Radioélectriques”

Source: Franklin Delano Roosevelt Memorial, Washington DC
CISPR

Purpose

Commercial Standardisation

1) CISPR = Comité International Spécial des Perturbations Radioélectriques (Internationales Sonderkomitee für Hochfrequenzstörungen)
2) CENELEC = Comité Européen de Normalisation Electrotechnique (Europäisches Komitee für elektrotechnische Normung)
3) ETSI = European Telecommunications Standards Institute

IEC

CISPR 1) TC 65 TC 77

EMI + EMS

EU

CENELEC 2) ETSI 3)

China
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VCCI

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FCC

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CISPR

CISPR Publication Levels

1. CISPR publications are structured into 3 levels
2. Basic standards come into force with normative references in generic and product standards

- **Product Standards**: CISPR 11, 12, 14-1, 15 ... 36
- **Generic Standards**: IEC 61000-6 series
- **Basic Standards**: CISPR 16 series
CISPR

CISPR Publication Levels

1. Basic Standards: Developed by CISPR sub-committee A
   - The CISPR 16 series is composed of 17 parts
   - Defines the measurement apparatus, measurement methods, measurement uncertainty and test facilities

2. Generic Standards: Developed by CISPR sub-committee H
   - The IEC 61000-6 series is composed of 2 parts for emission measurements and 2 parts for immunity testing for both residential and industrial environments
   - Sets limits through an interference model

3. Product Standards: Developed by CISPR sub-committees B, D, F, I
   - Product and product-family standards for both emission measurements and immunity testing
   - Provides both product-specific requirements, such as operation and arrangement of the EUT, measurement methods, measurement uncertainty, and justified deviations for limits
Normative References to CISPR 16 (EN 55016)

- Basic standards come into force with dated or undated normative references in product standards
  - If the reference is undated, the **latest** edition of the standard shall apply
  - If the reference is dated, the **specific** edition of the standard shall apply

- CISPR 13 Ed. 4.2 has **undated** references, whereas CISPR 11, CISPR 12, CISPR 13 Ed. 5.0, CISPR 14-1, CISPR 15, CISPR 22, CISPR 25 and CISPR 32 have **dated** references

- For the European economic area (EEA), the d.o.w. (date of withdrawal) applies
  - latest date by which the national standards conflicting with this EN standard have to be withdrawn
  - Generally, d.o.w. = d.o.r. + 3 years (d.o.r. = date of ratification) applies
  - d.o.w. database search in rubric “**advanced search**” via: [http://www.cenelec.eu/](http://www.cenelec.eu/)
CISPR 11

Industrial, scientific and medical equipment (ISM)

- Developed by CISPR sub-committee B
  - 6th Edition was published on 9 June 2015
  - In Europe published as EN 55011:2016, become mandatory 15 Feb 2019 in the European Economic Area (EEA)

- What’s New in the 6th Edition?
  - Induction cooking appliances were removed from CISPR 11 and transferred to CISPR 14-1. During transition period users may choose either CISPR 11 or CISPR 14-1 for measurements
  - The references to CISPR 16 were updated to make FFT-based receivers like R&S®ESW, R&S®ESR and R&S®ESU applicable for EMI compliance measurements
CISPR 11
Industrial, scientific and medical equipment (ISM)

What’s New in Edition 6? (continued)

General maintenance items

- Appropriate limits for magnetic field measurements for "small equipment" of Class A Group 2 from 150 kHz to 30 MHz, distance = 3 m

  Equipment is to be considered as small if it is either standing on the floor or a table, and would fit, including cables, in a cylindrical volume of 1.2 m in diameter and 1.5 m height to ground plane (inclusive of table)

- Field strength measurements on small size equipment in 3 m distance and figures for arrangement and routing of cables - use of CMADs

- Application of one set of peak limits (CW type) for all Group 2 equipment operating above 400 MHz (relaxed limits in Ed.5 Table 15 were deleted)

- Wireless power transfer (WPT) equipment covered by the scope of other CISPR standards is excluded from the scope of CISPR 11

- For radiated disturbance measurements in the range 1 GHz to 18 GHz the test site shall meet the $S_{VSWR}$ criterion in Clause 8 of CISPR 16-1-4.
Industrial, scientific and medical equipment (ISM)

What’s New in Edition 6? (continued)

- Requirements for "Grid Connected Power Converters" (GCPC) are included (these include converters for photovoltaic systems)
- The concept of component testing is used for assessing conducted RF disturbances at the DC input power port of GCPCs using an artificial network for the DC port (150 Ω Δ-AN)
- Specification for the DC-AN is included
- The proposed limits apply only to GCPCs intended for assembly into photovoltaic power generation systems
- Separate measurement configurations for GCPCs >20 kVA
- CISPR/A presently has 3 projects for the inclusion of the 150 Ω Δ-AN in the basic standards CISPR 16-1-2, 16-2-1 and 16-4-2 (presently at FDIS stage)
What’s New in Edition 6? (continued)

“APD method and associated limits for assessment of fluctuating RF disturbances in the range above 1 GHz” are included

The amplitude probability distribution (APD) measurement function is introduced as alternative to the established Log-AV (VBW=10Hz) detector for RE measurements of microwave ovens in the frequency range 1 to 18 GHz

- Oven under test is operated at maximum microwave power setting
- APD measurement is performed at the highest peak captured during preliminary peak measurements in each of the two bands, Band I: 1005-2395 MHz and Band II: 2505-17995 MHz but outside the band 5720-5880 MHz
- It is sufficient to measure at three frequencies around the preliminary peak (the centre and the both ends of a 10 MHz span), can be measured in sequence

A worldwide measurement campaign was conducted to compare APD results with the established measurement method. For the measurements the Test Receiver R&S®ESU was used (R&S®ESW and ESR also applicable)
Industrial, scientific and medical equipment (ISM)

What’s New in Amendment 1 to Edition 6?

- Fully anechoic room (FAR) acc. to CISPR 16-1-4 and measurement method acc. to CISPR 16-2-3 were added for field measurements <1 GHz
- For table top equipment only, measurement distance = 3 m
- The 3 m measurement distance applies only to small equipment ($D_{\text{max}} 1,2m$)
- Amendment 1 was published on 23 June 2016
CISPR 11

Industrial, scientific and medical equipment (ISM)

What’s Coming in Amendment 2 to Edition 6?

Wireless Power Transfer (Source: Document CISPR/B/663/CD)

- Radiated emission (magnetic field) 9 kHz to 30 MHz
- Conducted emission 9 kHz to 30 MHz is under consideration

Figure AC – Conceptual diagram of test set-up for type test of WPT off-board power supply and charging equipment for electric vehicles
CISPR 14-1

Household appliances and electric tools

- Developed by CISPR sub-committee F
  - 6th Edition was published on 10 August 2016
  - In Europe published as EN 55014-1:2016, becomes mandatory on 9 January 2019 in the EEA

- What’s New in Edition 6?
  - Editorial revision & restructuring of CISPR 14-1
  - General radiated disturbance measurement methods were added, it includes
    - Fully-anechoic room (FAR) acc. to CISPR 16-2-3 or IEC 61000-4-22
    - Set-up’s for air conditioners and robotic vacuum cleaners
    - Exemption for battery powered remote controls
CISPR 14-1
Household appliances and electric tools

What’s New in Edition 6? (continued)

- References to basic standard series CISPR 16 have been updated
  - CISPR 16-1-1 and CISPR 16-2-x to make fast FFT-based EMI receivers such as R&S®ESW/ESR/ESU applicable for EMI compliance measurements
  - CISPR 16-1-2 on new LISN requirements (phase, isolation, attenuation)
  - CISPR 16-1-4 on evaluation procedure for the influence of the set-up table material for radiated disturbance measurements

- Technical requirements for telecommunication ports based on CISPR 32
- Remove voltage probe measurement for load ports other than EUT with AE
- Extractor hoods shall be measured with the lighting function set to maximum together with the fan in operation, avoids application of CISPR 15
- Full implementation of MIU as specified in CISPR 16-4-2
- There is general support to incorporate the RMS-Average detector as an alternative to quasi-peak and average detector, will be considered as future work
CISPR 15

Lighting equipment

- Developed by CISPR sub-committee F
  - Amend. 1 to 8th Edition was published in March 2015
  - In Europe published as Amend.1:2015 to EN 55015:2013, it becomes mandatory on **1 May 2018 in the EEA**

- What’s New in Amendment 1 to 8th Edition?
  - **Full implementation of MIU** as specified in CISPR 16-4-2
  - Measurement arrangement for **rope lights** will be added
  - Inclusion of **radiated disturbance limits at 3 m** measurement distance
  - Update of Figures 5 and 6 and text in sub clause 8.2 for the use of an **AAN (asymmetric artificial network)** on control lines and exact EUT arrangement
  - **Extra-low voltage (ELV) lamps** with active circuit for symmetrical networks shall comply with voltage limits of Table 2a plus 26 dB at the ELV terminals; AMN is connected to a magnetic transformer or universal power supply
  - **Wall dimmers** that are only suitable for lamps other than incandescent lamps shall be tested with the appropriate lamps provided by the manufacturer
Lighting equipment

What’s New in Amendment 1 to 8th Edition? (continued)

- **Multifunction equipment** with lighting as a secondary function, there is no need to separately assess CISPR 15, provided that lighting function was operative during the assessment in accordance with the applicable standard; Examples: Range hoods, fans, refrigerators, freezers, ovens, TV
- New Annex E on test requirements (CE + RE) for double-capped lamps

What’s Coming in Edition 9?

- The currently used specification of the CDN in accordance with IEC 61000-4-6 is not suitable for performing radio frequency disturbance measurements in the frequency range from 30 MHz to 300 MHz
- Therefore, the CDN will be replaced by the new CDNE with an enhanced specification, e.g. CDNE-M2 or CDNE-M3 with reduced common mode (CM) impedance tolerance and additional parameter specification for the CM phase tolerance and differential mode impedance equal to 100 Ω; Furthermore, a minimum value of 20 dB for the parameter longitudinal conversion loss (LCL) will be added to prevent any influences of the symmetrical voltage on the measurement results supply
Multimedia equipment

Developed by CISPR sub-committee I
1st Edition was published on January 30, 2012

CISPR 13 (Radio & TV)
CISPR 22 (ITE)
EN 55103-1 (prof. AV)

In Europe published as EN 55032:2012, the date of withdrawal was set to 5 March 2015 → later on extended to 5 March 2017
EN 55032 is listed in the Official Journal (25 February 2014)

Definition of term multimedia equipment (MME):
“… equipment that is information technology equipment, audio equipment, video equipment, broadcast receiver equipment, entertainment lighting control equipment or combinations of these”.

CISPR 32 (Multimedia)
What’s New in Edition 1?

- **FFT-based receivers** like R&S®ESW, R&S®ESR and R&S®ESU are applicable for EMI compliance measurements.
- Multimedia equipment for professional use is within the scope.
- **Radio transmission function** according to ITU Radio Regulations is excluded.
- Port concept – measure disturbance characteristic of each port.
- The **measurement instrumentation uncertainty (MIU)** shall be calculated in accordance with CISPR 16-4-2; Both the measurement results and calculated uncertainty shall appear in the test report. But MIU shall not be taken into account in the determination of compliance.
- **Radiated disturbance** measurements in frequency range 30 MHz to 6 GHz based on system concept (same as CISPR 22).
- **Disturbance power** measurement not required any more (CISPR 13).
- If there is a choice of test methods, compliance can be shown against any of the test methods using the appropriate limit; in any situation where it is necessary to re-test the equipment to show compliance, **the test method originally chosen shall be used** to guarantee consistency of the results.
CISPR 32

Multimedia equipment – 2nd Edition published

Developed by CISPR sub-committee I

2nd Edition was published on 31 March 2015

In Europe published as EN 55032:2015, becomes mandatory on 5 May 2018 in the European Economic Area, publication in OJ expected in 2017
Multimedia equipment

What’s New in Edition 2?

- For the limits given in CISPR 32 the appropriate average detector is the linear average detector with meter time constant = **CISPR-Average detector**
- Adds **outdoor units of home satellite receivers (LNB)** to the scope
- **Fully anechoic room (FAR)** acc. to CISPR 16-1-4 and measurement method acc. to CISPR 16-2-3 was added for field measurements <1 GHz
- Emission-test arrangement for EUTs with different ways of mounting and application in practice (floor standing, table-top, wall mounted, handheld) → such EUTs shall be measured as table-top
- No need to measure DM voltage at each reception channel of broadcast receivers → use channels that produced highest emission during preview scan
- **TEM waveguide** acc. to IEC 61000-4-20 for battery operated EUTs without cables in informative Annex
- **RVC** acc. to IEC 61000-4-21 for measurements >1 GHz in informative Annex
- **Full implementation of measurement instrumentation uncertainty** as specified in CISPR 16-4-2 was not approved by National Committees
CISPR 32

Multimedia equipment

What’s Coming in future Amendments to Edition 2?

- **Full implementation** of measurement instrumentation uncertainty (MIU) as specified in CISPR 16-4-2
- Measurement of **power spectrum density (PSD)** mask in accordance with ITU as an alternative to measurements with AAN on telecommunication port
- Introduction of the **RMS-Average** detector as an alternative to quasi-peak and average detector for conducted and radiated disturbance measurements
- **Termination of cables leaving the test area** in SAC, → with **VHF-LISN** on single phase mains cable
  (FAR, DC, three-phase, cables other than mains still open)
- Clarification on **color bar test pattern** referenced in Clause B.2.2 of CISPR 32 → replace ITU-R BT.1729 by ITU-R BT.471 plus adding a small picture, both 100/0/100/0 (a) and 100/0/75/0 (b) will be applicable
- **Measurement method and limits for above 1 GHz** based upon the work of CISPR/A and CISPR/H → CISPR 16-2-3 may require full antenna height scan
Thank you for your interest!
Appendix
CISPR 16 – LISN requirements

Artificial mains V-networks (V-AMNs)
- New parameter of impedance characteristic: ±11.5° for phase tolerance (in addition to magnitude tolerance of ±20%)

Source: CISPR 16-1-2:2014-03 (Ed.2)
CISPR 16 – LISN requirements

Artificial mains V-networks (V-AMNs)

- RF isolation between EUT/Receiver and mains ports: minimum 40 dB
- Minimum 10-dB attenuator in addition to the isolation requirement

Source: CISPR 16-1-2:2014-03 (Ed.2)
Evaluation procedure for setup table influences

- Relevant for table-top equipment and antenna in horizontal polarization
- Frequency range 200 MHz to 1, 6, 18 GHz, step size ≤ 0.5% of max. frequency
- Up to 1 GHz use a small biconical antenna, overall length ≤ 40 cm
- Above 1 GHz use transmit antenna as used for site validation ($S_{\text{VSWR}}$)

$$\Delta_{\text{max}} = \max | V_{\text{r/with}} - V_{\text{r/without}} | \quad \Rightarrow \quad u_{\text{table}} = \frac{\Delta_{\text{max}}}{\sqrt{3}}$$

- Use table with low permittivity, e.g. Styrofoam with Teflon plate on top
CISPR 16 – FFT-based measuring receivers

Motivation for FFT-based measurement instrumentation

1. **More Speed** – FFT-based receivers are measuring spectral segments much wider than the resolution bandwidth during the measurement time by parallel calculation at several frequencies.

2. **More Reliable** – FFT allows application of longer measurement times, e.g. for measuring intermittent signals.

3. **More Insight** – FFT makes enhanced measurement functions like scan spectrogram and persistence mode applicable.

Ultra-fast scan time for the entire frequency range

Long scan time for the entire frequency range
CISPR 16 – FFT-based measuring receivers

Amendment 1:2010-06 to CISPR 16-1-1 (3rd Ed.)

- CISPR 16-1-1 uses black-box approach
  - FFT-based measuring instruments that meet the requirements of CISPR 16-1-1 can be used for compliance measurements!

- Definition of „measuring receiver“ includes all types of instruments, a new definition has been added for this purpose:
  
  “instrument such as a tunable voltmeter, an EMI receiver, a spectrum analyzer or an FFT-based measuring instrument, with or without preselection, that meets the relevant parts of this standard”

- Specific requirement for FFT-based measuring instruments
  
  ”for EMI measurements, FFT-based measuring instruments shall sample and evaluate the signal continuously during the measurement time”
Amendments to CISPR 16-2-x

- FFT-based instruments (may) combine the parallel calculation at N frequencies and a stepped scan
- Frequency range of interest is subdivided into several segments, which are measured sequentially
- The scan time $T_{\text{scan}}$ is

$$T_{\text{scan}} = T_m \times N_{\text{seg}}$$

- $T_m$ is to be selected longer than the pulse repetition interval $T_p$ for a correct measurement of a "BB" spectrum

Source: CISPR 16-2-3:2016-09 (Ed.4)
CISPR 16 – FFT-based measuring receivers

Wrong measurement time can result in enormous errors!

Pulse modulated carrier, 12 ms pulse period – Time Domain Scan

Closed trace with 12 ms measurement time

Gaps in trace with 10 ms measurement time

Important: Measurement time ≥ signal period
# CISPR 16 – FFT-based measuring receivers

## More Speed with Time-Domain Scan

<table>
<thead>
<tr>
<th>Frequency range</th>
<th>Weighting detector; measurement time; IF bandwidth; step width for stepped scan (SS) and Time Domain Scan (TD)</th>
<th>FFT-based measuring instrument</th>
<th>Stepped Scan</th>
<th>Time-domain Scan</th>
</tr>
</thead>
<tbody>
<tr>
<td>CISPR Band B 150 kHz to 30 MHz</td>
<td>Pk, 100 ms; 9 kHz; SS: 4 kHz, TD: 2.25 kHz</td>
<td>R&amp;S ESW</td>
<td>12:35 min</td>
<td>0.11 s</td>
</tr>
<tr>
<td>CISPR Band B 150 kHz to 30 MHz</td>
<td>QP + CAV, 1 s, 9 kHz; SS: 4 kHz, TD: 2.25 kHz</td>
<td></td>
<td>approx. 3.8 h</td>
<td>2 s</td>
</tr>
<tr>
<td>CISPR Bands C/D 30 to 1000 MHz</td>
<td>Pk, 10 ms, 120 kHz; SS: 40 kHz, TD: 30 kHz</td>
<td></td>
<td>4:15 min</td>
<td>0.62 s</td>
</tr>
<tr>
<td>CISPR Bands C/D 30 to 1000 MHz</td>
<td>Pk, 10 ms, 9 kHz; SS: 4 kHz, TD: 2.25 kHz</td>
<td></td>
<td>approx. 1 h</td>
<td>0.84 s</td>
</tr>
<tr>
<td>CISPR Bands C/D 30 to 1000 MHz</td>
<td>QP, 1 s, 120 kHz; SS: 40 kHz, TD: 30 kHz</td>
<td></td>
<td>approx. 10 h</td>
<td>80 s</td>
</tr>
<tr>
<td>CISPR Bands C/D 30 to 1000 MHz</td>
<td>QP + CAV, 1 s, 9 kHz; SS: 4 kHz, TD: 2.25 kHz</td>
<td></td>
<td>approx. 100 h</td>
<td>67 s</td>
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</table>
CISPR 16 – FFT-based measuring receivers

FFT-based measurement instrumentation

Applicability

- CISPR 13:2001 (Radio + TV) Applicable since 21.06.2010
- CISPR 32:2012 (Multimedia) Applicable since 30.01.2012
- CISPR 15:2013 (Lighting) Applicable since 08.05.2013
- CISPR 11:2015 (ISM) Applicable since 09.06.2015
- CISPR 14-1:2016 (Household) Applicable since 10.08.2016
- CISPR 12:201x (Automotive) Publication of Ed. 7 expected in 2018


→ But time domain scan can be used for preview measurements
CISPR 16 – FFT-based measuring receivers

- Applicability if latest CISPR 16-1-1 is not referenced

  - Signal detection in frequency range (preview) using Time-domain Scan

  - Data reduction

  - Emission maximization
    Final measurement acc. to peak list
    in Receiver Mode
CISPR 16 – FFT-based measuring receivers

Normative references to basic standard CISPR 16-1-1

I ANSI C63.2 has an undated reference to CISPR 16-1-1 in Clause 1:
“The following referenced documents are indispensable for the application of this standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document including any amendments or corrigenda) applies.


I FCC part 15 has an undated reference to CISPR 16 in Section 15.35:
"The specifications for the measuring instrument using the CISPR quasi-peak detector can be found in Publication 16 of the International Special Committee on Radio Interference (CISPR) of the International Electrotechnical Commission"
Linear CISPR-Average detector with meter time constant

- Band A/B = 160 ms, Band C/D/E = 100 ms

For pulse-modulated signals with a PRF lower than the meter time constant, e.g. $f_p < 6$ Hz for Band A/B, the measurement result is not the average!

but the maximum of the output of the meter simulating network
Example for pulse width = 10 ms, measurement time $T_{\text{meas}} > 10 / f_p$

**Band A/B:**
$T_{\text{meter}} = 160$ ms

**Band C/D/E:**
$T_{\text{meter}} = 100$ ms
CISPR 16 – CISPR-Average detector

Response to intermittent, unsteady and drifting narrowband disturbances

- Using a linear average detector without meter time constant (AV) will result in a wrong weighted measurement
- A tolerance of ±1,0 dB is allowed

Pulse signal:
Duration=100 ms
Period=1,6 s

Receiver:
RBW=120 kHz
MT=2s
CISPR 16 – RMS-Average detector

RMS-Average weighting function for all CISPR bands

- Weighting function = relationship between input peak voltage level and PRF for constant level indication of a measuring receiver with a weighting detector.
CISPR 16 – RMS-Average detector

RMS-Average compared to Average, Quasi-peak and Peak

1. Unmodulated sine wave signals
   - All detectors yield the same result

2. Gaussian noise
   - RMS-average detection indicates a level
     → approximately 1 dB higher than average detection level
     → 4 dB lower than quasi-peak detection (for Band B)
     → 6 dB lower than quasi-peak detection (for Bands C and D)
     → 10 dB lower than the peak detector indication

3. Impulsive noise
   - Level is between average detector level and quasi-peak detector or peak detector indications
CISPR 16 – RMS-Average detector

RMS-Average compared to Average, Quasi-peak and Peak

RMS-Average weighting detector compared to existing detectors (for Band B, shortest pulse duration possible)

Weighting Factor in dB

CISPR-Average
RMS-Average
Quasi-Peak
Peak

20 dB/decade
10 dB/decade
Corner frequency = 10 Hz

f_p in Hz

0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75

1
10
100
1000
10000
CISPR 16 – RMS-Average detector

RMS-Average compared to Average, Quasi-peak and Peak

![Graph showing the comparison of RMS-Average weighting detector to existing detectors for Bands C and D, showing the shortest pulse duration possible.](graph)

CISPR-Average weighting detector compared to existing detectors (for Bands C and D, shortest pulse duration possible).

- **RMS-Average**
- **Quasi-Peak**
- **Peak**

Weighting Factor in dB vs. Frequency (f_p) in Hz

- **CISPR-Average**
- **RMS-Average**
- **20 dB/decade**
- **10 dB/decade**
- **corner frequency = 100 Hz**

**CISPR A48**
CISPR 16-4-2 Measurement Instr. Uncertainty

- MIU for a test laboratory $U_{\text{lab}}$ shall be evaluated for each disturbance measurements based on the listed influence quantities.

- The standard uncertainty $u(x_i)$ in decibels and the associated sensitivity coefficient $c_i$ shall be evaluated for the estimate $x_i$ of each quantity.

- The **combined standard uncertainty** $u_c(y)$ of the estimate $y$ of the measurand (e.g. voltage) shall be calculated as:

$$u_c(y) = \sqrt{\sum_i c_i^2 u^2(x_i)}$$

- The expanded MIU $U_{\text{lab}}$ shall be calculated as:

$$U_{\text{lab}} = U(y) = 2 \, u_c(y)$$

and shall be stated in the test report if $U_{\text{lab}} > U_{\text{cispr}}$, for $U_{\text{lab}} \leq U_{\text{cispr}}$ compliance statement is sufficient.
Compliance or non-compliance with a disturbance limit shall be determined in the following manner:

- If $U_{\text{lab}} \leq U_{\text{cispr}}$, then compliance occurs, if no measured disturbance level exceeds the disturbance limit.
- If $U_{\text{lab}} > U_{\text{cispr}}$, then compliance occurs, if no measured disturbance level increased by $U_{\text{lab}} - U_{\text{cispr}}$ exceeds the disturbance limit.

The values of $U_{\text{cispr}}$ have been calculated most often based on the tolerances given in CISPR 16-1-x.

Basis for the calculation of $U_{\text{cispr}}$ together with useful information on the assumptions is given in Annexes A-E.
The values of $U_{\text{cispr}}$ in accordance with Table 1 of CISPR 16-4-2 Ed. 2

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Frequency Range</th>
<th>$U_{\text{cispr}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conducted disturbance at mains port using AMN</td>
<td>9 kHz – 150 kHz</td>
<td>3,8 dB</td>
</tr>
<tr>
<td></td>
<td>150 kHz – 30 MHz</td>
<td>3,4 dB</td>
</tr>
<tr>
<td>Conducted disturbance at mains port using VP</td>
<td>9 kHz – 30 MHz</td>
<td>2,9 dB</td>
</tr>
<tr>
<td>Conducted disturbance at telecommunication port using AAN</td>
<td>150 kHz – 30 MHz</td>
<td>5,0 dB</td>
</tr>
<tr>
<td>Conducted disturbance at telecommunication port using CVP</td>
<td>150 kHz – 30 MHz</td>
<td>3,9 dB</td>
</tr>
<tr>
<td>Conducted disturbance at telecommunication port using CP</td>
<td>150 kHz – 30 MHz</td>
<td>2,9 dB</td>
</tr>
<tr>
<td>Disturbance power</td>
<td>30 MHz – 300 MHz</td>
<td>4,5 dB</td>
</tr>
<tr>
<td>Radiated disturbance (electric field strength at an OATS or in a SAC)</td>
<td>30 MHz – 1 000 MHz</td>
<td>6,3 dB</td>
</tr>
<tr>
<td>Radiated disturbance (electric field strength in a FAR)</td>
<td>30 MHz – 1 000 MHz</td>
<td>5,3 dB</td>
</tr>
<tr>
<td>Radiated disturbance (electric field strength in a FAR)</td>
<td>1 GHz – 6 GHz</td>
<td>5,2 dB</td>
</tr>
<tr>
<td>Radiated disturbance (electric field strength in a FAR)</td>
<td>6 GHz – 18 GHz</td>
<td>5,5 dB</td>
</tr>
</tbody>
</table>
## CISPR 16-4-2 Measurement Instr. Uncertainty

Radiated disturbance in FAR, e.g. Table 6 of CISPR 16-4-2 Ed. 2

<table>
<thead>
<tr>
<th>Input quantity a</th>
<th>( x_i )</th>
<th>Uncertainty of ( x_i )</th>
<th>Probability distribution function</th>
<th>( c_i u(x_i) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receiver reading A1)</td>
<td>( V_r )</td>
<td>± 0.1 dB</td>
<td>( k = 1 )</td>
<td>0.10 dB</td>
</tr>
<tr>
<td>Attenuation: antenna-receiver A2)</td>
<td>( a_c )</td>
<td>± 0.2 dB</td>
<td>( k = 2 )</td>
<td>0.10 dB</td>
</tr>
<tr>
<td>LPDA antenna factor D1)</td>
<td>( F_a )</td>
<td>± 2.0</td>
<td>( k = 2 )</td>
<td>1.00 dB</td>
</tr>
<tr>
<td>Receiver corrections:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sine wave voltage A3)</td>
<td>( \delta V_{sw} )</td>
<td>± 1.0</td>
<td>( k = 2 )</td>
<td>0.50 dB</td>
</tr>
<tr>
<td>Pulse amplitude response A4)</td>
<td>( \delta V_{pa} )</td>
<td>± 1.5</td>
<td>Rectangular</td>
<td>0.87 dB</td>
</tr>
<tr>
<td>Pulse repetition rate response A4)</td>
<td>( \delta V_{pr} )</td>
<td>± 1.5</td>
<td>Rectangular</td>
<td>0.87 dB</td>
</tr>
<tr>
<td>Noise floor proximity A5)</td>
<td>( \delta V_{nf} )</td>
<td>+0.7/0.0</td>
<td>Rectangular</td>
<td>0.40 dB</td>
</tr>
<tr>
<td>Mismatch: antenna-receiver A7)</td>
<td>( \delta M )</td>
<td>+0.9/-1.0</td>
<td>U-shaped</td>
<td>0.67 dB</td>
</tr>
<tr>
<td>LPDA antenna corrections:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AF frequency interpolation A8)</td>
<td>( \delta F_{af} )</td>
<td>± 0.3</td>
<td>Rectangular</td>
<td>0.17 dB</td>
</tr>
<tr>
<td>AF variation due to FAR influence D2</td>
<td>( \delta F_{af} )</td>
<td>± 0.0</td>
<td>Rectangular</td>
<td>0.00 dB</td>
</tr>
<tr>
<td>Directivity difference D3)</td>
<td>( \delta F_{d} )</td>
<td>± 1.0</td>
<td>Rectangular</td>
<td>0.58 dB</td>
</tr>
<tr>
<td>Phase centre location D4)</td>
<td>( \delta F_{aph} )</td>
<td>± 1.0</td>
<td>Rectangular</td>
<td>0.58 dB</td>
</tr>
<tr>
<td>Cross-polarization D5)</td>
<td>( \delta F_{acp} )</td>
<td>± 0.9</td>
<td>Rectangular</td>
<td>0.52 dB</td>
</tr>
<tr>
<td>Balance D6)</td>
<td>( \delta F_{abal} )</td>
<td>± 0.0</td>
<td>Rectangular</td>
<td>0.00 dB</td>
</tr>
<tr>
<td>Site corrections:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site imperfections D7</td>
<td>( \delta a_{N} )</td>
<td>± 4.0</td>
<td>Triangular</td>
<td>1.63 dB</td>
</tr>
<tr>
<td>Effect of setup table material D10</td>
<td>( \delta a_{NT} )</td>
<td>± 0.5</td>
<td>Rectangular</td>
<td>0.29 dB</td>
</tr>
<tr>
<td>Separation distance D8</td>
<td>( \delta d )</td>
<td>± 0.3</td>
<td>Rectangular</td>
<td>0.17 dB</td>
</tr>
<tr>
<td>Table height D9</td>
<td>( \delta h )</td>
<td>± 0.1</td>
<td>( k = 2 )</td>
<td>0.05 dB</td>
</tr>
</tbody>
</table>

200 MHz to 1000 MHz
log. periodic antenna at distance of 3 m

Combined standard uncertainty can be reduced by 1 dB!

6.3 dB down to 5.3 dB
Typical cable arrangement for **small table-top EUT (3m)**

Source: CISPR 11:2015-06 (Ed.6)
CISPR 11 – General Maintenance Ed. 6

Typical cable arrangement for floor-standing EUT

Source: CISPR 11:2015-06 (Ed.6)
CISPR 32 Measurement in FAR

- Class B Limits in FAR (Table A.4 in CISPR 32 Ed. 2)

<table>
<thead>
<tr>
<th>A4.3</th>
<th>30 to 230</th>
<th>FAR</th>
<th>10</th>
<th>32 to 25</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>230 to 1000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A4.4</td>
<td>30 to 230</td>
<td>FAR</td>
<td>3</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>230 to 1000</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Set-up for table top equipment → for cables leaving the test area horizontal length ≥ 0.8m

Source: CISPR 32:2015-03 (Ed.2)
Termination of cables leaving the test area in SAC

- VHF-LISN on single phase mains cable with rated current less than 20 A
- Example measurement arrangement for table-top EUT (VHF-LISN above the ground plane)

Note 1): VHF-LISN should be bonded to the ground plane.
Note 2): The cable from VHF-LISN to power supply should be arranged as short as possible.
Clarification on color bar test pattern

- ITU-R BT.1729 Multi Zone Test Pattern 16:9 High Definition Television (HDTV)
- ITU-R BT.1729 Color Bar Test Pattern 16:9 for SDTV and HDTV
- ITU-R BT.471 Color Bar Test Pattern

- 1080i / 25 frames per second
- 1080p / 50 frames per second