

# TECHNICAL REPORT



INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

**Radio interference characteristics of overhead power lines and high-voltage  
equipment –  
Part 2: Methods of measurement and procedure for determining limits**

CISPR TR 18-2:2017

<https://standards.iteh.ai/catalog/standards/sist/8e6f249f-073a-430f-97bd-44fb6716343b/cispr-tr-18-2-2017>



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INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

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INTERNATIONAL ELECTROTECHNICAL COMMISSION  
INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

**RADIO INTERFERENCE CHARACTERISTICS  
OF OVERHEAD POWER LINES  
AND HIGH-VOLTAGE EQUIPMENT –**

**Part 2: Methods of measurement  
and procedure for determining limits**

FOREWORD

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CISPR 18-2, which is a technical report, has been prepared by CISPR subcommittee B: Interference relating to industrial, scientific and medical radio-frequency apparatus, to other (heavy) industrial equipment, to overhead power lines, to high voltage equipment and to electric traction.

This third edition cancels and replaces the second edition published in 2010. This edition constitutes a technical revision.



This edition includes the following significant technical changes with respect to the previous edition:

- a) updated description of the RF characteristics of spark discharges;
- b) measurement method for radiated disturbances in the frequency range from 300 MHz to 3 GHz.

The text of this technical report is based on the following documents:

DTR	Report on voting
CIS/B/654/DTR	CIS/B/675/RVDTR

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the CISPR 18 series can be found, under the general title *Radio interference characteristics of overhead power lines and high-voltage equipment*, on the IEC website.

The committee has decided that the contents of this 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- withdrawn,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 [CISPR TR 18-2:2017](http://standards.iteh.ai/catalog/standards/sist/8e6f249f-073a-430f-97bd-44fb6716343b/cispr-tr-18-2-2017)
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A bilingual version of this publication may be issued at a later date.

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## INTRODUCTION

This Technical Report is the second of a three-part series dealing with radio noise generated by electrical power transmission and distribution facilities (overhead lines and substations). It contains recommendations for performance of on-site measurements of electromagnetic noise fields in the vicinity of high-voltage (HV) overhead power lines and substations and for determination of limits for protection of radio reception.

The recommendations given in this Part 2 of the CISPR 18 series are intended to be a useful aid to engineers involved in maintenance of overhead power lines and substations and also to anyone concerned with checking the radio noise performance of a line to ensure satisfactory protection of radio reception. Information on the physical phenomena involved in the generation of electromagnetic noise fields is found in CISPR TR 18-1. It also includes the main properties of such fields and their numerical values. CISPR TR 18-3 eventually contains a Code of Practice for minimizing the generation of radio noise.

This third edition of CISPR TR 18-2 is adapted to the modern structure and content of technical reports issued by IEC. The second edition of CISPR TR 18-2 underwent thorough edition and adaptation to modern terminology. This third edition now also covers an adequate method of measurement for radiated disturbances from HV overhead power lines and substations in the range 300 MHz to 3 GHz, since gap-type discharges can be a potential noise source disturbing modern digital radio communication. However, because

- 1) there is not sufficient experience and information regarding gap-type noise and thus further investigations regarding noise characteristics and how gap noise disturbs digital radio communication are necessary,
- 2) gap noise is not persistent in normal operation of the electric power facility and tends to emerge from defective components,

there is no discussion in this edition regarding technical considerations for derivation of limits in the frequency range 300 MHz to 3 GHz.

The CISPR 18 series does not deal with biological effects on living matter or any issues related to exposure to electromagnetic fields.

The main content of this technical report is based on historical CISPR Rec. No. 56 given below:

### RECOMMENDATION No. 56

#### METHODS OF MEASUREMENT OF RADIO INTERFERENCE CAUSED BY OVERHEAD POWER LINES AND HIGH-VOLTAGE EQUIPMENT AND THE PROCEDURE FOR DETERMINING LIMITS

The CISPR

#### CONSIDERING

- a) that a general description of the radio interference characteristics of overhead power lines and high-voltage equipment has been published in CISPR 18-1,
- b) that the methods of measurement of these characteristics need to be established,
- c) that national authorities require guidance on the procedure for determining limits of such radio interference.

## RECOMMENDS

That the latest edition of CISPR TR 18-2, including amendments, be used for methods of measurement of radio interference characteristics of overhead power lines and high-voltage equipment and for procedures for determining limits.

CISPR TR 18-1 describes the main properties of the physical phenomena involved in the production of disturbing electromagnetic fields by overhead lines and provides numerical values of such fields.

In CISPR TR 18-2, methods of measurement and procedures for determining limits of such radio interference are recommended.

The methods of measurement in CISPR TR 18-2 detail the techniques and procedures for use when measuring electromagnetic fields arising from radio interference at sites close to overhead lines and also the techniques and procedures for making laboratory measurements of interference voltages and currents generated by line equipment and accessories.

The procedures for determining limits define the expected values of radio noise field and the width of the "disturbed" corridor following the route of the line.

This corridor takes into account the effective field strength of the wanted signal, the signal-to-noise ratio selected and the expected strength of the noise field for a given line.

The procedures are only valid for long and medium waves because procedures applicable to VHF analogue television broadcasting and digital terrestrial television broadcasting have not yet been decided, due to insufficient knowledge.

It is emphasized that this part of CISPR 18 does not specify a single set of limits to be applied internationally. Rather it details the procedures to enable national authorities to specify limits where it is decided that there is a need for regulations.

# RADIO INTERFERENCE CHARACTERISTICS OF OVERHEAD POWER LINES AND HIGH-VOLTAGE EQUIPMENT –

## Part 2: Methods of measurement and procedure for determining limits

### 1 Scope

This part of CISPR 18, which is a Technical Report, applies to radio noise from overhead power lines and high-voltage equipment which may cause interference to radio reception.

The frequency range covered by this publication is 0,15 MHz to 3 GHz.

A general procedure for establishing the limits of the radio noise field from the power lines and equipment is recommended, together with typical values as examples, and methods of measurement.

The clause on limits concentrates on the low frequency and medium frequency bands and it is only in these bands where ample evidence, based on established practice, is available. No examples of limits to protect radio reception in the frequency band 30 MHz to 3 GHz have been given, as measuring methods and certain other aspects of the problems in this band have not yet been fully resolved. Site measurements and service experience have shown that levels of noise from power lines at frequencies higher than 300 MHz in normal operation are so low that interference is unlikely to be caused to television reception.

The values of limits given as examples are calculated to provide a reasonable degree of protection to the reception of broadcasting at the boundary of the recognized service areas of the appropriate transmitters in the radio frequency bands used for a.m. radio broadcasting, in the least favourable conditions likely to be generally encountered. These limits are intended to provide guidance at the planning stage of the line and national standards or other specifications against which the performance of the line may be checked after construction and during its useful life.

The measuring apparatus and methods used for checking compliance with limits should comply with the respective CISPR specifications, as e.g. the basic standards series CISPR 16, see [1]<sup>1</sup>.

### 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.

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

IEC 60060-2, *High-voltage test techniques – Part 2: Measuring systems*

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<sup>1</sup> The figures in square brackets refer to the Bibliography.

CISPR 16-1-1, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-1: Radio disturbance and immunity measuring apparatus – Measuring apparatus*

ISO IEC Guide 99, *International vocabulary of metrology – Basic and general concepts and associated terms (VIM)*

NOTE Informative references are listed in the Bibliography.

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-161 and the ISO IEC Guide 99 apply.

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

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

### 4 Measurements

#### 4.1 Measuring instruments

##### 4.1.1 Response of a standard quasi-peak CISPR measuring receiver to AC generated corona noise

CISPR 16-1-1 specifies the response characteristic of a measuring receiver to periodically repeated pulses, according to their repetition frequency, for a number of different frequency ranges and bandwidths including the range 0,15 MHz to 30 MHz and a resolution bandwidth of 9 kHz.

Figure 1 indicates the form these pulses take as they progress through the various stages of the measuring receiver. However, in the special case of corona pulses generated by high-voltage AC power systems, the individual pulses are not equally spaced throughout a cycle but occur in closely packed groups or bursts around the peak of the voltage waveform. A burst has a duration not exceeding 2 ms to 3 ms and this is followed by a quiescent no-corona period.

Owing to its inherent time constants, a standard quasi-peak CISPR measuring receiver is unable to respond to individual pulses within a burst, which is seen as a single pulse whose amplitude is discussed below.

Hence, the pulse repetition frequency, in the meaning of the CISPR definition, is constant at  $2f$  (where  $f$  is the power system frequency) for single phase and  $6f$  for three-phase single or multi-circuit systems, provided that the individual circuits are part of the same system.

Figure 2 indicates the usual case where individual corona pulses generated around the positive peaks of the voltage waveform are much greater in amplitude than those generated around the negative peaks. Hence in a three-phase power line there are three bursts of higher amplitude and three burst of lower amplitude noise during each period of  $1/f$ .

Also, in the measurement of the radio noise field strength in close vicinity of an operational line, the antenna of the measuring receiver is not located at the same distance from all the phase conductors. Because a quasi-peak detector responds only to the higher amplitude bursts and disregards the lower ones, rules of summation of the radio noise generated by the individual phases of a line can be formulated which are specific to the CISPR characteristics

and are given in Clause 4 of CISPR TR 18-3: \_\_<sup>2</sup>. It should be noted that the loudspeaker of a radio receiver, and consequently the listener, perceives the overall generated noise.

To examine the response of the CISPR measuring receiver to a given burst of pulses, it should be borne in mind that each individual pulse becomes, at the output of the amplifier of Figure 1 of pass-band  $\Delta f$ , a damped oscillation whose duration can be taken as approximately  $2/\text{RBW}$  (i.e. 0,5 times its IF amplifier resolution bandwidth), or 0,22 ms for 9 kHz. When there are a large number of pulses distributed at random within a burst, the resulting oscillations will overlap randomly and the overall quasi-peak signal will be approximately equal to the quadratic sum of the individual quasi-peak values. This statement, which is difficult to prove mathematically, has been well proven by experience and justifies the use, in quasi-peak detection, of the quadratic summation law which would moreover be rigorous if the noise levels were expressed in RMS values.

#### 4.1.2 Other measuring instruments

Measuring instruments differing from standard CISPR instruments are referred to in Annex A although measuring instruments having detectors other than quasi-peak are also referred to in CISPR 16-1-1.

### 4.2 On-site measurements on HV overhead power lines

#### 4.2.1 General

On-site measurements in the vicinity of HV overhead power lines should be carried out in accordance with the instructions given in this subclause. Further information about a possible assessment and documentation of measured data is found in 5.3.5 and 5.4.

#### 4.2.2 Measurements in the frequency range 0,15 MHz to 30 MHz

[CISPR TR 18-2:2017](#)

##### 4.2.2.1 Reference frequency

The reference measurement frequency is 0,5 MHz. It is recommended that measurements are made at a frequency of  $0,5 \text{ MHz} \pm 10 \%$  but other frequencies, for example 1 MHz, may also be used. The frequency of 0,5 MHz (or 1 MHz) is preferred because, usually, the level of radio noise at this part of the spectrum is representative of the higher levels and also because 0,5 MHz lies between the low and medium frequency broadcast bands.

Because of the possibility of error due to the presence of standing waves, it is inadvisable to rely on the measured value of the radio noise field strength at a single frequency but to draw a mean curve through the results of a number of readings throughout the noise spectrum. Measurements should be made at, or near, the following frequencies: 0,15 MHz, 0,25 MHz, 0,5 MHz, 1,0 MHz, 1,5 MHz, 3,0 MHz, 6,0 MHz, 10,15 MHz and 30 MHz although, clearly, frequencies at which interference to the wanted noise is received, should be avoided.

##### 4.2.2.2 Measurement antenna

The antenna used for the measurements shall be an electrically-screened vertical loop, whose dimensions are such that the antenna will be completely enclosed by a square having a side of 600 mm in length. The balance shall be such that in a uniform field the ratio between the maximum and minimum indications on the measuring receiver when the antenna is rotated shall not be less than 20 dB. The base of the loop should be about 2 m above ground. The antenna shall be rotated around a vertical axis and the maximum indication noted. If the plane of the loop is not effectively parallel to the direction of the power line, the orientation should be stated.

<sup>2</sup> Under preparation. Stage at the time of publication: CISPR/RPUB 18-3:2017.

According to the ANSI/IEEE Standard 430 (1986) [4], the antenna height using measurement vehicle is recommended as below:

If a vehicle-mounted antenna is used, the antenna should be at least 2 m above the roof of the vehicle. The effects of vehicles on vehicle-mounted antennas have been found to be negligible if this minimum height of 2 m is maintained; however, the vehicle and antenna combination should be calibrated to confirm the antenna factors and to check for existence of azimuthal asymmetries in the antenna pattern, as described in Section 5 of IEEE Standard 473 (1985) [5].

A check shall be made to ensure that the supply mains, if used, or other conductors connected to the measuring apparatus do not affect the measurements.

#### **4.2.2.3 Selection of measurement points along the pathway of the overhead HV power transmission line**

To determine the radio noise performance of a line, certain positions of measurement should be avoided; but these restrictions would not apply when an investigation into a case of interference is being carried out.

Measurements should be made at mid-span between the towers and preferably at several such positions. Measurements should not be made near points where lines change direction or intersect.

Sites at an abnormal height of span should be avoided. The measuring site should be flat, free from trees and bushes and remote from large metal structures and other overhead power and telephone lines.

Ideally the measuring site should be at a distance greater than 10 km from a line termination, in order to avoid reflection effects and consequently inaccurate results, but lower voltage distribution lines are sometimes too short to enable this condition to be met. However, the results of measurement (see reference [6]) indicate that the level of the radio noise field strength in the absence of reflections corresponds to the geometric mean of the maximum and minimum values, in microvolt per metre ( $\mu\text{V}/\text{m}$ ), of the frequency spectrum from a line subjected to reflections.

If the line is transposed, the measuring site should be located as far as possible from the transposition towers.

The atmospheric conditions should be approximately uniform along the line. Measurements under rain conditions will be valid only if the rain extends over at least 10 km of the line on either side of the measuring site.

Annex B gives a list of such information.

#### **4.2.2.4 Selection of measurement points lateral to the pathway of the overhead HV power transmission line**

Measurements are performed e.g. for determination of the lateral field strength profile of the radio noise field generated by overhead HV power transmission lines. In these conditions, a number of measurement points at mid-span in between two towers should be chosen along a straight line departing perpendicular from the pathway of the overhead HV power transmission line under test. The distances of measurement shall be taken laterally from the vertical projection to ground of the outmost sub-conductor of the transmission line (reference point  $(x,y,z)$ , i.e.  $x$  = place along the line at mid-span where the measurements are made,  $y = 0$  m and  $z = 0$  m corresponding to the vertical projection to ground of the outmost sub-conductor) to the centre of the antenna used for the measurements. For determination of the overall typical lateral field strength profile of the radio noise field of a given overhead HV power