SLOVENSKI STANDARD
SIST EN 50121-2:2017

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Železniške naprave - Elektromagnetna združljivost - 2. del: Sevanje celotnega železniškega sistema v okolje

Railway applications - Electromagnetic compatibility - Part 2: Emission of the whole railway system to the outside world

Bahnanwendungen - Elektromagnetische Verträglichkeit - Teil 2: Störaussendungen des gesamten Bahnsystems in die Außenwelt

Applications ferroviaires - Compatibilité électromagnétique - Partie 2: Emission du système ferroviaire dans son ensemble vers le monde extérieur

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English Version

Railway applications - Electromagnetic compatibility - Part 2: Emission of the whole railway system to the outside world

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European Committee for Electrotechnical Standardization
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CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

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Contents

Page

European foreword

This document (EN 50121-2:2017) has been prepared by CLC/TC 9X, “Electrical and electronic applications for railways”.

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) [2017-11-07]
- latest date by which the national standards conflicting with this document have to be withdrawn (dow) [2019-11-07]

This document supersedes EN 50121-2:2015.

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.

EN 50121-2:2016 includes the following significant technical change with respect to EN 50121-2:2015:

a) deletion of Annex ZZ.

This European Standard will be read in conjunction with EN 50121-1.

EN 50121, *Railway applications — Electromagnetic compatibility*, consists of the following parts:

— *Part 1: General*;

— *Part 2: Emission of the whole railway system to the outside world* [the present document];

— *Part 3-1: Rolling stock — Train and complete vehicle*;

— *Part 3-2: Rolling stock — Apparatus*;

— *Part 4: Emission and immunity of the signalling and telecommunications apparatus*;

— *Part 5: Emission and immunity of fixed power supply installations and apparatus*.

1 Scope

This European Standard is intended to define the electromagnetic environment of the whole railway system including urban mass transit and light rail system. It describes the measurement method to verify the emissions, and gives the cartography values of the fields most frequently encountered.

This European Standard specifies the emission limits of the whole railway system to the outside world.

The emission parameters refer to the particular measuring points defined in Clause 5. These emissions should be assumed to exist at all points in the vertical planes which are 10 m from the centre lines of the outer electrified railway tracks, or 10 m from the fence of the substations.

Also, the zones above and below the railway system may be affected by electromagnetic emissions and particular cases need to be considered individually.

These specific provisions need to be used in conjunction with the general provisions in EN 50121-1.

For existing railway lines, it is assumed that compliance with the emission requirements of EN 50121-3-1, EN 50121-3-2, EN 50121-4 and EN 50121-5 will ensure the compliance with the emission values given in this part.

For newly built railway systems it is best practice to provide compliance to the emission limits given in this part of the standard (as defined in the EMC plan according to EN 50121-1).

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 55016-1-1, *Specification for radio disturbance and immunity measuring apparatus and methods — Part 1-1: Radio disturbance and immunity measuring apparatus — Measuring apparatus (CISPR 16-1-1)*

EN 55016-1-4, *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 (CISPR 16-1-4)*

IEC 60050-161, *International Electrotechnical Vocabulary. Chapter 161: Electromagnetic compatibility*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

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

3.1.1
apparatus
device or assembly of devices which can be used as an independent unit for specific functions

[SOURCE: IEC 60050-151:2001, 151-11-22]

3.1.2
environment
surroundings in which a product or system exists, including air, water, land, natural resources, flora, fauna, humans and their interrelation

[SOURCE: IEC Guide 109:2012, 3.3]

[SOURCE: IEC 60050-901:2013, 901-07-01]

3.1.3
railway substation
installation whose main function is to supply a contact line system at which the voltage of a primary supply system, and in some cases the frequency, is transformed to the voltage and frequency of the contact line

3.1.4
rolling stock
all the vehicles with or without one or more motors

[SOURCE: IEC 60050-811: CDV2015, 811-02-01]

3.2 Abbreviations

For the purposes of this document, the following abbreviations apply.

AC	alternating current
bw	band width
DC	direct current
E	electric (field)
EMC	Electromagnetic Compatibility
FFT	Fast Fourier transform
H	magnetic (field)
HV	high voltage

4 Emission limits

4.1 Emission from the open railway system during train operation

The emission limits in the frequency range 150 kHz to 1 GHz are given in Figure 1 and the measurement method is defined in Clause 5.

Annex B gives guidance values for typical maximum field values at fundamental frequency of different electrification systems which may occur. They depend on numerous geometrical and operational parameters which may be obtained from the infrastructure manager.

It is not possible to undertake complete tests with quasi-peak detection due to the reasons stated in Annex A.

There may be cases in which radio or other railway external services with working frequencies below 150 kHz are in operation close to the railway system. The EMC management plan covers these cases and an adequate level of emission from the railway system on these working frequencies may be found in the values given in informative Annex C hence no guarantee can be given for an undisturbed operation.

4.2 Radio frequency emission from railway substations

Radio frequency noise emission from the railway substation to the outside environment measured according to the method defined in Clause 5 shall not exceed the limits in Figure 2.

The limits are defined as quasi-peak values and the bandwidths are those used in EN 55016-1-1:

	Bandwidth
frequencies from 150 kHz to 30 MHz	9 kHz
frequencies above 30 MHz	120 kHz

The distance of 10 m defined in Clause 5 shall be measured from the fence of the substation. If no fence exists, the measurements shall be taken at 10 m from the apparatus or from the outer surface of the enclosure if it is enclosed.

For other kinds of fixed installations like auto-transformers, the same limit and measuring distance shall be applied.

There may be cases in which radio or other railway external services with working frequencies below 150 kHz are in operation close to the railway substation. The EMC management plan covers these cases and an adequate level of emission from railway substation on these working frequencies may be found in the values given in informative Annex C hence no guarantee can be given for an undisturbed operation.

5 Method of measurement of emission from moving rolling stock and substations

NOTE The method of measurement is adapted from EN 55016–2–3 to a railway system with moving rolling stock and substations. The background to the method of measurement of moving rolling stock is given in Annex A.

5.1 General and specific measurement parameters

5.1.1 General measurement parameters

5.1.1.1 Frequency bands

Frequency bands and bandwidths at –6 dB used for measurements are in accordance with EN 55016-1-1.

These are:

Frequency bands:	0,15 MHz to 30 MHz	30 MHz to 300 MHz	300 MHz to 1 GHz
Bandwidth:	9 kHz	120 kHz	120 kHz

Other bandwidth for peak measurement can be chosen according to EN 55016-1-1. Data measured with the reference bandwidth shall take precedence.

5.1.1.2 Measurement uncertainty

The measurement uncertainty of the measuring equipment shall comply with the requirements in EN 55016-1-1 and EN 55016-1-4.

Due to the measurement method, the normalized site attenuation may not be considered in the measurement uncertainty.

5.1.1.3 Types of antennas

To cover the full frequency range, antennas of different design are required. Typical equipment is described below:

— for 150 kHz to 30 MHz, a loop or frame antenna is used to measure H field (see Figure 3);

— for 30 MHz to 300 MHz, a biconical dipole is used to measure E field (see Figure 4);

— for 300 MHz to 1,0 GHz, a log-periodic antenna is used to measure E field (see Figure 5).

For measurements in the frequency range of 30 MHz to 1 GHz a combined antenna may be used.

Calibrated antenna factors are used to convert the terminal voltage of the antenna to field strength.

5.1.1.4 Measurement distance and height

The preferred distance of the measuring antenna from the centreline of the track on which the vehicle is moving (Test track) is 10 m. In the case of the log-periodic antenna, the 10 m distance is measured to the mechanical centre of the array.

The preferred distance of the measuring antenna while measuring the emission of the substation is 10 m from the outer fence of the substation, at the midpoints of the three sides, excluding the side which faces the railway system, unless this side is more than 30 m from the centre of the nearest electrified railway track. In this case all four sides shall be measured. If the length of the side of the substation is more than 30 m, measurements shall be taken additionally at the corners.

Where the antennas are not at 10 m, the results can be converted to an equivalent 10 m value by using the following formula:

$$E_{10} = E_x + n \times 20 \times log_{10} (D/10)$$

where

E_{10} is the value at 10 m

E_x is the measured value at D m

n is a factor taken from Table 1 below.

Table 1 — Conversion factor n

Frequency range	n
0,15 MHz to 0,4 MHz	1,8
0,4 MHz to 1,6 MHz	1,65
1,6 MHz to 110 MHz	1,2
110 MHz to 1 000 MHz	1,0

The measured values (at the equivalent 10 m distance) shall not exceed the limits given in Figure 1 for the appropriate system voltage.

No measurements are necessary for total underground railway systems with no surface operation (no victim outside this railway system can be affected).

The height above reference level of the antenna centre shall be within the range 1,0 m to 2,0 m for the loop antenna, and within 2,5 m to 3,5 m to the centre of measuring antenna above 30 MHz. One measuring height within the given range is sufficient and it is not required to do measurements with several antenna heights within this range. The selected height shall be noted in the test report.

The reference level for the substation is the ground.

The reference level for moving trains is the top of the rail.

If the actual level of the ground at the antenna differs from the top of the rail by more than 0,5 m, the actual value shall be noted in the test report.

It is accepted that the fixed antenna position may result in values being less than the absolute maximum at some frequencies.

5.1.1.5 Values of measurement

The values measured are expressed as:

— dBμA/m for magnetic fields,

— dBμV/m for electric fields.

These are obtained by using the appropriate antenna factors and conversions.

5.1.1.6 Antenna position and orientation

The plane of the loop antenna shall be positioned to measure the horizontal component of the magnetic field perpendicular to the track respectively to the wall of the substation. The biconical dipole shall be placed in the vertical and horizontal axis. The log periodic antenna shall be arranged to measure the vertical and horizontal polarization signal, with the antenna directed towards the track respectively to the wall of the substation.

The test locations should whenever possible avoid objects with changing of field characteristic like turnouts, walls and under bridges.

Figures 3, 4 and 5 show the positions and vertical alignments of the antennas as an example for measurements at the track.

5.1.1.7 Ambient noise

At the beginning and at the end of the test series the ambient noise shall be recorded.

If at specific frequencies or in specific frequency ranges the ambient noise is higher than the limit values less 6 dB, the measurements at these frequencies need not be considered. These frequencies shall be noted in the test report.

5.1.2 Measurement parameter for moving trains

This subclause summarizes the specific conditions for the measurement of moving rolling stock.

— It is not considered necessary to carry out two tests to examine both sides of the rolling stock, even if it contains different apparatus on the two sides, as in the majority of cases the level of fields is due to the radiation of catenary and not to the direct radiation from the train. For systems with a third rail, measurements shall be performed at the same side of it.

— The peak measurement method is used. The duration at selected frequency shall be sufficient to obtain an accurate reading. This is a function of the measuring set and the recommended value is 50 ms.

— The noise may not attain its maximum value as the traction vehicle passes the measuring point, but may occur when the vehicle is a long distance away. Therefore, the measuring set shall be active for a sufficient duration before and after the vehicle passes by to ensure that the maximum noise level is recorded.

— In the case of elevated railway systems, if the antenna heights specified above cannot be achieved, the height of the antenna centre can be referenced to the level of the ground instead of to the top of the rail. The conversion formula in 5.1.1.4 shall be employed where D is the slant distance between the train and the antenna. The train shall be visible from the location of the antenna and the axis of the antenna shall be elevated to point directly at the train. A measurement distance of 30 m from the track centreline is preferred for highly elevated railway systems. Full details of the test configuration shall be noted in the test report.

— If tests are being carried out on a railway system with overhead electrified supply, the measuring point shall be at midspan between the support masts of the overhead contact line and not at a discontinuity of the contact wire. It is recognized that resonance can exist in an overhead system at radio frequencies and this may require changes in the values of frequency chosen for measurement. If resonance exists, this shall be noted in the test report.