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INTERNATIONAL STANDARD

colour inside

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

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RAILWAY APPLICATIONS – ELECTROMAGNETIC COMPATIBILITY –

Part 2: Emission of the whole railway system to the outside world

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 62236-2 has been prepared by IEC technical committee 9: Electrical equipment and systems for railways.

This third edition cancels and replaces the second edition published in 2008. It constitutes a technical revision and has been developed on the basis of EN 50121-2:2015.

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

a) clarification of scope (Clause 1);
b) combination of former Clause 5 and Annex A related to method of measurement for moving trains and traction substations (5.1);
c) moving emission values for radiated H-fields in the frequency range 9 kHz to 150 kHz to new Annex C due to the fact that:
   – there are very few outside world victims;
   – there is low reproducibility.
d) clarification of acquisition method (5.2).

This International Standard is to be read in conjunction with IEC 62236-1.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
9/2336/FDIS	9/2366/RVD

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

A list of all parts in the IEC 62236, published under the general title *Railway applications – Electromagnetic compatibility*, can be found on the IEC website.

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

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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RAILWAY APPLICATIONS – ELECTROMAGNETIC COMPATIBILITY –

Part 2: Emission of the whole railway system to the outside world

1 Scope

This part of IEC 62236 ~~sets~~ is intended to define the ~~emission limits from~~ electromagnetic environment of the whole railway system including urban ~~vehicles for use in city streets~~ 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 document specifies the emission limits of the whole railway system to the outside world.

The ~~limits~~ emission parameters refer to the particular measuring points defined in Clause 5 ~~and Annex A~~. These emissions ~~should be~~ are 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 ~~shall be~~ are considered individually.

These specific provisions are ~~to be~~ used in conjunction with the general provisions in IEC 62236-1.

For existing railway lines, it is assumed that compliance with the emission requirements of IEC 62236-3-1, IEC 62236-3-2, IEC 62236-4 and IEC 62236-5 will ensure the compliance with the emission values given in this document.

For newly built railway systems, it is best practice to provide compliance to the emission limits given in this document (to be defined in the EMC plan according to IEC 62236-1).

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 (EMC)*~~

IEC 62236-1:2018, *Railway applications – Electromagnetic compatibility – Part 1: General*

~~IEC 62236-3-1, *Railway applications – Electromagnetic compatibility – Part 3-1: Rolling stock – Train and complete vehicle*~~

CISPR 16-1-1:2015, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-1: Radio disturbance and immunity measuring apparatus – Measuring apparatus*

CISPR 16-1-4:2010, *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 16-1-4:2010/AMD1:2012
CISPR 16-1-4:2010/AMD2:2017

~~CISPR 22, *Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement*~~

3 Terms, definitions and abbreviated terms

For the purposes of this document, the following terms and definitions ~~of IEC 60050-161 and the following~~ 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

3.1 Terms and definitions

3.1.1
apparatus
~~electric or electronic product with an intrinsic function intended for implementation into a fixed railway installation~~
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
~~the surrounding objects or region which may influence the behaviour of the system and/or may be influenced by the system~~
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]

~~**3.3**~~
~~external interface~~
~~boundary where a system interacts with any other or where a system interacts with its environment~~

~~**3.4**~~
~~railway substation~~
~~installation the main function of which 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~~

~~**3.5**~~
~~**railway supply lines**~~
~~conductors running within the boundary of the railway which supply power to only the railway but are not energised at railway system voltage~~

3.1.3
traction substation, <in electric traction>
substation, <in electric traction>
substation the main function of which is to supply an electric traction system

Note 1 to entry: The synonym substation is used only when the context is clear.

[SOURCE: IEC 60050-811:2017, 811-36-02]

3.1.4
rolling stock
all vehicles with or without motors

Note 1 to entry: Examples of vehicles include a locomotive, a coach and a wagon.

[SOURCE: IEC 60050-811:2017, 811-02-01]

3.2 Abbreviated terms

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
ITU	International Telecommunication Union
r.m.s.	root mean square

4 Emission limits

4.1 Emission from the open railway ~~route~~ system during train operation

The emission limits in the frequency range ~~9~~ 150 kHz to 1 GHz are given in Figure 1 and the measurement method is defined in Clause 5. ~~For non-electrified lines, the limits are the same as those given for 750 V d.c.~~

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

~~For urban vehicles operating in city streets, the emission limits given in Figure 1 for 750 V d.c. conductor rail shall not be exceeded.~~

~~NOTE 1 There are very few external radio services operating in the range 9 kHz to150 kHz with which the railway can interfere. If it can be demonstrated that no compatibility problem exists, any emission level exceeding the relevant limits given in Figure 1 may be acceptable.~~

~~NOTE 2~~ 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~~ traction substations

Radio frequency ~~noise~~ emission from the ~~railway~~ traction substation to the outside environment measured according to the method defined in ~~Annex A~~ 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 CISPR 16-1-1:

	Bandwidth
~~frequencies up to 150 kHz~~	~~200 Hz~~
Frequencies from 150 kHz to 30 MHz	9 kHz (BW 1)
Frequencies above 30 MHz	120 kHz (BW 2)

The distance of 10 m defined in ~~Annex A~~ 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.

~~Emission of trains shall not enter into the measurement.~~

~~NOTE 1 There are very few external radio services operating in the range 9 kHz to 150 kHz with which the railway can interfere. If it can be demonstrated that no compatibility problem exists, any emission level exceeding the relevant limits given in Figure 2 may be acceptable.~~

~~NOTE 2~~ 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 traction substation. The EMC management plan covers these cases and an adequate level of emission from traction 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 ~~trains~~ rolling stock and substations

5.1 General and specific measurement parameters

NOTE The method of measurement is adapted from CISPR ~~16-1-1~~ 16-2-3 to a railway system with moving ~~vehicles~~ rolling stock and substations. The background to the method of measurement of moving rolling stock is given in Annex A.

~~The electromagnetic fields generated by rail vehicles when operating on a railway network are measured by means of field strength meters with several different set frequencies. The horizontal component of the magnetic field perpendicular to the track and both the vertical and horizontal (parallel to the track) components of the radiated electric field are measured.~~

5.1.1 General measurement parameters

5.1.1.1 Frequency bands

~~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.~~

Frequency bands and bandwidths at –6 dB used for measurements are in accordance with CISPR 16-1-1.

These are:

Frequency bands:	~~9-150 kHz~~	0,15 MHz to 30 MHz	30 MHz to 300 MHz	300 MHz to 1 GHz
Bandwidth:	~~200 Hz~~	9 kHz (BW 1)	120 kHz (BW 2)	120 kHz (BW 2)

~~When connected to the antenna, the error of measurement of the strength of a uniform sine-wave field shall not differ more than ± 4,0 dB from CISPR 16-1-1 equipment.~~

Other bandwidth for peak measurement can be chosen according to CISPR 16-1-1. Data measured with the reference bandwidth shall take precedence.

~~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.~~

5.1.1.2 Measurement uncertainty

The measurement uncertainty of the measuring equipment shall comply with the requirements in CISPR 16-1-1 and CISPR 16-1-4.

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 9 kHz to 30 MHz, a loop or frame antenna is used to measure H field (see Figure 3);~~
- 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.

~~It is not considered necessary to carry out two tests to examine both sides of the vehicle, even if it contains different apparatus on the two sides, since the majority of the emission is produced by the sliding contact if the train is moving.~~

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 tests are carried out at a site which meets all the recommended criteria except that~~ the antennas are not at 10 m ~~from the track centreline~~, 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*
~~9 kHz to 150 kHz~~	~~2~~
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 Figure1 for the appropriate system voltage.

~~Where the physical layout of the railway totally prevents the use of reference distances, a method shall be agreed to suit the particular circumstances. For example, if the railway is in tunnel, miniature antennas can be used on the wall of the tunnel. In such a case, the limits selected shall take into account the method of measurement.~~

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 ~~rail~~ 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 ~~dipole or log-periodic antennas~~ 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 ~~level~~ 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 ~~vertical and parallel to the line of the track~~ 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 (ambient noise > (emission limit – 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 have to 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 ~~level~~. 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~~s~~ 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 ~~the mid-point~~ 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