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INTERNATIONAL STANDARD

colour inside

Railway applications – Electromagnetic compatibility – Part 3-1: Rolling stock – Train and complete vehicle

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FOREWORD

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International Standard IEC 62236-3-1 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 50121-3-1:2015.

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

a) clarification of scope (Clause 1);

b) clarification of definitions (Clause 3);

c) clarification of applicability (Clause 4);

d) clarification of interference on outside party telecommunication lines (6.2), psophometric current (Annex A);

e) moving emission values for radiated H-field in the frequency range 9 kHz to 150 kHz into new Annex C due to the fact that:

   – there are very few outside world victims (e.g. radio services),

   – the radiated emission measured at 10 m is not representative of the compatibility with internal railway apparatus,

   – the EMC with other railway apparatus in this frequency range is covered in other procedures and standards like IEC 62427 series,

   – there is low reproducibility.

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
9/2337/FDIS	9/2367/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.

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

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

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- withdrawn,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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INTRODUCTION

High powered electronic equipment, together with low power microcontrollers and other electronic devices, is being installed on trains in great numbers. Electromagnetic compatibility has therefore become a critical issue for the design of train-related apparatus as well as of the train as a whole.

This Product Standard for rolling stock sets limits for electromagnetic emission and immunity in order to ensure a well functioning system within its intended environment.

Immunity limits are not given for the complete vehicle. Part 3-2 of this series defines requirements for the apparatus installed in the rolling stock, since it is impractical to test the complete unit. An EMC plan ~~should be established for~~ includes equipment covered by this document.

RAILWAY APPLICATIONS – ELECTROMAGNETIC COMPATIBILITY –

Part 3-1: Rolling stock – Train and complete vehicle

1 Scope

This part of IEC 62236 specifies the emission and immunity requirements for all types of rolling stock. It covers traction stock, hauled stock and trainsets including urban vehicles for use in city streets. This document specifies the emission limits of the rolling stock to the outside world.

The scope of this document ends at the interface of the rolling stock with its respective energy inputs and outputs. In the case of ~~locomotives~~ traction units, trainsets, trams, etc., this is the current collector (pantograph, shoe gear). In the case of hauled stock, this is the AC or DC auxiliary power connector. However, since the current collector is part of the traction stock, it is not entirely possible to exclude the effects of this interface with the power supply line. The slow moving test has been designed to minimize these effects.

~~Basically, all apparatus to be integrated into a vehicle should meet the requirements of Part 3-2 of this standard. In exceptional cases, where apparatus meets another EMC standard, but full compliance with Part 3-2 is not demonstrated, EMC should be assured by adequate integration measures of the apparatus into the vehicle system and/or by an appropriate EMC analysis and test which justifies deviating from Part 3-2.~~

There may be additional compatibility requirements within the railway system identified in the EMC plan (e.g. as specified in IEC 62427).

~~The electromagnetic interference concerning~~ Electromagnetic emissions of the railway system as a whole ~~is~~ are dealt with in IEC 62236-2.

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

The frequency range considered is from 0 Hz (DC) to 400 GHz. No measurements need to be performed at frequencies where no requirement is specified.

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

IEC 62236-2:2018, *Railway applications – Electromagnetic compatibility – Part 2: Emission of the whole railway system to the outside world*

IEC 62236-3-2:2018, *Railway applications – Electromagnetic compatibility – Part 3-2: Rolling stock – Apparatus*

~~IEC 62427, *Railway applications – Compatibility between rolling stock and train detection systems*~~

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*

~~ITU-T, *Directive concerning the protection of telecommunication lines against harmful effects from electrical power and electrified railway lines – Volume VI: Danger and disturbances*~~

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions 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

3.1.1
traction stock
~~electric and diesel locomotives, high speed trainsets, electric and diesel multiple units (no locomotive, each coach has its own traction equipment) for main line vehicles, Light Railway Vehicles (LRV) such as underground trainsets, trams, etc., for urban vehicles~~
electric and diesel traction unit, high speed trainset, elementary fixed combination of traction stock and hauled stock, electric and diesel multiple unit (no traction unit, distributed traction equipment), Light Railway Vehicle (LRV), such as tram, trolley bus or any other electrical vehicle for urban mass transit, underground trainset

3.1.2
hauled stock
~~all~~ independent passenger coaches and freight wagons (if they contain electric apparatus such as freezing equipment) which may be hauled in random combinations by different types of ~~locomotives~~ traction units

3.1.3
main line vehicles
vehicles such as high speed trains, suburban trains, freight trains, mainly designed to operate between cities

3.1.4
urban vehicles
vehicles such as underground trainsets, trams, LRV (Light Rail Vehicles), trolleybuses, mainly designed to operate within the boundary of a city

3.2 Abbreviated terms

AC	Alternating current
BW	Band width
DC	Direct current
E	Electric (field)
EMC	Electromagnetic compatibility
EUT	Equipment under test

H	Magnetic (field)
ISDN	Integrated Services Digital Network
ITU-T	International Telecommunucation Union – Telecommunication Standardization Sector
LRV	Light rail vehicle
PCM	Pulse – code modulation
QC	Quadrant converters
QP	Quasi-Peak
xDSL	All types of **d***igital* **s***ubscriber* **l***ines*

4 Applicability

Generally, it is not possible to test electromagnetic compatibility invoking every function of the stock. The tests shall be made at typical operating modes considered to produce the largest emission.

The typical operating mode shall require all systems to be energised which are normally in continuous operation during service. It is not necessary during the test to exercise systems which operate transiently such as for example operation of internal doors, although they should be energised. It is not necessary to test degraded modes of operation.

The configuration and mode of operation shall be specified in the test plan and the actual conditions during the tests shall be precisely noted in the test report.

5 Immunity ~~tests and limits~~ requirements

No tests are applied to the complete vehicle~~, but the immunity tests and limits in Part 3-2 of this standard were selected in the knowledge that the vehicle can be deemed to be immune to a level of 20 V/m over the frequency range 0,15 MHz to 2 GHz~~. It is expected that the assembly of the apparatus into a complete vehicle will give adequate immunity, provided that an EMC plan has been prepared and implemented, taking into account the ~~limits~~ requirements in IEC 62236-3-2.

In exceptional cases, where apparatus meets another EMC Standard, but full compliance with IEC 62236-3-2 is not demonstrated, EMC shall be ensured by adequate integration measures of the apparatus into the vehicle system and/or by an appropriate EMC analysis and test which justifies deviating from IEC 62236-3-2.

6 Emission tests and limits

6.1 General

The emission tests and limits for rolling stock in this document should ensure as far as possible that the rolling stock does not interfere with typical installations in the vicinity of the railway system.

Measurements shall be performed in well-defined and reproducible conditions. It is not possible to totally separate the effects of the railway system and the stock under test. ~~Therefore, the operator and the manufacturer have to define in the contract the test conditions and the test site for compatibility with signalling and communication systems and for interference on telecommunication lines, (e.g. load conditions, speed and configuration of the units).~~ For radiated emissions, the test conditions are defined in 6.3.1 and 6.3.2. ~~The contributions of other parts of the railway system (e.g. substations, signalling) and of the~~

~~external environment (e.g. power lines, industrial sites, radio and television transmitters) to the measurements must be known and taken into account.~~

~~6.1 Compatibility with signalling and communication systems~~

NOTE 1 Signalling and communication, train radio and other railway systems (axle counters, track circuits, train control systems, etc.) are different in every country in terms of operating frequencies and waveforms. Therefore, ~~emission~~ compatibility requirements ~~shall be~~ are specified according to the type of signalling and communication systems used ~~(see IEC 62427)~~.

NOTE 2 There can be cases in which radio or other railway external services with working frequencies below 150 kHz are in operation close to the railway. The EMC plan covers these cases and an adequate level of emission from railway 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.

~~The requirements need to take into account sources of disturbance other than the rolling stock, including the train radio and signalling systems themselves, and the effects of transients due to bad contact, pantograph bouncing, third rail gaps, etc.~~

6.2 Interference on outside party telecommunication lines

6.2.1 Digital telecommunication lines

Interference with digital systems such as PCM, ISDN, xDSL is not covered in this document.

It should be noted that these systems operate in a higher frequency range using multiple carriers and various automatic error correction protocols.

It is considered unlikely that rolling stock can produce sufficient interference in this frequency range.

6.2.2 Analogue telecommunication lines

~~The harmonics in the traction current of a railway system may induce noise in a conventional analogue telecommunication system. The acceptable level of noise on conventional analogue telephone lines is specified by ITU-T. The value of this noise is measured with a psophometric filter. The relationship between the current absorbed or generated by the traction vehicle and the noise in the telephone line is neither under the total control of the vehicle manufacturer nor of the operator of the network (for details see Clause A.1). Thus it shall be the responsibility of the purchaser of the tractive stock in accordance with the rules of the Infrastructure Controllers to specify a frequency weighted current limit at the vehicle interface.~~

~~One method commonly used is to specify the psophometric current I_{pso} which has a psophometrical frequency weighting. The background and application of this method is described in Annex A. As it is known that the I_{pso} method does not fully represent the noise effect of the harmonics in the kHz range, alternative methods of frequency weighting may be specified by the purchaser.~~

No harmonized limits apply.

Information about interference on telecommunication lines can be found in Annex A.

6.3 Radiated electromagnetic disturbances

6.3.1 Test site

~~The test site shall meet as far as possible the "free space" requirements below within the existing constraints of the railway environment:~~

~~– no trees, walls, bridges, tunnels or vehicles shall be close to the measurement point, minimum separation distance:~~

~~30 m for main line vehicles,~~

~~10 m for urban vehicles;~~

It can be assumed that measurements will not take place in laboratory conditions. Trees, walls, bridges, tunnels or other conductive objects in the vicinity of the measurement antenna could have an impact on the measurement. Other railway vehicles operating in the same feeding section or nearby the measuring point may affect the measurement result. Overhead/third rail discontinuities as well as substations, power lines, buried lines, transformers, neutral sections, section insulators, etc., close to the measuring point may cause additional variations.

These influences shall be reduced as far as practical but in any case no obstacles above rail level which may influence the measurements shall be located between antenna and EUT.

The overhead/third rail should be a continuous line as far as practical on both sides of the measurement point (typically at least 200 m).

Since it is impossible to avoid the support masts of the overhead, the measurement point shall be at the midpoint between masts, on the opposite side of the track (in case of a double track, on the side of the track which is being used). If the railway system is powered by a third rail, the antenna shall be on the same side of the track (worst case).

~~– the overhead/third rail should be an "infinite" line on both sides of the measurement point, the minimum clear length on both sides of the measurement point should be:~~

~~3 km for main line vehicles,~~

~~500 m for urban vehicles~~

~~Overhead/third rail discontinuities as well as substations, transformers, neutral sections, section insulators, etc., should be avoided.~~

Since resonances may occur in the overhead line at radio-frequencies, it may be necessary to change the test site. The exact location of the test site and features of both the site and the overhead system layout shall be noted.

The contribution of the substation may be considered when assessing the emissions from the vehicle. Note that the contribution of a DC substation depends on its load current and will not be measured properly in a no-load condition.

~~– close proximity to power lines including buried lines, substations, etc., should be avoided;~~

~~– no other railway vehicle should be operating in the same feeding section or within a distance of~~

~~20 km for main line vehicles,~~

~~2 km for urban vehicles~~

~~If these conditions are not possible, the ambient noise before and after each emission measurement of the vehicle under test shall be recorded. Otherwise, only two ambient noise measurements at the beginning and the end of the test series are sufficient.~~

At the beginning and at the end of the test series the ambient noise shall be recorded. This measurement shall be done without any influence of the vehicle.

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

NOTE It is helpful to perform this ambient noise measurement also with the vehicle completely powered down in front of the antenna.

6.3.2 Test conditions

The tests shall cover the operation of all systems onboard the rolling stock which may produce radiated emissions.

Hauled stock (a representative version) shall be tested while stationary in an energised mode (auxiliary converters, battery chargers, etc., in operation). The antenna should be sited opposite the equipment expected to produce the greatest emissions at the frequencies under measurement.

Tests for identical coaches or wagons are performed only once.

Traction stock shall be tested while stationary and at slow moving speed. During the stationary test, the auxiliary converters shall operate (it is not inevitably under maximum load conditions that the maximum emission level is produced) and the traction converters shall be under voltage but not operating. The antenna ~~should~~ shall be ~~sited opposite~~ in front of the middle of each vehicle ~~centre line~~ unless an alternative location is expected to produce higher emission levels.

For the slow moving test, the speed shall be low enough to avoid arcing at or bouncing of the sliding contact and high enough to allow for electric braking. The recommended speed range is (20 ± 5) km/h for urban vehicles and (50 ± 10) km/h for main line vehicles. When passing the antenna, the vehicle shall accelerate or decelerate with approximately 1/3 of its maximum tractive effort within the given speed range.

The slow moving test may be replaced by a stationary test with the vehicle operating at 1/3 of its maximum tractive effort against the mechanical brakes, if the following conditions are fulfilled:

– the traction equipment ~~allows for operation whilst~~ can be operated while the vehicle is stationary;
– tests of electric braking are not required, if no different circuits are used in braking.

If the slow moving test is replaced by a stationary test with tractive effort, then the slow moving limits ~~shall be applied~~ apply. ~~The decision for the stationary test with tractive effort has to be justified in the test report.~~

Any vehicles using onboard energy storage for traction shall use the test procedure and limits for slow moving test for the charging process.

NOTE Slow moving test procedure and limits are used for charging process (for traction energy storing devices) because it has a short duration with high energy transfer.

6.3.3 Emission limits

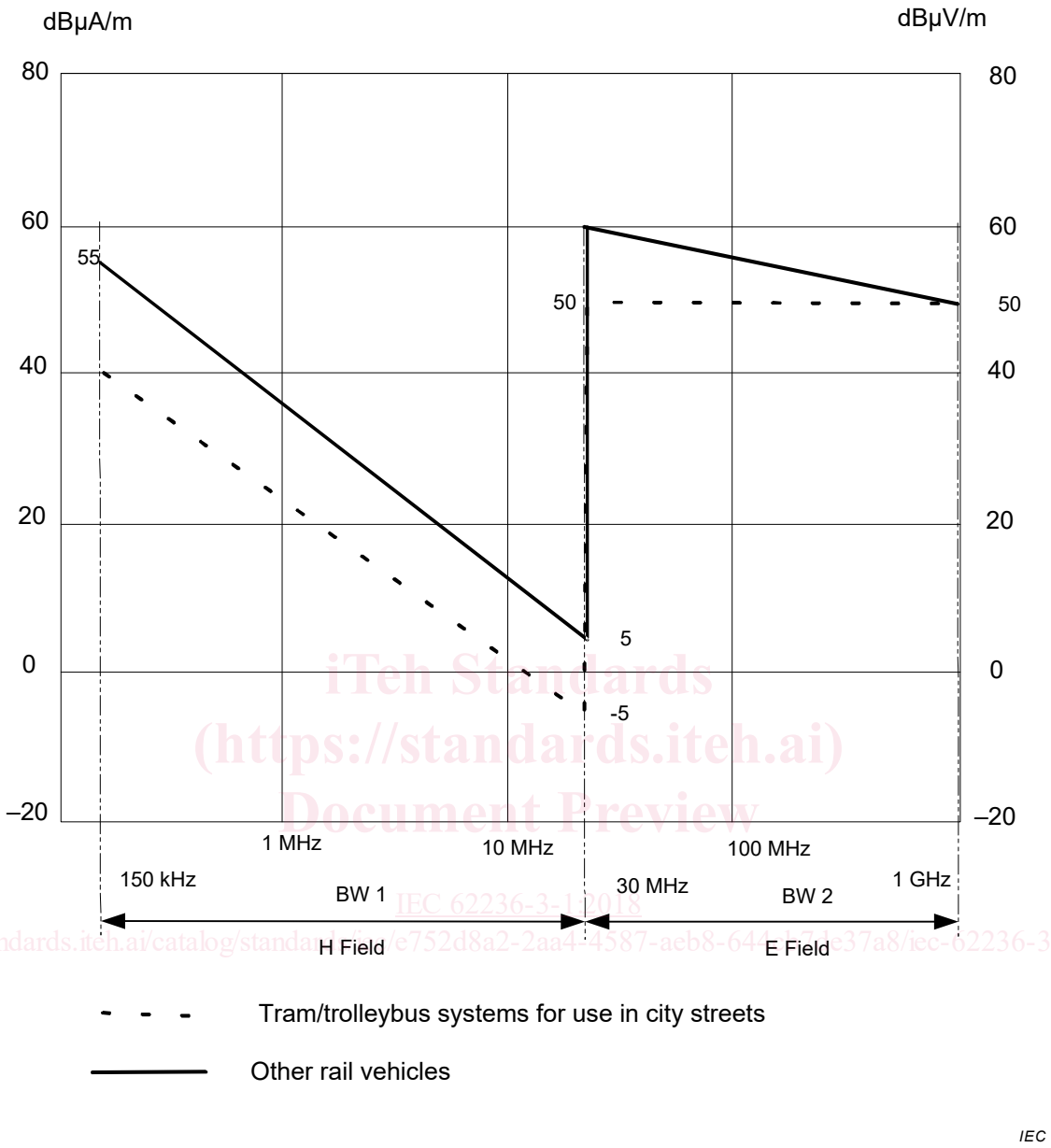

Figure 1 – Limits for stationary test (quasi-peak, 10 m)

~~NOTE~~ 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~~ from 30 MHz to 1 GHz	120 kHz (BW 2)

~~NOTE~~ All values are measured at a distance of 10 m from the centre of the track.

The emission limits are specified up to 1 GHz due to the fact that there are no significant sources of interference above 1 GHz and that emissions from microprocessor controlled equipment which may give rise to emissions at frequencies greater than 1 GHz are addressed by compliance with IEC 62236-3-2.