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INTERNATIONAL STANDARD

colour inside

Railway applications – Electromagnetic compatibility –
Part 5: Emission and immunity of fixed power supply installations and apparatus

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RAILWAY APPLICATIONS – ELECTROMAGNETIC COMPATIBILITY –

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

FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

International Standard IEC 62236-5 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 50121-5:2015.

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

a) clarification of scope (Clause 1);
b) emission requirement extended in the frequency range 1 GHz to 6 GHz following IEC 61000-6-4;
c) immunity requirement extended in the frequency range 5,1 GHz to 6 GHz;
d) removal of limits for radiated H-fields in the frequency range 9 kHz to 150 kHz due to the fact that:
   – there are very few outside world victims;
   – there is low reproducibility.

This 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
9/2340/FDIS	9/2370/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- withdrawn,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

The requirements of this part of IEC 62236 have been specified so as to ensure a level of electromagnetic emission which will cause minimal disturbance to other equipment. The levels, however, do not cover the following cases:

~~a) where the probability of an occurrence likely to produce emissions in excess of those which would normally be experienced is extremely low,~~

a) which may occur with an extremely low probability of occurrence in any location;

b) where highly susceptible apparatus ~~will be~~ is used in close proximity of the equipment covered by this document, in which case further measures may have to be taken.

The emission limits given are on the basis that the equipment of the product family range is installed in ~~railway~~ traction substation areas.

RAILWAY APPLICATIONS – ELECTROMAGNETIC COMPATIBILITY –

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

1 Scope

This part of IEC 62236 applies to emission and immunity aspects of EMC for ~~fixed power supply installations and~~ electrical and electronic apparatus and systems intended ~~to be used in these installations~~ for use in railway fixed installations for power supply. This includes the power feed to the apparatus, the apparatus itself with its protective control circuits, trackside items such as switching stations, power autotransformers, booster transformers, substation power switchgear and power switchgear to other longitudinal and local supplies.

Filters operating at railway system voltage (for example, for harmonic suppression or power factor correction) are not included in this document since each site has special requirements. Filters would normally have separate enclosures with separate rules for access. If electromagnetic limits are required, these will appear in the specification for the equipment.

~~The limits in this standard do not apply to intentional communication signals.~~

If a port is intended to transmit or receive for the purpose of radio communication (intentional radiators, e.g. transponder systems), then the radiated emission requirements in this document are not intended to be applicable to the intentional transmission from a radio-transmitter as defined by the ITU.

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

Emission and immunity limits are given for items of apparatus which are situated:

a) within the boundary of a substation which delivers electric power to a railway;

b) beside the track for the purpose of controlling or regulating the railway power supply, including power factor correction ~~and filtering~~;

c) along the track for the purpose of supplying electrical power to the railway other than by means of the conductors used for contact current collection, and associated return conductors. Included are high voltage feeder systems within the boundary of the railway which supply substations at which the voltage is reduced to the railway system voltage;

~~NOTE 1 Examples are one conductor of a 25-0-25 kV 50 Hz system and the 110 kV 16,7 Hz supply systems.~~

~~NOTE 2 Similar conductors which are outside the railway boundary are treated as in the public area and are considered to be general overhead power lines although they feed only the railway.~~

d) beside the track for controlling or regulating electric power supplies to ancillary railway uses. This category includes power supplies to marshalling yards, maintenance depots and stations;

e) various other non-traction power supplies from railway sources which are shared with railway traction.

The immunity levels given in this document apply for:

– vital equipment such as protection devices;

– equipment having connections to the traction power conductors;

– apparatus inside the 3 m zone;

– ports of apparatus inside the 10 m zone with connection inside the 3 m zone;
– ports of apparatus inside the 10 m zone with cable length > 30 m.

Apparatus and systems which are in an environment which can be described as residential, commercial or light industry, even when placed within the physical boundary of the railway substation, ~~shall comply with the relevant generic International EMC standard~~ comply with IEC 61000-6-1 for immunity and IEC 61000-6-3 for emission requirements.

Excluded from the immunity requirements of this document is power supply apparatus which is intrinsically immune to the tests defined in Table 1 to Table 6 of this document.

NOTE An example is an 18 MVA 230 kV to 25 kV power supply transformer.

These specific provisions are ~~to be~~ used in conjunction with the general provisions in 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 61000-3-2, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current up to and including 16 A per phase)*~~

~~IEC 61000-3-3, *Electromagnetic compatibility (EMC) – Part 3-3: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection*~~

IEC 61000-4-2:2008, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3:2006, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4:2012, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-5:2014, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61000-4-6:2013, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-8:2009, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*

~~IEC 61000-4-12, *Electromagnetic compatibility (EMC) – Part 4-12: Testing and measurement techniques – Ring wave immunity test*~~

IEC 61000-4-18:2006, *Electromagnetic compatibility (EMC) – Part 4-18: Testing and measurement techniques – Damped oscillatory wave immunity test*

IEC 61000-6-4:2006, *Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments*
IEC 61000-6-4:2006/AMD1:2010

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*

~~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*~~

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

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
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
~~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]

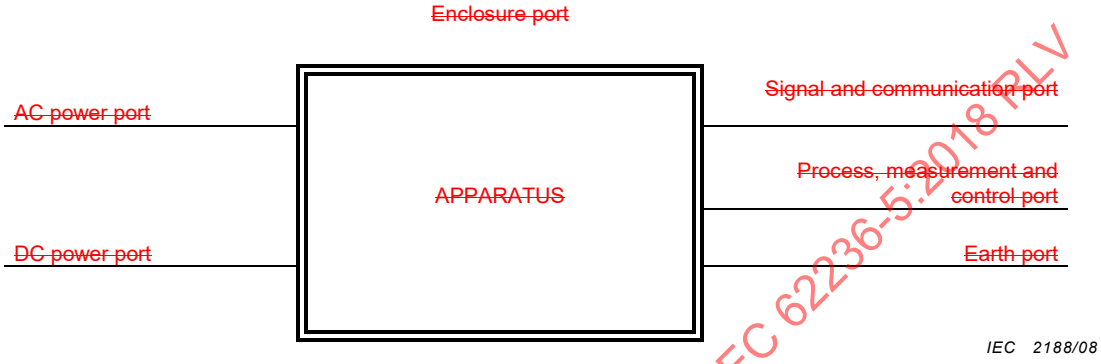
[SOURCE: IEC 60050-901:2013, 901-07-01]

~~**3.3**~~
~~**port**~~
~~particular interface of the apparatus with the external environment, for example a.c. power port, d.c. power port, I/O (input/output) port, earth port (see Figure 1)~~

~~**3.4**~~
~~**enclosure port**~~
~~physical boundary of the apparatus through which electromagnetic fields may radiate or impinge~~

~~**3.5**~~
~~**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~~

~~**3.6**~~
~~**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~~



~~**Figure 1 – Main categories of ports**~~

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
long bus
bus cables with a length of more than 30 m

3.1.5
3 m zone
area along the railway line within a distance of 3 m from the centreline of the nearest track at both sides of the track

3.1.6
10 m zone
area along the railway line within a distance of 10 m from the centreline of the nearest track at both sides of the track

3.1.7
railway system voltage
railway system dedicated voltage converted from high voltage

EXAMPLE 25-0-25 kV, 50 Hz; 110 kV, 16,7 Hz.

3.2 Abbreviated terms

AC	Alternating current
AM	Amplitude modulation
DC	Direct current

EMC Electromagnetic compatibility
ITU International Telecommunication Union
r.m.s. Root mean square

4 Performance criteria

The variety and diversity of the apparatus within the scope of this document make it difficult to define precise criteria for the evaluation of the immunity test results. Three general levels of performance are therefore used, as defined in IEC 62236-1.

5 Emission tests and limits

5.1 Emission from the traction substation to the outside world

Limit values for this emission, over the frequency range ~~9~~ 150 kHz to 1 GHz are given in IEC 62236-2.

~~NOTE~~ Guidance values are given in IEC 62236-2 for emission of DC and power frequency magnetic fields.

Conductors (overhead or underground) between the substation and the railway are part of the railway installation, but because of their wide variety of positions and ampere loadings, limit values cannot be set for the magnetic fields which they produce.

~~For apparatus which is under ground, measurements shall be made in the frequency range 9 kHz to 150 kHz at the surface of the ground above the apparatus.~~

~~NOTE~~ No limits are set for emissions into the active space of the underground railway due to the complexities of obtaining measurements in the confined space and the lack of a precise method of relating the measured values to the degree of disturbance which other apparatus would suffer.

No measurements are necessary for total underground railway systems with no surface operation.

5.2 Emission test for apparatus operating at less than 1 000 V r.m.s. AC

The emission limits for apparatus covered by this document which is supplied with electrical power at a voltage below 1 000 V r.m.s. are given on a port by port basis in IEC 61000-6-4~~, Table 1~~.

5.3 Emission values within the boundary of the substation

Because there is such a wide variety of options for the design and the construction of the substation, limits are not given for emission within the general space inside the boundary of the substation. Practical measurements have been made and guidance values are given in Annex A. These are for information only and are not part of the normative content of this document.

6 Immunity ~~tests and limits~~ requirements

The immunity test requirements for apparatus covered by this document are given on a port by port basis in Table 1 to Table 6.

Tests shall be conducted in a well-defined and reproducible manner. The tests shall be carried out as single tests in sequence. The sequence of testing is optional.

The description of the tests, the test generator, the test methods, and the test set-up are given in the Basic Standards which are referred to in Table 1 to Table 6. The contents of the Basic Standards are not repeated herein, however, modifications or additional information needed for the practical application of the tests are given in this document.

Where possible, the tests shall be made with a typical operating mode chosen to produce the maximum susceptibility to ~~noise~~ disturbance in the frequency band being investigated, consistent with normal applications. The manufacturer shall define the conditions of the test in the test plan.

~~NOTE~~ If the apparatus is part of a system or can be connected to auxiliary apparatus, then the apparatus should preferably be tested while connected to the minimum configuration of auxiliary apparatus necessary to exercise the test point in accordance with the general methods of ~~CISPR 22 and~~ IEC 61000-4 series.

The configuration and mode of operation during the tests shall be precisely noted in the test report. It is not always possible to test every function of the apparatus; in such cases the most critical mode of operation should be selected.

The tests shall be carried out within the specified operating range for the apparatus and at its rated supply voltage.

Some of the immunity levels are higher than those of the heavy industrial Generic Standard, because this has been found necessary in practice.

Voltages induced by traction currents are not ~~addressed~~ treated here. They ~~shall~~ have to be covered by the functional specification (e.g. IEC 62497-1).

Table 1 – Immunity – Enclosure port

	Environmental phenomena	Test specification		Basic standard	Test set-up	Remarks	Performance criteria
1.1	**Radio-frequency electromagnetic field, amplitude modulated**	80 MHz - 1 000 MHz 10 V/m (r.m.s.) 80 % AM, 1 kHz	Unmodulated carrier	IEC 61000-4-3	IEC 61000-4-3	The test level specified is the r.m.s. value of the unmodulated carrier	**A**
1.2	**Radio-frequency electromagnetic field, from digital mobile telephones**	800 MHz - 1 000 MHz 20 V/m (r.m.s.) 80 % AM, 1 kHz	Unmodulated carrier	IEC 61000-4-3	IEC 61000-4-3	See Note 3 The test level specified is the r.m.s. value of the unmodulated carrier	**A**
		1 400 MHz - 2 100 MHz 10 V/m (r.m.s.) 80 % AM, 1 kHz	Unmodulated carrier				
		2 100 MHz - 2 500 MHz 5 V/m (r.m.s.) 80 % AM, 1 kHz	Unmodulated carrier				
1.3	**Power - frequency magnetic field**	16,7 Hz; 50/60 Hz 100 A/m (r.m.s.)	a.c. systems	IEC 61000-4-8	IEC 61000-4-8	See Note 1 All frequencies have to be tested	**A**
		0 Hz 300 A/m	d.c. systems			See Note 1	
1.4	**Electrostatic discharge**	± 6 kV ± 8 kV	Contact discharge Air discharge	IEC 61000-4-2	IEC 61000-4-2	See Note 2	**B**

NOTE 1 Test only applies to apparatus containing devices sensitive to magnetic fields, for example Hall elements, electro-dynamic microphones, etc. Unshielded CRT displays can exhibit interference effects above 1A/m (r.m.s.).

NOTE 2 See basic standard for applicability of contact and/or air discharge test.

NOTE 3 The test in 5.2 of IEC 61000-4-3 should be applied at the digital radio telephone frequencies in use in the countries in which the equipment is intended to be operated.

	Environmental phenomena	Test specification		Basic standard	Test set-up	Applicability note	Remarks	Performance criteria
1.1	**Radio-frequency electromagnetic field. Amplitude modulated**	80 MHz to 800 MHz 10 V/m (r.m.s.) 80 % AM, 1 kHz	Unmodulated carrier	IEC 61000-4-3	IEC 61000-4-3		The test level specified is the r.m.s. value of the unmodulated carrier	**A**
1.2	**Radio-frequency electromagnetic field**	800 MHz to 1 000 MHz 20 V/m (r.m.s.) 80 % AM, 1 kHz	Unmodulated carrier	IEC 61000-4-3	IEC 61000-4-3		The test level specified is the r.m.s. value of the unmodulated carrier These tests are intended to simulate disturbances from digital communication devices	**A**
		1 400 MHz to 2 000 MHz 10 V/m (r.m.s.) 80 % AM, 1 kHz	Unmodulated carrier					
		2 000 MHz to 2 700 MHz 5 V/m (r.m.s.) 80 % AM, 1 kHz	Unmodulated carrier					
		5 100 MHz to 6 000 MHz 3 V/m (r.m.s.) 80 % AM, 1 kHz	Unmodulated carrier					

	Environmental phenomena	Test specification		Basic standard	Test set-up	Applicability note	Remarks	Performance criteria
1.3	**Power – frequency magnetic field**	16,7 Hz 100 A/m 50 Hz / 60 Hz 100 A/m 0 Hz 300 A/m		IEC 61000-4-8	IEC 61000-4-8	See [a]	Tests only for applicable frequencies Testing time is ≥ 10 s	**A**
1.4	**Electrostatic discharge**	± 6 kV ± 8 kV	Contact discharge Air discharge	IEC 61000-4-2	IEC 61000-4-2	See [b]		**B**

[a] Test only applies to apparatus containing devices sensitive to magnetic fields, e.g. Hall elements, electro-dynamic microphones, etc. Unshielded CRT displays can exhibit interference effects above 1 A/m (r.m.s.).

[b] See basic standard for applicability of contact and/or air discharge test.

Table 2 – Immunity – Ports for signal lines and data buses not involved in process control

	Environmental phenomena	Test specification		Basic standard	Test set-up	Applicability note	Remarks	Performance criteria
2.1	**Radio-frequency common mode**	0,15 MHz to 80 MHz 10 V (r.m.s.) 80 % AM, 1 kHz	Unmodulated carrier	IEC 61000-4-6	IEC 61000-4-6	See [a]	The test level specified is the r.m.s. value of the unmodulated carrier	**A**
2.2	**Fast transients**	± 2 kV 5/50 ns 5 kHz	Peak T_r / T_h Repetition frequency	IEC 61000-4-4	IEC 61000-4-4	See [b]	Capacitive clamp used	~~**B**~~ **A**

[a] The test level can also be defined as the equivalent current into a 150 Ω load.

[b] Applicable only to ports interfacing with cables whose total length according to the manufacturer's functional specification may exceed 1 m.

Table 3 – Immunity – Ports for process, measurement and control lines, and long bus

	Environmental phenomena	Test specification		Basic standard	Test set-up	Applicability note	Remarks	Performance criteria
3.1	**Radio-frequency common mode**	0,15 MHz to 80 MHz 10 V (r.m.s.) 80 % AM, 1 kHz	Unmodulated carrier	IEC 61000-4-6	IEC 61000-4-6	See [a]	The test level specified is the r.m.s. value of the unmodulated carrier	**A**
3.2	**Damped oscillatory voltage** **(oscillatory waves)**	2,5 kV 1 kV	Line to earth Line to line	IEC 61000-4-18	IEC 61000-4-18		Both 100 kHz and 1 MHz	**B**
3.3	**Fast transients**	± 2 kV 5/50 ns 5 kHz	Peak T_r / T_h Repetition frequency	IEC 61000-4-4	IEC 61000-4-4		Capacitive clamp used	~~B~~ **A**
3.4	**Surges**	1,2 / 50 µs ± 2 kV ± 1 kV	Open circuit test voltage, line to earth Open circuit test voltage, line to line	IEC 61000-4-5	IEC 61000-4-5		All severity levels below the given severity level have to be tested with 5 pulses for each severity level and a test sequence not alternating but starting with one polarity followed by the other polarity.	**B**

[a] The test level can also be defined as the equivalent current into a 150 Ω load.

Table 4 – Immunity – DC input and DC output power ports

	Environmental phenomena	Test specification		Basic standard	Test set-up	Applicability note	Remarks	Performance criteria
4.1	**Radio-frequency common mode**	0,15 MHz to 80 MHz 10 V (r.m.s.) 80 % AM, 1 kHz	Unmodulated carrier	IEC 61000-4-6	IEC 61000-4-6	See [a]	The test level specified is the r.m.s. value of the unmodulated carrier	**A**
4.2	**Fast transients**	± 4 kV 5/50 ns 5 kHz	Peak T_r / T_h Repetition frequency	IEC 61000-4-4	IEC 61000-4-4	See [b]		~~**B**~~ **A**
4.3	**Surges**	1,2 / 50 µs ± 2 kV ± 1 kV	Open circuit test voltage, line to earth Open circuit test voltage, line to line	IEC 61000-4-5	IEC 61000-4-5	See [b]	All severity levels below the given severity level have to be tested with 5 pulses for each severity level and a test sequence not alternating but starting with one polarity followed by the other polarity.	**B**

[a] The test level can also be defined as the equivalent current into a 150 Ω load.

[b] Not applicable to input ports intended for connection to a battery or a rechargeable battery which ~~must~~ shall be removed or disconnected from the apparatus for recharging.

Table 5 – Immunity – AC input and AC output power ports

	Environmental phenomena	Test specification		Basic standard	Test set-up	Applicability note	Remarks	Performance criteria
5.1	**Radio-frequency common mode**	0,15 MHz to 80 MHz 10 V (r.m.s.) 80 % AM, 1 kHz	Unmodulated carrier	IEC 61000-4-6	IEC 61000-4-6	See [a]	The test level specified is the r.m.s. value of the unmodulated carrier	**A**
5.2	**Fast transients**	± 4 kV 5/50 ns 5 kHz	Peak T_r / T_h Repetition frequency	IEC 61000-4-4	IEC 61000-4-4			~~**B**~~ **A**
5.3	**Surges**	1,2 / 50 µs ± 4 kV ± 2 kV	Open circuit test voltage, line to earth Open circuit test voltage, line to line	IEC 61000-4-5	IEC 61000-4-5		All severity levels below the given severity level have to be tested with 5 pulses for each severity level and a test sequence not alternating but starting with one polarity followed by the other polarity.	**B**
[a] The test level can also be defined as the equivalent current into a 150 Ω load.								

Table 6 – Immunity – Earth port

	Environmental phenomena	Test specification		Basic standard	Test set-up	Applicability note	Remarks	Performance criteria
6.1	**Radio-frequency common mode**	0,15 MHz to 80 MHz 10 V (r.m.s.) 80 % AM, 1 kHz	Unmodulated carrier	IEC 61000-4-6	IEC 61000-4-6	See [a, b]	The test level specified is the r.m.s. value of the unmodulated carrier	**A**
6.2	**Fast transients**	± 1 kV 5/50 ns 5 kHz	Peak T_r / T_h Rep. frequency	IEC 61000-4-4	IEC 61000-4-4	See [b]		**A**

[a] The test level can also be defined as the equivalent current into a 150 Ω load.

[b] Test may not be practicable with cable length less than 3 m.

7 Fixed power supplies on railway property which are not used for railway traction purposes

These are used for example for signalling systems, station services, office building services, freight cranes and yard lighting.

They fall into two categories:

a) those that are supplied from non-railway sources. Examples are supplies from the local public electricity supplier or from separate generators. These are outside the scope of this document. For products in the scope of IEC 61000-3-2, IEC 61000-3-3, IEC 61000-3-11 or IEC 61000-3-12, the requirements of those standards also apply;

b) those that are supplied from railway sources which are shared with train traction. The supply voltage may have a substantial harmonic content. ~~It is the responsibility of the body which puts the apparatus into service to establish the levels of immunity and emission which will ensure EMC.~~ The levels of immunity and emission should be defined in agreement between the suppliers and client. Examples are supplies from tertiary windings on rectifier transformers or from the railway AC overhead via transformers.

Annex A
(informative)

Emission within the boundary of the substation for normal operation and during the operation of switches

As part of the programme of work to measure the emission from the boundary of the substation, measurements were made of emissions at radio frequencies inside the substation boundary. The antennas were placed in safe positions and fields were measured during normal operation and during the operation of switches. Peak values of field strength were found. Similar values were found in both AC and DC systems. Antennas were 3 m from switches during tests.

A sufficient number of results were obtained to allow Figure A.1 and Figure A.2 to be drawn. These show the upper boundary of all results, for the frequency range ~~9~~ 150 kHz to 1 000 MHz. Values are peak fields, measured with CISPR 16-1-1 test apparatus and with the recommended bandwidths.

Values are included in this annex for information only and ~~must~~ are not ~~be interpreted as being~~ the basis for limits. They are an indication of the performance of apparatus of different ages and designs, now in use in ~~railway~~ traction substations.

Substations have a wide range of configurations, ratings and system voltages. It has not been found possible to set emission limits for apparatus which will be installed within the boundary of the substation. Each specific substation will need to be the subject of detailed study to ensure EMC between the various apparatus used inside the boundary.

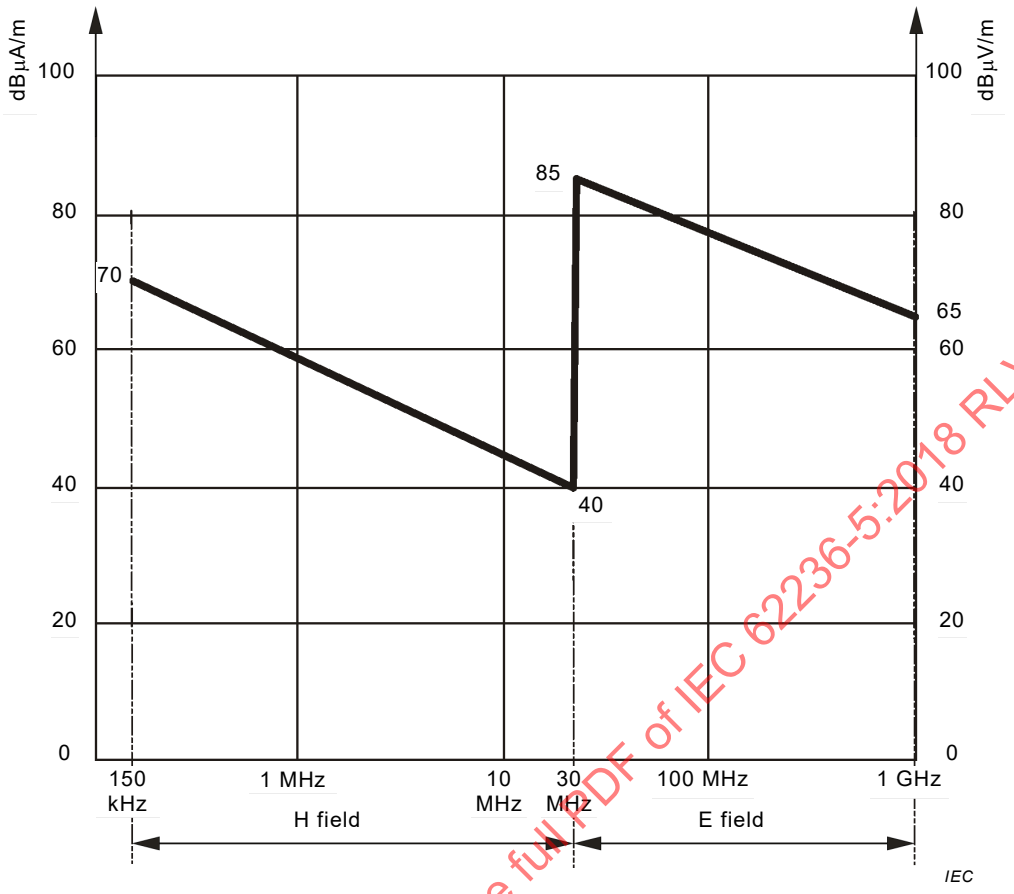


Figure A.1 – Emission from switches – Peak

NOTE 1 Operation of switches will generate transient radio fields and when the switch interrupts nominal rated current under conditions of rated voltage, the emission when measured with CISPR 16-1-1 equipment at 3 m from the apparatus is not expected to exceed the values shown in Table A.1 and Table A.2.

Table A.1 – Emission from switches (150 kHz to 30 MHz)

Frequency MHz	**Field, peak** dB(µA/m)
~~0,009~~	~~90~~
~~0,15~~	~~45~~
0,15	70
30	40
Measured by a loop antenna with the base between 1 m and 1,5 m above ground level.	

Table A.2 – Emission from switches (30 MHz to 1 000 MHz)

Frequency MHz	Field, peak, vertical polarization dB(µA/m)
30	85
1 000	65
Measured with dipole antennas with the centre of the antenna 3 m above ground level, the values being the end points of straight lines on dB / log(f) ~~plots~~ graph.	

~~NOTE~~ The measuring distance refers to the distance from the nearest point of the individual item of apparatus, or its enclosure.

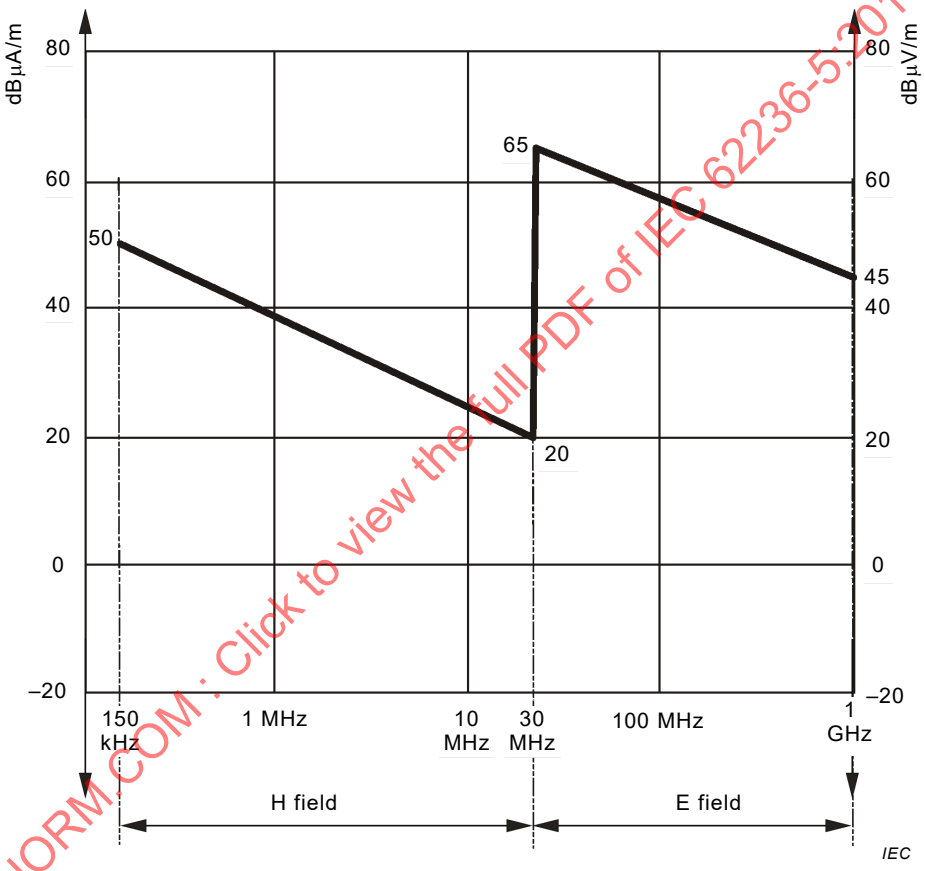


Figure A.2 – Emission within substation boundary – Peak

NOTE 2 Due to the wide variety of construction, no limits are set for the emission within the substation boundary (but outside the building). Measurements have been made in typical substations with CISPR 16-1-1 equipment and the following values in Table A.3 and Table A.4 are representative:

Table A.3 – Emission within substation (150 kHz to 30 MHz)

Frequency MHz	**Field, peak** dB(μA/m)
~~0,009~~	~~70~~
~~0,15~~	~~25~~
0,15	50
30	20
Measured by a loop antenna with the base between 1 m and 1,5 m above ground level.	

Table A.4 – Emission within substation (30 MHz to 1 000 MHz)

Frequency MHz	**Field, peak, vertical polarization** dB(μA/m)
30	65
1 000	45
Measured with dipole antennas with the centre of the antenna 3 m above ground level, the values being the end points of straight lines on dB/ log(f) graph.	

WARNING: There is a danger of electric shock from uninsulated conductors in most substations and any attempt to measure emissions from these conductors ~~must~~ is to be done with the most careful attention to ensuring safe methods of working.

Bibliography

~~Other standards which are relevant to the EMC behaviour of apparatus used in railway substations are listed below. Where limits are in conflict, those contained within this standard take precedence.~~

~~IEC 60255 (all parts), *Electrical relays*~~

IEC 61000-3-2:2014, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current up to and including 16 A per phase)*

IEC 61000-3-3:2013, *Electromagnetic compatibility (EMC) – Part 3-3: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection*

IEC 61000-3-11:2017, *Electromagnetic compatibility (EMC) – Part 3-11: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems – Equipment with rated current ≤75 A and subject to conditional connection*

IEC 61000-3-12:2011, *Electromagnetic compatibility (EMC) – Part 3-12: Limits – Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current > 16 A and ≤75 A per phase*

IEC 61000-6-1:2016, *Electromagnetic compatibility (EMC) – Part 6-1: Generic standards – Immunity standard for residential, commercial and light-industrial environments*

IEC 61000-6-2:2016, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity standard for industrial environments*

IEC 61000-6-3:2006, *Electromagnetic compatibility (EMC) – Part 6-3: Generic standards – Emission standard for residential, commercial and light-industrial environments*
IEC 61000-6-3:2006/AMD1:2010

~~IEC 62271-1:2007, *High-voltage switchgear and controlgear – Part 1: Common specifications*~~

IEC 62497-1:2010, *Railway applications – Insulation coordination – Part 1: Basic requirements – Clearances and creepage distances for all electrical and electronic equipment*

~~IEC 62505-1, *Railway applications – Fixed installation – Particular requirements for a.c. switchgear – Part 1: Single phase circuit breakers with U_n above 1 kV*~~

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 18 (all parts), *Radio interference characteristics of overhead power lines and high-voltage equipment*~~

IEC 62236-5

Edition 3.0 2018-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Railway applications – Electromagnetic compatibility –
Part 5: Emission and immunity of fixed power supply installations and apparatus

Applications ferroviaires – Compatibilité électromagnétique –
Partie 5: Emission et immunité des installations fixes d'alimentation de puissance et des équipements associés

IEC 62236-5:2018-02(en-fr)

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

RAILWAY APPLICATIONS – ELECTROMAGNETIC COMPATIBILITY –

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

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 62236-5 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 50121-5:2015.

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

a) clarification of scope (Clause 1);
b) emission requirement extended in the frequency range 1 GHz to 6 GHz following IEC 61000-6-4;
c) immunity requirement extended in the frequency range 5,1 GHz to 6 GHz;

d) removal of limits for radiated H-fields in the frequency range 9 kHz to 150 kHz due to the fact that:
   – there are very few outside world victims;
   – there is low reproducibility.

This 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
9/2340/FDIS	9/2370/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.

INTRODUCTION

The requirements of this part of IEC 62236 have been specified so as to ensure a level of electromagnetic emission which will cause minimal disturbance to other equipment. The levels, however, do not cover the following cases:

a) which may occur with an extremely low probability of occurrence in any location;

b) where highly susceptible apparatus is used in close proximity of the equipment covered by this document, in which case further measures may have to be taken.

The emission limits given are on the basis that the equipment of the product family range is installed in traction substation areas.

RAILWAY APPLICATIONS – ELECTROMAGNETIC COMPATIBILITY –

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

1 Scope

This part of IEC 62236 applies to emission and immunity aspects of EMC for electrical and electronic apparatus and systems intended for use in railway fixed installations for power supply. This includes the power feed to the apparatus, the apparatus itself with its protective control circuits, trackside items such as switching stations, power autotransformers, booster transformers, substation power switchgear and power switchgear to other longitudinal and local supplies.

Filters operating at railway system voltage (for example, for harmonic suppression or power factor correction) are not included in this document since each site has special requirements. Filters would normally have separate enclosures with separate rules for access. If electromagnetic limits are required, these will appear in the specification for the equipment.

If a port is intended to transmit or receive for the purpose of radio communication (intentional radiators, e.g. transponder systems), then the radiated emission requirements in this document are not intended to be applicable to the intentional transmission from a radio-transmitter as defined by the ITU.

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

Emission and immunity limits are given for items of apparatus which are situated:

a) within the boundary of a substation which delivers electric power to a railway;

b) beside the track for the purpose of controlling or regulating the railway power supply, including power factor correction;

c) along the track for the purpose of supplying electrical power to the railway other than by means of the conductors used for contact current collection, and associated return conductors. Included are high voltage feeder systems within the boundary of the railway which supply substations at which the voltage is reduced to the railway system voltage;

d) beside the track for controlling or regulating electric power supplies to ancillary railway uses. This category includes power supplies to marshalling yards, maintenance depots and stations;

e) various other non-traction power supplies from railway sources which are shared with railway traction.

The immunity levels given in this document apply for:

– vital equipment such as protection devices;

– equipment having connections to the traction power conductors;

– apparatus inside the 3 m zone;

– ports of apparatus inside the 10 m zone with connection inside the 3 m zone;

– ports of apparatus inside the 10 m zone with cable length > 30 m.

Apparatus and systems which are in an environment which can be described as residential, commercial or light industry, even when placed within the physical boundary of the railway

substation, comply with IEC 61000-6-1 for immunity and IEC 61000-6-3 for emission requirements.

Excluded from the immunity requirements of this document is power supply apparatus which is intrinsically immune to the tests defined in Table 1 to Table 6 of this document.

NOTE An example is an 18 MVA 230 kV to 25 kV power supply transformer.

These specific provisions are used in conjunction with the general provisions in 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 61000-4-2:2008, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3:2006, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4:2012, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-5:2014, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61000-4-6:2013, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-8:2009, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*

IEC 61000-4-18:2006, *Electromagnetic compatibility (EMC) – Part 4-18: Testing and measurement techniques – Damped oscillatory wave immunity test*

IEC 61000-6-4:2006, *Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments*
IEC 61000-6-4:2006/AMD1:2010

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*

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
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
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
long bus
bus cables with a length of more than 30 m

3.1.5
3 m zone
area along the railway line within a distance of 3 m from the centreline of the nearest track at both sides of the track

3.1.6
10 m zone
area along the railway line within a distance of 10 m from the centreline of the nearest track at both sides of the track

3.1.7
railway system voltage
railway system dedicated voltage converted from high voltage

EXAMPLE 25-0-25 kV, 50 Hz; 110 kV, 16,7 Hz.

3.2 Abbreviated terms

AC	Alternating current
AM	Amplitude modulation
DC	Direct current
EMC	Electromagnetic compatibility
ITU	International Telecommunication Union
r.m.s.	Root mean square

4 Performance criteria

The variety and diversity of the apparatus within the scope of this document make it difficult to define precise criteria for the evaluation of the immunity test results. Three general levels of performance are therefore used, as defined in IEC 62236-1.

5 Emission tests and limits

5.1 Emission from the traction substation to the outside world

Limit values for this emission, over the frequency range 150 kHz to 1 GHz are given in IEC 62236-2.

Guidance values are given in IEC 62236-2 for emission of DC and power frequency magnetic fields.

Conductors (overhead or underground) between the substation and the railway are part of the railway installation, but because of their wide variety of positions and ampere loadings, limit values cannot be set for the magnetic fields which they produce.

No limits are set for emissions into the active space of the underground railway due to the complexities of obtaining measurements in the confined space and the lack of a precise method of relating the measured values to the degree of disturbance which other apparatus would suffer.

No measurements are necessary for total underground railway systems with no surface operation.

5.2 Emission test for apparatus operating at less than 1 000 V r.m.s. AC

The emission limits for apparatus covered by this document which is supplied with electrical power at a voltage below 1 000 V r.m.s. are given on a port by port basis in IEC 61000-6-4.

5.3 Emission values within the boundary of the substation

Because there is such a wide variety of options for the design and the construction of the substation, limits are not given for emission within the general space inside the boundary of the substation. Practical measurements have been made and guidance values are given in Annex A. These are for information only and are not part of the normative content of this document.

6 Immunity requirements

The immunity test requirements for apparatus covered by this document are given on a port by port basis in Table 1 to Table 6.

Tests shall be conducted in a well-defined and reproducible manner. The tests shall be carried out as single tests in sequence. The sequence of testing is optional.

The description of the tests, the test generator, the test methods, and the test set-up are given in the Basic Standards which are referred to in Table 1 to Table 6. The contents of the Basic Standards are not repeated herein, however, modifications or additional information needed for the practical application of the tests are given in this document.

Where possible, the tests shall be made with a typical operating mode chosen to produce the maximum susceptibility to disturbance in the frequency band being investigated, consistent

with normal applications. The manufacturer shall define the conditions of the test in the test plan.

If the apparatus is part of a system or can be connected to auxiliary apparatus, then the apparatus should preferably be tested while connected to the minimum configuration of auxiliary apparatus necessary to exercise the test point in accordance with the general methods of IEC 61000-4 series.

The configuration and mode of operation during the tests shall be precisely noted in the test report. It is not always possible to test every function of the apparatus; in such cases the most critical mode of operation should be selected.

The tests shall be carried out within the specified operating range for the apparatus and at its rated supply voltage.

Some of the immunity levels are higher than those of the heavy industrial Generic Standard, because this has been found necessary in practice.

Voltages induced by traction currents are not treated here. They have to be covered by the functional specification (e.g. IEC 62497-1).

Table 1 – Immunity – Enclosure port

	Environmental phenomena	Test specification		Basic standard	Test set-up	Applicability note	Remarks	Performance criteria
1.1	**Radio-frequency electromagnetic field. Amplitude modulated**	80 MHz to 800 MHz 10 V/m (r.m.s.) 80 % AM, 1 kHz	Unmodulated carrier	IEC 61000-4-3	IEC 61000-4-3		The test level specified is the r.m.s. value of the unmodulated carrier	**A**
1.2	**Radio-frequency electromagnetic field**	800 MHz to 1 000 MHz 20 V/m (r.m.s.) 80 % AM, 1 kHz	Unmodulated carrier	IEC 61000-4-3	IEC 61000-4-3		The test level specified is the r.m.s. value of the unmodulated carrier These tests are intended to simulate disturbances from digital communication devices	**A**
		1 400 MHz to 2 000 MHz 10 V/m (r.m.s.) 80 % AM, 1 kHz	Unmodulated carrier					
		2 000 MHz to 2 700 MHz 5 V/m (r.m.s.) 80 % AM, 1 kHz	Unmodulated carrier					
		5 100 MHz to 6 000 MHz 3 V/m (r.m.s.) 80 % AM, 1 kHz	Unmodulated carrier					

	Environmental phenomena	Test specification		Basic standard	Test set-up	Applicability note	Remarks	Performance criteria
1.3	**Power – frequency magnetic field**	16,7 Hz 100 A/m --- 50 Hz / 60 Hz 100 A/m --- 0 Hz 300 A/m		IEC 61000-4-8	IEC 61000-4-8	See [a]	Tests only for applicable frequencies Testing time is ≥ 10 s	**A**
1.4	**Electrostatic discharge**	± 6 kV ± 8 kV	Contact discharge Air discharge	IEC 61000-4-2	IEC 61000-4-2	See [b]		**B**

[a] Test only applies to apparatus containing devices sensitive to magnetic fields, e.g. Hall elements, electro-dynamic microphones, etc. Unshielded CRT displays can exhibit interference effects above 1 A/m (r.m.s.).

[b] See basic standard for applicability of contact and/or air discharge test.

Table 2 – Immunity – Ports for signal lines and data buses not involved in process control

	Environmental phenomena	Test specification		Basic standard	Test set-up	Applicability note	Remarks	Performance criteria
2.1	**Radio-frequency common mode**	0,15 MHz to 80 MHz 10 V (r.m.s.) 80 % AM, 1 kHz	Unmodulated carrier	IEC 61000-4-6	IEC 61000-4-6	See [a]	The test level specified is the r.m.s. value of the unmodulated carrier	**A**
2.2	**Fast transients**	± 2 kV 5/50 ns 5 kHz	Peak T_r / T_h Repetition frequency	IEC 61000-4-4	IEC 61000-4-4	See [b]	Capacitive clamp used	**A**

[a] The test level can also be defined as the equivalent current into a 150 Ω load.

[b] Applicable only to ports interfacing with cables whose total length according to the manufacturer's functional specification may exceed 1 m.

Table 3 – Immunity – Ports for process, measurement and control lines, and long bus

	Environmental phenomena	Test specification		Basic standard	Test set-up	Applicability note	Remarks	Performance criteria
3.1	**Radio-frequency common mode**	0,15 MHz to 80 MHz 10 V (r.m.s.) 80 % AM, 1 kHz	Unmodulated carrier	IEC 61000-4-6	IEC 61000-4-6	See [a]	The test level specified is the r.m.s. value of the unmodulated carrier	**A**
3.2	**Damped oscillatory voltage** **(oscillatory waves)**	2,5 kV 1 kV	Line to earth Line to line	IEC 61000-4-18	IEC 61000-4-18		Both 100 kHz and 1 MHz	**B**
3.3	**Fast transients**	± 2 kV 5/50 ns 5 kHz	Peak T_r / T_h Repetition frequency	IEC 61000-4-4	IEC 61000-4-4		Capacitive clamp used	**A**
3.4	**Surges**	1,2 / 50 µs ± 2 kV ± 1 kV	Open circuit test voltage, line to earth Open circuit test voltage, line to line	IEC 61000-4-5	IEC 61000-4-5		All severity levels below the given severity level have to be tested with 5 pulses for each severity level and a test sequence not alternating but starting with one polarity followed by the other polarity.	**B**

[a] The test level can also be defined as the equivalent current into a 150 Ω load.

Table 4 – Immunity – DC input and DC output power ports

	Environmental phenomena	Test specification		Basic standard	Test set-up	Applicability note	Remarks	Performance criteria
4.1	**Radio-frequency common mode**	0,15 MHz to 80 MHz 10 V (r.m.s.) 80 % AM, 1 kHz	Unmodulated carrier	IEC 61000-4-6	IEC 61000-4-6	See [a]	The test level specified is the r.m.s. value of the unmodulated carrier	**A**
4.2	**Fast transients**	± 4 kV 5/50 ns 5 kHz	Peak T_r / T_h Repetition frequency	IEC 61000-4-4	IEC 61000-4-4	See [b]		**A**
4.3	**Surges**	1,2 / 50 µs ± 2 kV ± 1 kV	Open circuit test voltage, line to earth Open circuit test voltage, line to line	IEC 61000-4-5	IEC 61000-4-5	See [b]	All severity levels below the given severity level have to be tested with 5 pulses for each severity level and a test sequence not alternating but starting with one polarity followed by the other polarity.	**B**

[a] The test level can also be defined as the equivalent current into a 150 Ω load.

[b] Not applicable to input ports intended for connection to a battery or a rechargeable battery which shall be removed or disconnected from the apparatus for recharging.

Table 5 – Immunity – AC input and AC output power ports

	Environmental phenomena	Test specification		Basic standard	Test set-up	Applicability note	Remarks	Performance criteria
5.1	**Radio-frequency common mode**	0,15 MHz to 80 MHz 10 V (r.m.s.) 80 % AM, 1 kHz	Unmodulated carrier	IEC 61000-4-6	IEC 61000-4-6	See [a]	The test level specified is the r.m.s. value of the unmodulated carrier	**A**
5.2	**Fast transients**	± 4 kV 5/50 ns 5 kHz	Peak T_r / T_h Repetition frequency	IEC 61000-4-4	IEC 61000-4-4			**A**
5.3	**Surges**	1,2 / 50 µs ± 4 kV ± 2 kV	Open circuit test voltage, line to earth Open circuit test voltage, line to line	IEC 61000-4-5	IEC 61000-4-5		All severity levels below the given severity level have to be tested with 5 pulses for each severity level and a test sequence not alternating but starting with one polarity followed by the other polarity.	**B**
[a] The test level can also be defined as the equivalent current into a 150 Ω load.								

Table 6 – Immunity – Earth port

	Environmental phenomena	Test specification		Basic standard	Test set-up	Applicability note	Remarks	Performance criteria
6.1	**Radio-frequency common mode**	0,15 MHz to 80 MHz 10 V (r.m.s.) 80 % AM, 1 kHz	Unmodulated carrier	IEC 61000-4-6	IEC 61000-4-6	See [a, b]	The test level specified is the r.m.s. value of the unmodulated carrier	**A**
6.2	**Fast transients**	± 1 kV 5/50 ns 5 kHz	Peak T_r / T_h Rep. frequency	IEC 61000-4-4	IEC 61000-4-4	See [b]		**A**

[a] The test level can also be defined as the equivalent current into a 150 Ω load.

[b] Test may not be practicable with cable length less than 3 m.

7 Fixed power supplies on railway property which are not used for railway traction purposes

These are used for example for signalling systems, station services, office building services, freight cranes and yard lighting.

They fall into two categories:

a) those that are supplied from non-railway sources. Examples are supplies from the local public electricity supplier or from separate generators. These are outside the scope of this document. For products in the scope of IEC 61000-3-2, IEC 61000-3-3, IEC 61000-3-11 or IEC 61000-3-12, the requirements of those standards also apply;

b) those that are supplied from railway sources which are shared with train traction. The supply voltage may have a substantial harmonic content. The levels of immunity and emission should be defined in agreement between the suppliers and client. Examples are supplies from tertiary windings on rectifier transformers or from the railway AC overhead via transformers.

Annex A
(informative)

Emission within the boundary of the substation for normal operation and during the operation of switches

As part of the programme of work to measure the emission from the boundary of the substation, measurements were made of emissions at radio frequencies inside the substation boundary. The antennas were placed in safe positions and fields were measured during normal operation and during the operation of switches. Peak values of field strength were found. Similar values were found in both AC and DC systems. Antennas were 3 m from switches during tests.

A sufficient number of results were obtained to allow Figure A.1 and Figure A.2 to be drawn. These show the upper boundary of all results, for the frequency range 150 kHz to 1 000 MHz. Values are peak fields, measured with CISPR 16-1-1 test apparatus and with the recommended bandwidths.

Values are included in this annex for information only and are not the basis for limits. They are an indication of the performance of apparatus of different ages and designs, now in use in traction substations.

Substations have a wide range of configurations, ratings and system voltages. It has not been found possible to set emission limits for apparatus which will be installed within the boundary of the substation. Each specific substation will need to be the subject of detailed study to ensure EMC between the various apparatus used inside the boundary.

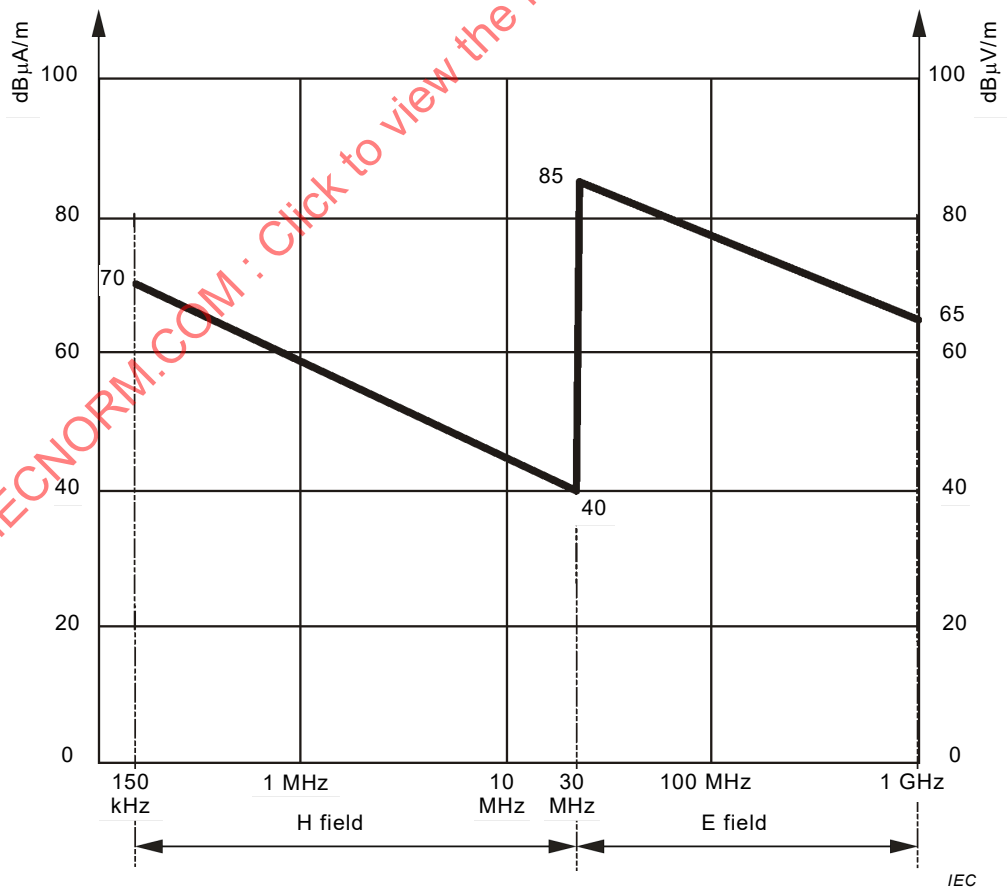

Figure A.1 – Emission from switches – Peak

NOTE 1 Operation of switches will generate transient radio fields and when the switch interrupts nominal rated current under conditions of rated voltage, the emission when measured with CISPR 16-1-1 equipment at 3 m from the apparatus is not expected to exceed the values shown in Table A.1 and Table A.2.

Table A.1 – Emission from switches (150 kHz to 30 MHz)

Frequency MHz	**Field, peak** dB(µA/m)
0,15	70
30	40
Measured by a loop antenna with the base between 1 m and 1,5 m above ground level.	

Table A.2 – Emission from switches (30 MHz to 1 000 MHz)

Frequency MHz	**Field, peak, vertical polarization** dB(µA/m)
30	85
1 000	65
Measured with dipole antennas with the centre of the antenna 3 m above ground level, the values being the end points of straight lines on dB / log(f) graph.	

The measuring distance refers to the distance from the nearest point of the individual item of apparatus, or its enclosure.

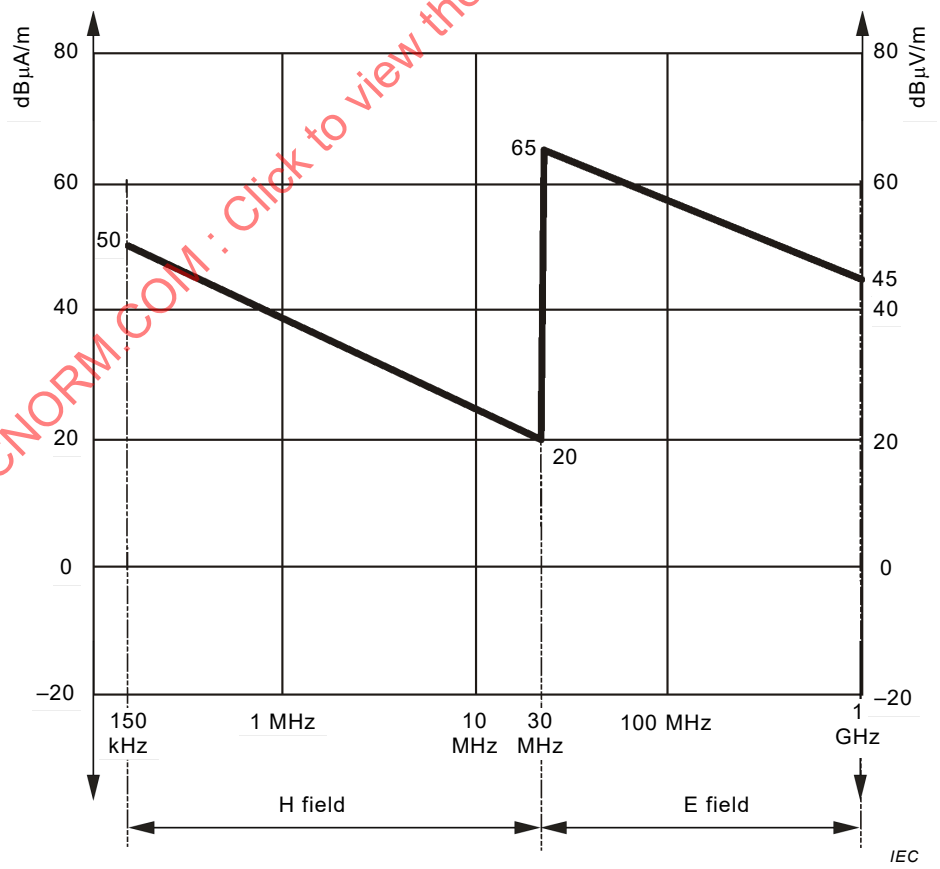

Figure A.2 – Emission within substation boundary – Peak

NOTE 2 Due to the wide variety of construction, no limits are set for the emission within the substation boundary (but outside the building). Measurements have been made in typical substations with CISPR 16-1-1 equipment and the following values in Table A.3 and Table A.4 are representative:

Table A.3 – Emission within substation (150 kHz to 30 MHz)

Frequency MHz	**Field, peak** dB(μA/m)
0,15	50
30	20
Measured by a loop antenna with the base between 1 m and 1,5 m above ground level.	

Table A.4 – Emission within substation (30 MHz to 1 000 MHz)

Frequency MHz	**Field, peak, vertical polarization** dB(μA/m)
30	65
1 000	45
Measured with dipole antennas with the centre of the antenna 3 m above ground level, the values being the end points of straight lines on dB / log(f) graph.	

WARNING: There is a danger of electric shock from uninsulated conductors in most substations and any attempt to measure emissions from these conductors is to be done with the most careful attention to ensuring safe methods of working.

Bibliography

IEC 61000-3-2:2014, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current up to and including 16 A per phase)*

IEC 61000-3-3:2013, *Electromagnetic compatibility (EMC) – Part 3-3: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection*

IEC 61000-3-11:2017, *Electromagnetic compatibility (EMC) – Part 3-11: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems – Equipment with rated current ≤75 A and subject to conditional connection*

IEC 61000-3-12:2011, *Electromagnetic compatibility (EMC) – Part 3-12: Limits – Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current > 16 A and ≤75 A per phase*

IEC 61000-6-1:2016, *Electromagnetic compatibility (EMC) – Part 6-1: Generic standards – Immunity standard for residential, commercial and light-industrial environments*

IEC 61000-6-2:2016, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity standard for industrial environments*

IEC 61000-6-3:2006, *Electromagnetic compatibility (EMC) – Part 6-3: Generic standards – Emission standard for residential, commercial and light-industrial environments*
IEC 61000-6-3:2006/AMD1:2010

IEC 62497-1:2010, *Railway applications – Insulation coordination – Part 1: Basic requirements – Clearances and creepage distances for all electrical and electronic equipment*

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*

SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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APPLICATIONS FERROVIAIRES – COMPATIBILITÉ ÉLECTROMAGNÉTIQUE –

Partie 5: Emission et immunité des installations fixes d'alimentation de puissance et des équipements associés

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La Norme internationale IEC 62236-5 a été établie par le comité d'études 9 de l'IEC: Matériels et systèmes électriques ferroviaires.

Cette troisième édition annule et remplace la deuxième édition publiée en 2008. Elle constitue une révision technique et a été développée sur la base de EN 50121-5:2015.

Cette édition inclut les changements techniques significatifs suivants par rapport à l'édition précédente:

a) clarification du domaine d'application (Article 1);
b) exigences d'émissions étendues dans la plage de fréquences 1 GHz à 6 GHz, suivant l'IEC 61000-6-4;

c) exigences d'immunité étendues dans la plage de fréquences 5,1 GHz à 6 GHz;

d) déplacement des valeurs d'émissions pour les champs H rayonnés de largeurs de bande 9 kHz – 150 kHz pour les raisons suivantes:

   – il y a très peu de victimes du monde extérieur;

   – la reproductibilité est faible.

Cette Norme doit être lue conjointement avec l'IEC 62236-1.

Le texte de cette Norme internationale est issu des documents suivants:

FDIS	Rapport de vote
9/2340/FDIS	9/2370/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette norme.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2.

Une liste de toutes les parties de la série IEC 62236, publiées sous le titre général *Applications ferroviaires – Compatibilité électromagnétique*, peut être consultée sur le site web de l'IEC.

Le comité a décidé que le contenu de ce document ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous "http://webstore.iec.ch" dans les données relatives au document recherché. A cette date, le document sera

- reconduit,
- supprimé,
- remplacé par une édition révisée, ou
- amendé.

INTRODUCTION

Les exigences de la présente partie de l'IEC 62236 ont été spécifiées pour assurer un niveau d'émission électromagnétique qui causera des perturbations minimales pour les autres équipements. Cependant, ces niveaux ne couvrent pas les cas suivants:

a) qui peuvent se produire selon une probabilité extrêmement faible, quel que soit l'emplacement;

b) cas où des appareils à susceptibilité élevée sont utilisés à proximité d'équipements couverts par le présent document, ce qui peut devoir entraîner des mesures supplémentaires.

Les limites d'émission sont données pour des équipements de la gamme de la famille des produits installés dans les zones de sous-stations de traction.

APPLICATIONS FERROVIAIRES – COMPATIBILITÉ ÉLECTROMAGNÉTIQUE –

Partie 5: Emission et immunité des installations fixes d'alimentation de puissance et des équipements associés

1 Domaine d'application

La présente partie de l'IEC 62236 s'applique aux aspects d'émission et d'immunité de CEM pour les appareils et les systèmes électriques et électroniques destinés à être utilisés dans les installations fixes associées à l'alimentation. Cela concerne l'alimentation des appareils, les appareils eux-mêmes avec leurs circuits de commande de protection, les composants au bord des voies tels que les stations de sectionnement, les autotransformateurs, les transformateurs suceurs, les appareillages de coupure de sous-station et les appareillages de coupure d'autres alimentations longitudinales et locales.

Les filtres qui fonctionnent à la tension du système ferroviaire (par exemple, pour la suppression d'harmoniques ou la correction de facteur de puissance) ne sont pas inclus dans le présent document dans la mesure où chaque site répond à des exigences spéciales. Normalement, les filtres sont dans des enceintes séparées avec des règles d'accès particulières. Si des limites électromagnétiques sont nécessaires, elles apparaîtront dans la spécification pour l'équipement.

Si un accès est destiné à transmettre ou recevoir pour des besoins de radiocommunication (rayonnant intentionnel, par exemple les systèmes de transpondeur), alors les exigences d'émission rayonnée dans le présent document ne sont pas destinées à être applicables à la transmission intentionnelle d'un émetteur radioélectrique comme défini par l'UIT.

La plage de fréquences concernée va du courant continu à 400 GHz. Aucune mesure n'est nécessaire aux fréquences pour lesquelles aucune exigence n'est spécifiée.

Les limites d'émission et d'immunité sont données pour les composants des appareils qui sont situés:

a) dans les limites de la sous-station qui alimente le réseau de traction en électricité;

b) près des voies pour contrôler et réguler l'alimentation électrique du réseau de traction, y compris la correction de facteur de puissance;

c) le long de la voie pour fournir de l'énergie électrique au système ferroviaire par d'autres moyens que les conducteurs utilisés pour le captage du courant de contact et les conducteurs de retour associés. Ceci englobe les systèmes d'alimentation à haute tension dans les limites du système ferroviaire qui alimentent les sous-stations dans lesquelles la tension est ramenée à la valeur de la tension du système ferroviaire;

d) près des voies pour contrôler et réguler les alimentations électriques utilisées à différents usages ferroviaires auxiliaires. Cette catégorie englobe les alimentations des installations de triage, des dépôts de maintenance et des gares;

e) différentes alimentations qui ne concernent pas la traction alimentées par une des sources ferroviaires qui sont partagées avec la traction ferroviaire.

Les niveaux d'immunité donnés dans le présent document s'appliquent aux:

– équipements vitaux tels que les dispositifs de protection;

– équipements dotés de raccordements vers les conducteurs de puissance de traction;

– appareils situés dans la zone de 3 m;

– accès des appareils situés dans la zone de 10 m avec connexion dans la zone de 3 m;
– accès des appareils situés dans la zone de 10 m avec longueur de câble > 30 m.

Les appareils et les systèmes qui sont dans un environnement qui peut être décrit comme résidentiel, commercial ou d'industrie légère, même s'ils sont situés dans les limites physiques de la sous-station ferroviaire, sont conformes à l'IEC 61000-6-1 pour l'immunité et l'IEC 61000-6-3 pour les exigences d'émission.

Les appareils d'alimentation qui ont une immunité intrinsèque aux essais définis aux Tableau 1 à Tableau 6 du présent document sont exclus des exigences relatives à l'immunité du présent document.

NOTE Un transformateur 18 MVA 230 kV / 25 kV en est un exemple.

Ces dispositions spécifiques sont utilisées avec les dispositions générales données dans l'IEC 62236-1.

2 Références normatives

Les documents suivants cités dans le texte constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 61000-4-2:2008, *Compatibilité électromagnétique (CEM) – Partie 4-2: Techniques d'essai et de mesure – Essai d'immunité aux décharges électrostatiques*

IEC 61000-4-3:2006, *Compatibilité électromagnétique (CEM) – Partie 4-3: Techniques d'essai et de mesure – Essai d'immunité aux champs électromagnétiques rayonnés aux fréquences radioélectriques*

IEC 61000-4-4:2012, *Compatibilité électromagnétique (CEM) – Partie 4-4: Techniques d'essai et de mesure – Essai d'immunité aux transitoires électriques rapides en salves*

IEC 61000-4-5:2014, *Compatibilité électromagnétique (CEM) – Partie 4-5: Techniques d'essai et de mesure – Essai d'immunité aux ondes de choc*

IEC 61000-4-6:2013, *Compatibilité électromagnétique (CEM) – Partie 4-6: Techniques d'essai et de mesure – Immunité aux perturbations conduites, induites par les champs radioélectriques*

IEC 61000-4-8:2009, *Compatibilité électromagnétique (CEM) – Partie 4-8: Techniques d'essai et de mesure – Essai d'immunité au champ magnétique à la fréquence du réseau*

IEC 61000-4-18:2006, *Compatibilité électromagnétique (CEM) – Partie 4-18: Techniques d'essai et de mesure – Essai d'immunité à l'onde oscillatoire amortie*

IEC 61000-6-4:2006, *Compatibilité électromagnétique (CEM) – Partie 6-4: Normes génériques – Norme sur l'émission pour les environnements industriels*
IEC 61000-6-4:2006/AMD1:2010

IEC 62236-1:2018, *Applications ferroviaires – Compatibilité électromagnétique – Partie 1: Généralités*

IEC 62236-2:2018, *Applications ferroviaires – Compatibilité électromagnétique – Partie 2: Émission du système ferroviaire dans son ensemble vers le monde extérieur*

3 Termes, définitions et termes abrégés

3.1 Termes et définitions

Pour les besoins du présent document, les termes et définitions suivants s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse http://www.electropedia.org/
- ISO Online browsing platform: disponible à l'adresse http://www.iso.org/obp

3.1.1
appareil
dispositif ou assemblage de dispositifs qui peut être utilisé comme unité indépendante pour remplir des fonctions particulières

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

3.1.2
environnement
milieu dans lequel un produit ou un système existe, incluant l'air, l'eau, le sol, les ressources naturelles, la flore, la faune, les êtres humains et leurs interrelations

[SOURCE: IEC Guide 109:2012, 3.3]

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

3.1.3
sous-station de traction <en traction électrique>
sous-station <en traction électrique>
poste dont la fonction principale consiste à alimenter un réseau de traction

Note 1 à l'article: Le synonyme sous-station est utilisé uniquement quand le contexte est clair.

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

3.1.4
bus de données de grande longueur
câbles de bus de données d'une longueur supérieure à 30 m

3.1.5
zone de 3 m
zone le long de la ligne de chemin de fer située à une distance de 3 m au maximum de la ligne centrale de la voie la plus proche des deux côtés de la voie

3.1.6
zone de 10 m
zone le long de la ligne de chemin de fer située à une distance de 10 m au maximum de la ligne centrale de la voie la plus proche des deux côtés de la voie

3.1.7
tension du système ferroviaire
tension dédiée au système ferroviaire convertie de la haute tension

EXEMPLE 25-0-25 kV, 50 Hz; 110 kV, 16,7 Hz.

3.2 Termes abrégés

CA	Courant alternatif
MA	Modulation d'amplitude
CC	Courant continu
CEM	Compatibilité électromagnétique
UIT	Union Internationale des Télécommunications
r.m.s.	Root mean square (valeur efficace)

4 Critères d'aptitude à la fonction

La variété et la diversité des appareils définis dans le domaine d'application du présent document rendent difficile la définition de critères précis pour l'évaluation des résultats des essais d'immunité. Par conséquent, trois niveaux généraux d'aptitude à la fonction sont utilisés tels que définis dans l'IEC 62236-1.

5 Essais d'émission et limites

5.1 Émissions de la sous-station de traction d'alimentation vers le monde extérieur

Les valeurs limites d'émission dans la plage de fréquences de 150 kHz à 1 GHz sont données dans l'IEC 62236-2.

L'IEC 62236-2 donne à titre de lignes directrices des valeurs pour l'émission des champs magnétiques à la fréquence industrielle et en courant continu.

Les conducteurs (aériens ou souterrains) entre la sous-station et le système ferroviaire font partie de l'installation ferroviaire, mais compte tenu de la grande variété d'emplacements et de charges en ampères, les valeurs limites ne peuvent pas être fixées pour les champs magnétiques qu'ils produisent.

Aucune limite n'a été fixée pour les émissions dans l'espace actif des systèmes ferroviaires souterrains en raison des difficultés rencontrées pour obtenir des mesures en espace confiné et en raison du manque de méthode précise pour lier les valeurs mesurées au degré de perturbation que d'autres appareils endureraient.

Aucune mesure n'est nécessaire pour les systèmes ferroviaires souterrains sans exploitation en surface.

5.2 Essai d'émission pour les appareils fonctionnant à des tensions inférieures à 1 000 V en valeur efficace en courant alternatif

Les limites d'émission pour les appareils couverts par le présent document qui sont alimentés en électricité à une tension inférieure à 1 000 V en valeur efficace sont données accès par accès dans l'IEC 61000-6-4.

5.3 Valeurs d'émission à l'intérieur des limites de la sous-station

Compte tenu de la grande variété d'options qui existent pour la conception et la construction de la sous-station, aucune limite n'est donnée pour l'émission dans l'espace situé à l'intérieur de la zone de la sous-station. Des mesures pratiques ont été effectuées et des valeurs servant de lignes directrices sont données à l'Annexe A. Elles n'ont qu'une valeur informative et ne font pas partie du contenu normatif du présent document.