IEC 62236-3-2

Edition 3.0 2018-02
REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

Railway applications – Electromagnetic compatibility – Part 3-2: Rolling stock – Apparatus

IEC 62236-3-2:2018-02 RLV(en)

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue
The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

Electropedia - www.electropedia.org
The world's leading online dictionary of electronic and electrical terms containing 21 000 terms and definitions in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary
67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC 62236-3-2

Edition 3.0 2018-02
REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

Railway applications – Electromagnetic compatibility – Part 3-2: Rolling stock – Apparatus

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.100; 45.060.01

ISBN 978-2-8322-5406-6

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD 3
1 Scope 5
2 Normative references 6
3 Terms, definitions and abbreviated terms 6
3.1 Terms and definitions 7
3.2 Abbreviated terms 7
4 Performance criteria 8
5 Conditions during testing 8
6 Applicability 8
7 Emission tests and limits 9
8 Immunity ~~tests and limits~~ requirements 14
Annex A (informative) Examples of apparatus and ports 19
Annex B (informative) Conducted disturbances generated by power converters ~~in the range of 9 kHz to 30 MHz~~ 25

Figure 1 – Main categories of ports 7
Figure A.1 – AC fed ~~locomotive~~ traction unit with AC traction drive and psophometric filter on the line side 22
Figure A.2 – AC/AC system with power factor correction filter on the converter side and with DC or three-phase auxiliary and train power supply 22
Figure A.3 – Conventional system with AC input and DC traction motors fed by phase control converter 23
Figure A.4 – DC fed system with AC traction drive 23
Figure A.5 – Additional ports of converter and control electronics 24
Figure B.1 – Test set-up 26

~~Table – Emission – Traction a.c. power ports~~ .....
~~Table – Emission – Traction d.c. power ports~~ .....
~~Table – Emission – Auxiliary a.c. or d.c. power ports~~ .....
~~Table – Emission – Battery referenced ports~~ .....
~~Table – Emission – Process measurement and control ports~~ .....
~~Table – Emission – Enclosure port~~ .....
Table 1 – Emission – Auxiliary AC or DC power ports (input and output) 13
Table 2 – Emission – Battery power supply (input and output) 13
Table 3 – Immunity – Battery referenced ports (except at the output of energy sources), auxiliary AC power input ports (rated voltage ≤ ~~400~~ 480 $V_{r.m.s.}$) 15
Table 4 – Immunity – Signal and communication, process measurement and control ports 16
Table 5 – Immunity – Enclosure ports 17
Table A.1 – Typical examples of apparatus 20
Table A.2 – Typical port descriptions 21
Table B.1 – Emission requirements for AC and DC power ports 26

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

RAILWAY APPLICATIONS – ELECTROMAGNETIC COMPATIBILITY –

Part 3-2: Rolling stock – 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.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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 62236-3-2 has been prepared by IEC technical committee 9: Electrical equipment and systems for railways.

This third edition cancels and replaces the second edition published in 2008. It constitutes a technical revision and has been developed on the basis of EN 50121-3-2:2015.

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

a) clarification of scope (Clause 1);
b) new definition of ports and clarification in Tables 1 to 5;
c) emission requirement extended in the frequency range 1 GHz to 6 GHz following IEC 61000-6-4;
d) immunity requirement extended in the frequency range 5,1 GHz to 6 GHz;
e) revision of Annex B.

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
9/2338/FDIS	9/2368/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.

IMPORTANT – The "colour inside" logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this publication using a colour printer.

RAILWAY APPLICATIONS – ELECTROMAGNETIC COMPATIBILITY –

Part 3-2: Rolling stock – Apparatus

1 Scope

This part of IEC 62236 applies to emission and immunity aspects of EMC for electrical and electronic apparatus intended for use on railway rolling stock. IEC 62236-3-2 applies for the integration of apparatus on rolling stock.

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

The application of tests ~~shall~~ depends on the particular apparatus, its configuration, its ports, its technology and its operating conditions.

This document takes into account the internal environment of the railway rolling stock and the external environment of the railway, and interference to the apparatus from equipment such as hand-held radio-transmitters.

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 ~~and immunity limits in this standard at the communication frequency do not apply~~ requirement in this document is not intended to be applicable to the intentional transmission from a radio-transmitter as defined by the ITU.

Immunity limits do not apply in the exclusion bands as defined in the corresponding EMC related standard for radio equipment.

This document does not apply to transient emissions when starting or stopping the apparatus.

The objective of this document is to define limits and test methods for electromagnetic emissions and immunity test requirements in relation to conducted and radiated disturbances.

These limits and tests represent essential electromagnetic compatibility requirements.

Emission requirements have been selected so as to ensure that disturbances generated by the apparatus operated normally on railway rolling stock do not exceed a level which could prevent other apparatus from operating as intended. The emission limits given in this document take precedence over emission requirements for individual apparatus on board the rolling stock given in other standards.

Likewise, the immunity requirements have been selected so as to ensure an adequate level of immunity for rolling stock apparatus.

~~The levels do not however cover extreme cases which may occur with an extremely low probability of occurrence in any location. Specific requirements which deviate from this standard shall be specified.~~

Test requirements are specified for each port considered.

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 60571:2012, *Railway applications – Electronic equipment used on rolling stock*

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 61000-4-3:2006/AMD1:2007
IEC 61000-4-3:2006/AMD2:2010

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 61000-4-5:2014/AMD1:2017

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 61000-4-30:2015, *Electromagnetic compatibility (EMC) – Part 4-30: Testing and measurement techniques – Power quality measurement methods*

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

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 62236-3-1:2018, *Railway applications – Electromagnetic compatibility – Part 3-1: Rolling stock – Train and complete vehicle*

~~CISPR 11, *Industrial, scientific and medical (ISM) radio-frequency equipment – Electromagnetic disturbance characteristics – Limits and methods of measurement*~~

~~CISPR 16 (all parts), *Specification for radio disturbance and immunity measuring apparatus and methods*~~

CISPR 16-2-1:2014, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-1: Methods of measurement of disturbances and immunity – Conducted disturbance measurements*

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

CISPR 32:2015, *Electromagnetic compatibility of multimedia equipment – Emission requirements*

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
rolling stock apparatus
finished product with an intrinsic function intended for implementation into the rolling stock installation

3.1.2
port <in electromagnetic compatibility>
particular interface of ~~the specified apparatus~~ an equipment which couples this equipment with the external electromagnetic environment (161-01-01) and through which the equipment is influenced by this environment

EXAMPLE Auxiliary AC or DC power port, I/O (input/output) port, earth port.

Note 1 to entry: The main categories of ports for rolling stock apparatus are presented in Figure 1.

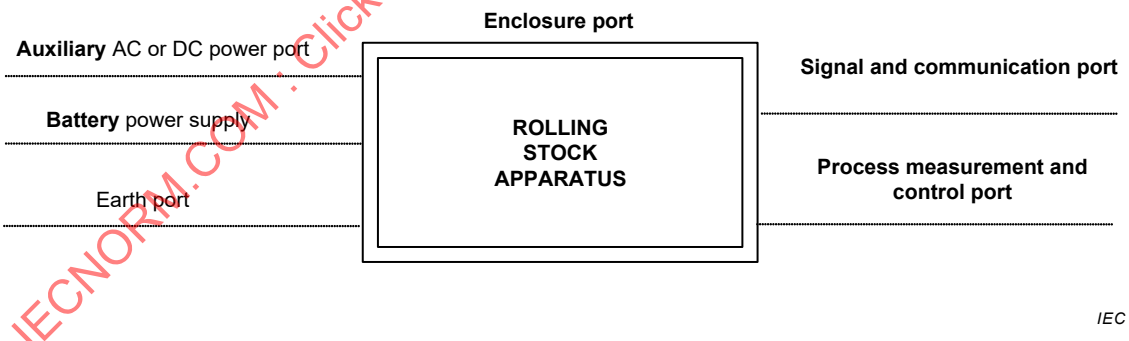


Figure 1 – Main categories of ports

Note 2 to entry: Typical examples of rolling stock apparatus with their ports are listed in Annex A.

Note 3 to entry: Traction power ports are not covered in IEC 62236-3-2:2018, see Annex B.

[SOURCE: IEC 60050-161:1990, AMD4:2014 161-01-27, modified]

3.1.3
enclosure port
physical boundary of the apparatus through which electromagnetic fields may radiate or impinge

3.2 Abbreviated terms

AC	Alternating current
AM	Amplitude modulation
CISPR	Comité international spécial des perturbations radioélectriques
DC	Direct current
EMC	Electromagnetic compatibility
I/O	Input / Output
ITU	International Telegraph Union
PC	Personal computer
r.m.s.	Root mean square
THD	Total harmonic distortion
TV	Television

4 Performance criteria

The variety and the 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.

A functional description and a definition of performance criteria, during or as a consequence of the EMC testing, shall be provided by the manufacturer and noted in the test report, based on the criteria A, B, C defined in IEC 62236-1:2018.

5 Conditions during testing

It is not always possible to test every function of the apparatus. The tests shall be made at a typical operating mode considered by the manufacturer to produce the largest emission or maximum susceptibility to ~~noise~~ disturbance as appropriate in the frequency band being investigated consistent with normal applications. ~~The manufacturer shall define~~ The conditions during testing shall be defined in a test plan (see basic standard of IEC 61000-4 series).

If the apparatus is part of a system, or can be connected to auxiliary apparatus, then the apparatus shall be tested while connected to the minimum configuration of auxiliary apparatus necessary to exercise the ports in accordance e.g. with ~~CISPR 22~~ CISPR 32:2015, Clause 6.

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.

If the apparatus has a large number of similar ports or ports with many similar connections, then a sufficient number shall be selected to simulate actual operating conditions and to ensure that all the different types of termination are covered (e.g. 20 % of the ports or at least four ports).

The tests shall be carried out within the specified operating range for the apparatus and at its ~~rated~~ nominal supply voltage, unless otherwise indicated ~~in the basic standard~~.

6 Applicability

The measurements in this document shall be made on the relevant ports of the apparatus.

It may be determined from consideration of the electrical characteristics, the connection and the usage of a particular apparatus that some of the tests are not applicable (e.g. radiated

immunity of induction motors, transformers). In such cases, the decision not to test has to be recorded in the test plan ~~or~~ and test report.

If not otherwise specified, the EMC tests shall be type tests.

7 Emission tests and limits

The emission tests and limits for apparatus covered by this document are given on a port by port basis.

Measurements shall be performed in well-defined and reproducible conditions for each type of disturbance.

The radiated emission limits defined for enclosure port in IEC 61000-6-4:2006, Table 1 shall be complied with. The description of the test, the test methods and the test set-up are given in Basic Standards which are referred to in ~~Tables 1 to 6~~ IEC 61000-6-4:2006.

Measurement distance is 10 m according to line 1.1 in IEC 61000-6-4:2006, Table 1. A measurement distance of 3 m may be used with the limit increased by 10 dB.

Traction converters and auxiliary converters over 50 kVA need not be tested individually, but when the vehicle is tested as a whole in accordance with IEC 62236-3-1.

The description of the conducted emission tests, the test methods and the test set-up are given in Basic Standards which are referred to in Tables 1 and 2.

The contents of these Basic Standards are not repeated herein, however, modifications or additional information needed for the practical application of the tests are given in this document.

NOTE The reference to “Basic Standard“ is intended to be limited to those parts of the standard that give the description of the test, the test methods and the test set-up.

Table 1 – Emission – Traction a.c. power ports

	Port	Test specification		Basic standard	Test set-up	Remarks
1.1	**High voltage connection, input side before filter** (port 3 on Figures A.1, A.2 and A.3)	Signalling and telecommunication frequencies	see IEC 62236-3-1			
		9 kHz - 30 MHz	No limits			See Notes 1 and 2
NOTE 1 No conducted radio frequency limits are applied. The apparatus when installed with other surrounding equipment should satisfy the radiated emission limits of IEC 62236-3-1 for trains. NOTE 2 It is desirable but not possible to apply conducted radio frequency limits. No practical test method exists and the relationship between conducted emissions and radiated emissions is not possible to define.						

Table 2 – Emission – Traction d.c. power ports

	Port	Test specification		Basic standard	Test set-up	Remarks
2.1	**High voltage connection, input side before filter** (port 3 on Figure A.4)	Signalling and telecommunication frequencies	see IEC 62236-3-1			
		9 kHz - 30 MHz	No limits			See Notes 1 and 2
NOTE 1 No conducted radio frequency limits are applied. The apparatus when installed with other surrounding equipment should satisfy the radiated emission limits of IEC 62236-3-1 for trains. NOTE 2 At present, there is no agreed method or limit for conducted emissions on the traction supply from 9 kHz to 30 MHz. Limiting conducted emissions from an apparatus connected to the traction supply will prevent excessive radiated emissions from the supply system. A method for measuring conducted emissions is proposed in Annex B. Experience in this technique and the relationship between conducted and radiated emissions are necessary in order to make this standard progress in the future.						

Table 3 – Emission – Auxiliary a.c. or d.c. power ports

	Port	Test specification		Basic standard	Test set-up	Remarks
3.1	**Auxiliary supply sinusoidal a.c. or d.c.** (port 9 on Figures A.1, A.2 and A.4)	9 kHz - 150 kHz	No limits	CISPR 11	CISPR 11	See Notes 1 and 2
		150 kHz - 500 kHz	99 dBµV quasi-peak			See Notes 3, 4 and 5
		500 kHz - 30 MHz	93 dBµV quasi-peak			See Notes 3, 4 and 5

NOTE 1 At present, there are no limits for conducted emissions from 9 kHz to 150 kHz. Limiting conducted emissions from an apparatus will prevent excessive radiated emissions. Experience in this technique and the relationship between conducted and radiated emissions are necessary in order to make this standard progress in the future.

NOTE 2 230 V AC power outlet ports for public use should offer a power quality, which is sufficient for the use of intended equipment like PC and mobile telephone chargers. The total harmonic distortion should be limited by a sine-filter to ≤ 8 %. The burst and surge emissions of the outlet should be limited to the levels of residential equipment according to IEC 61000-6-1. AM radio receivers are not intended to be supplied by these power outlets.

NOTE 3 Wherever applicable the method defined by CISPR 11 is to be used. At present, the existing method of measuring conducted emissions (CISPR 11) has limitations in terms of voltage and current rating of coupling networks. In addition, the method of measuring voltage has safety implications for testing high power systems. Limiting conducted emissions from apparatus connected to external cable systems will prevent excessive radiated emissions.

NOTE 4 This requirement refers to the industrial limit values but considering they have been defined to protect radio and TV sets and as the objective is not the same here, the applicable limit for railway applications has been relaxed by 20 dB to be more representative of potential problems.

NOTE 5 This requirement is not applicable to power ports which are connected to other dedicated, compatible ports.

Table 4 – Emission – Battery referenced ports

	Port	Test specification		Basic standard	Test set-up	Remarks
4.1	**Battery power supply** (port 10 on Figures A.1 to A.5)	9 kHz - 150 kHz	No limits	CISPR 11	CISPR 11	See Note 1
		150 kHz - 500 kHz	99 dBµV quasi-peak			See Note 2
		500 kHz - 30 MHz	93 dBµV quasi-peak			See Note 2

NOTE 1 At present, there are no limits for conducted emissions from 9 kHz to 150 kHz. Limiting conducted emissions from an apparatus will prevent excessive radiated emissions. Experience in this technique and the relationship between conducted and radiated emissions is necessary in order to make this standard progress in the future.

NOTE 2 This requirement refers to the industrial limit values but considering they have been defined to protect radio and TV sets and as the objective is not the same here, the applicable limit for railway applications has been relaxed by 20 dB to be more representative of potential problems.

Table 5 – Emission – Process measurement and control ports

	Port	Test specification		Basic standard	Test set-up	Remarks
5.1	Electronic supply sinusoidal a.c. or d.c. (port 16 on Figure A.5)	9 kHz - 150 kHz	No limits	CISPR 11	CISPR 11	See Note 1
		150 kHz - 500 kHz	99 dBμV quasi-peak			See Note 2
		500 kHz - 30 MHz	93 dBμV quasi-peak			See Note 2

NOTE 1 At present, there are no limits for conducted emissions from 9 kHz to 150 kHz. Limiting conducted emissions from an apparatus will prevent excessive radiated emissions. Experience in this technique and the relationship between conducted and radiated emissions is necessary in order to make this standard progress in the future.

NOTE 2 This requirement refers to the industrial limit values but considering they have been defined to protect radio and TV sets and as the objective is not the same here, the applicable limit for railway applications has been relaxed by 20 dB to be more representative of potential problems.

Table 6 – Emission – Enclosure port

	Port	Test specification		Basic standard	Test set-up	Remarks
6.1	Enclosure	30 MHz - 230 MHz	40 dBμV/m quasi-peak	CISPR 11	CISPR 11	See Notes 1 and 2
		230 MHz - 1 GHz	47 dBμV/m quasi-peak			See Notes 1 and 2

NOTE 1 The measurement distance is 10 m. A measurement distance of 3 m may be used with the limit increased by 10 dB.

NOTE 2 Traction converters and auxiliary converters over 50 kVA need not be tested individually but when the vehicle is tested as a whole in accordance with IEC 62236-3-1.

Table 1 – Emission – Auxiliary AC or DC power ports (input and output)

	Port	Test specification		Basic Standard	Test set-up	Applicability note	Remarks
1.1	**Auxiliary supply sinusoidal AC or DC** (port 9 on Figures A.1, A.2 and A.4)	150 kHz to 500 kHz 500 kHz to 30 MHz	99 dBµV quasi-peak 93 dBµV quasi-peak	CISPR 16-2-1	CISPR 16-2-1	See [a, b] and [c]	For the time being there are no limits for shore supply mode. Therefore the limits given in this table are valid. Other limits may apply if connected e.g. to the public low voltage power supply and should be specified by the train operator.
1.2	**AC power outlet port for public use**	50 Hz to 2 kHz	THD < 8 % (THD: total harmonic distortion)	IEC 61000-4-30			230 V AC power outlet ports for public use shall offer a power quality, which is sufficient for the use of intended equipment like PC and mobile telephone chargers. The harmonic distortion in differential mode shall be limited by a sine-filter to < 8 %.

[a] Wherever applicable the method defined by CISPR 16-2-1 is to be used. At present the existing method of measuring conducted emissions (CISPR 16-2-1) has limitations in terms of voltage and current rating of coupling networks. In addition, the method of measuring voltage has safety implications for testing high power systems. Limiting conducted emissions from apparatus connected to external cable systems will prevent excessive radiated emissions.

[b] This requirement refers to the industrial limit values, but considering they have been defined to protect radio and TV sets and as the objective is not the same here, the applicable limit for railway applications has been relaxed by 20 dB to be more representative of potential problems.

[c] This requirement is not applicable to power ports which are connected to other dedicated, compatible ports.

Table 2 – Emission – Battery power supply (input and output)

	Port	Test specification		Basic standard	Test set-up	Applicability note	Remarks
2.1	**Battery power supply** (port 10 on Figures A.1 to A.5)	150 kHz to 500 kHz	99 dBµV quasi-peak	CISPR 16-2-1	CISPR 16-2-1	See [a]	
		500 kHz to 30 MHz	93 dBµV quasi-peak				

[a] This requirement refers to the industrial limit values, but considering they have been defined to protect radio and TV sets and as the objective is not the same here, the applicable limit for railway applications has been relaxed by 20 dB to be more representative of potential problems.

8 Immunity ~~tests and limits~~ requirements

The immunity ~~tests and limits~~ requirements for apparatus covered by this document are given on a port by port basis.

The levels do not however cover all cases which may occur with an extremely low probability of occurrence in any location. Specific requirements which deviate from this document shall be specified.

To ensure the immunity of the complete vehicle, the ~~limits~~ requirements shall be applicable to all relevant apparatus.

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 test, the test generator, the test methods and the test set-up are given in Basic Standards which are referred to in Tables 3 to 5.

The contents of these Basic Standards are not repeated herein, however, modifications or additional information needed for the practical application of the tests are given in this document.

When installing new apparatus in existing rolling stock or replacing apparatus, special care should be taken to ensure that EMC is maintained, e.g. in the EMC plan.

Table 3 – Immunity – Battery referenced ports (except at the output of energy sources), auxiliary AC power input ports (rated voltage ≤ ~~400~~ 480 $V_{r.m.s.}$)

	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	**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]	Direct coupling	**A**
3.3	**Surges**	1,2 / 50 µs ±2 kV 42 Ω, 0,5 µF ±1 kV 42 Ω, 0,5 µF	 Open circuit test voltage, line to ground Open circuit test voltage, line to line	IEC 61000-4-5	IEC 61000-4-5	See [b,c]	All severity levels below the given severity level have to be tested with each 5 pulses and a test sequence not alternating but first one polarity, then the other polarity Test with maximum permanent supply voltage as defined in IEC 60571	**B**

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

[b] The test applies to the power supply ports and the battery control input output ports, with direct coupling, positive and negative polarity.

[c] The test applies to the power supply ports and the battery control input output ports.This test is intended to replicate the phenomenon known as direct coupling; hence, an output impedance of 42 Ω (40 Ω and 2 Ω generator) and a coupling capacitance of 0,5 µF is specified. This value is accepted as a compromise, as the impedance of battery referenced network inside a rolling stock can vary up to a few hundred ohms depending on its length.

Table 4 – Immunity – Signal and communication, process measurement and control 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 [b,c]	The test level specified is the r.m.s. value of the unmodulated carrier	**A**
4.2	**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 [a,b]	Capacitive clamp used	**A**

[a] Capacitive coupling, positive and negative polarity. Battery referenced control ports are covered by requirements in Table 3.

[b] Applicable only to ports interfacing with cables whose total length according to the manufacturer's functional specification may exceed 3 m.

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

Table 5 – Immunity – Enclosure ports

	Environmental phenomena	Test specification		Basic standard	Test set-up	Remarks	Performance criteria
9.1	**Radio-frequency electromagnetic field. Amplitude modulated**	80 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 Notes 1 and 2 The test level specified is the r.m.s. value of the unmodulated carrier	**A**
9.2	**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 Notes 2, 3 and 4 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				
9.3	**Electrostatic discharge**	± 6 kV ± 8 kV	Contact discharge Air discharge	IEC 61000-4-2	IEC 61000-4-2	See Note 5	**B**

NOTE 1 This limit applies to equipment mounted in the passenger compartments, drivers cab or external to the rolling stock (roof, underframe). For equipment mounted in all other areas, a severity level of 10 V/m may be used.

NOTE 2 For large apparatus (e.g. traction drives, auxiliary converters) it is often not practical to perform the immunity test to radiated electromagnetic fields on the complete unit. In such cases the manufacturer should test susceptible sub-systems (e.g. control electronics). The test report should justify the selection or not of sub-systems and any assumptions made (e.g. reduction of field due to case shielding).

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.

NOTE 4 The immunity test levels may be reduced for equipment mounted in areas where the threat from mobile digital radio telephones has been demonstrated to be less severe.

NOTE 5 Only applicable to equipment accessible to passengers and operational staff (not maintenance).

	Environmental phenomena	Test specification		Basic Standard	Test set-up	Applicability note	Remarks	Performance criteria
5.1	**Radio-frequency electromagnetic field. Amplitude modulated**	80 MHz to 800 MHz 20 V/m (r.m.s.) 80 % AM, 1 kHz	Unmodulated carrier	IEC 61000-4-3	IEC 61000-4-3	See [a] and [b]	The test level specified is the r.m.s. value of the unmodulated carrier	**A**
5.2	**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	See [b]	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					
5.3	**Electrostatic discharge**	± 6 kV ± 8 kV	Contact discharge Air discharge	IEC 61000-4-2	IEC 61000-4-2	See [c]		**B**

[a] This limit applies to equipment mounted in the passenger compartments, drivers cab or external to the rolling stock (roof, underframe). For equipment mounted in all other areas, a severity level of 10 V/m may be used.

[b] For large apparatus (e.g. traction drives, auxiliary converters), it is often not practical to perform the immunity test to radiated electromagnetic fields on the complete unit. In such cases the manufacturer should test susceptible sub-systems (e.g. control electronics). The test report should justify the selection or not of sub-systems and any assumptions made (e.g. reduction of field due to case shielding).

[c] Only applicable to equipment accessible to passengers and operational staff (not maintenance).

Annex A
(informative)

Examples of apparatus and ports

The purpose of this annex is to provide examples of the different types of rolling stock apparatus together with their ports. Examples of apparatus which may be placed on the market as a single commercial unit are given in Table A.1. However, these items of apparatus may also form a sub-system in a larger apparatus (e.g. control electronics in an auxiliary converter). In this case, the requirements of the standard apply only to the apparatus which is placed on the market. A port is defined in the standard as the interface of an apparatus with the external environment. The matrix in the table indicates whether the particular apparatus is relevant to emission, immunity or neither. This guidance is offered for the benefit of users of this document, but it is not intended to be definitive. It is for the user of the document to make the necessary technical judgements in determining whether or not a test is applicable.

~~The drawings of~~ The following figures clarify the most essential ports. They show examples of different arrangements.

Figure A.1 applies for an AC fed ~~locomotive~~ traction unit with AC traction drive and psophometric filter on the line side.

Figure A.2 shows another AC/AC system with power factor correction filter on the converter side and with DC or three-phase auxiliary and train power supply.

Figure A.3 shows a more conventional system with AC input and DC traction motors fed by phase control converter.

Figure A.4 is a DC fed system with AC traction drive.

Figure A.5 shows some additional ports of converter and control electronics.

Of course, many other different system arrangements are possible.

Table A.1 – Typical examples of apparatus

Apparatus	Test requirements
Traction converter	Emission and immunity
Main circuit breaker	No test requirements
Traction transformers	No test requirements
Traction motor	No test requirements
Auxiliary motor (e.g. induction motor for fans)	No test requirements
DC auxiliary supply (battery)	Emission and immunity
~~Electronic control supply~~	~~Emission and immunity~~
Signalling and communication equipment	Emission and immunity
Electronic man-machine interface	Emission and immunity
Environmental conditioning equipment	Emission and immunity
Passenger information equipment	Emission and immunity
Door control	Emission and immunity
Auxiliary equipment for train operation	Emission and immunity
Auxiliary equipment for passenger services	Emission and immunity
Train management systems	Emission and immunity
Electronic power supply	Emission and immunity
Braking control system	Emission and immunity

In Tables 1 to 5, tests are specified for application to a specific port (interface of an apparatus). Table A.2 lists some more typical descriptions used for these ports and the type of apparatus which may have such a port. Examples of these ports are given in the accompanying figures, except for ports No. 11, 13 and 14.

Table A.2 – Typical port descriptions

Port No. on figures	Typical port name	Typical apparatus
	Traction AC power ports	
1	Pantograph line terminal	Main circuit breaker
3	High voltage connection (before filter)	Filter
4	Connection filter-transformer, HV side	Filter
5	Train power line single phase	Auxiliary converter
6	Connection transformer-converter	Propulsion converter
7	Traction motor cables	Traction motors
8	Auxiliary feed windings of transformer	DC auxiliary supply
	Traction DC power ports	
2	DC conductor input	Main circuit breaker
3	High voltage connection (before filter)	Filter
6	Connection filter-converter	Propulsion converter
7	Traction motor cables	Traction motors
	Auxiliary AC ports	
9	Auxiliary AC supply	Environmental conditioning equipment
	Auxiliary DC ports	
9	Auxiliary DC supply	
	Battery referenced ports	
10	Battery power supply	Electronic power supply
11	Train control bus (conventional battery voltage)	Train management system
19	Relay logic input/output	Electronic control system
	Signal and communication ports	
12	Databus within vehicle	Electronic control system
13	Databus within train	Train management system
14	Passenger entertainment network	Passenger entertainment equipment
15	Firing control line	Electronic control system
17, 18	Sensor/transducer signal (digital or analog)	Electronic control system
20	Communication interface (maintenance)	Electronic control system
	Process measurement and control ports	
16	Internal electronic supply	Electronic control system
18	Sensor/transducer signal (analog)	Electronic control system
	Enclosure port	
21	Equipment enclosure	All apparatus
	Earth port	
22	Earth connection	All apparatus

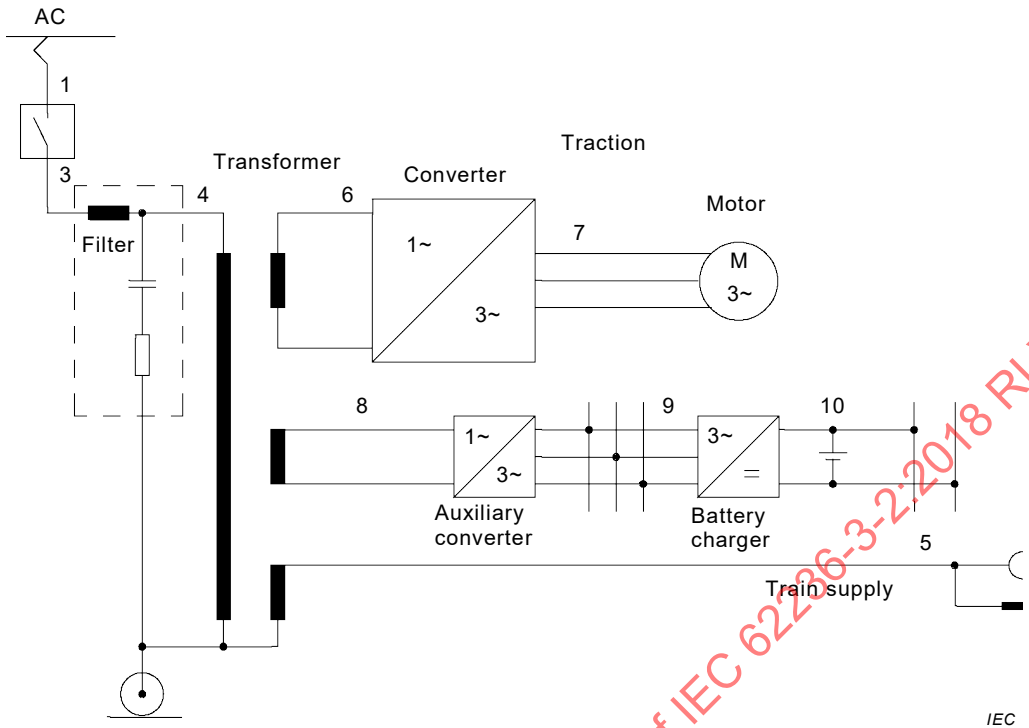


Figure A.1 – AC fed ~~locomotive~~ traction unit with AC traction drive and psophometric filter on the line side

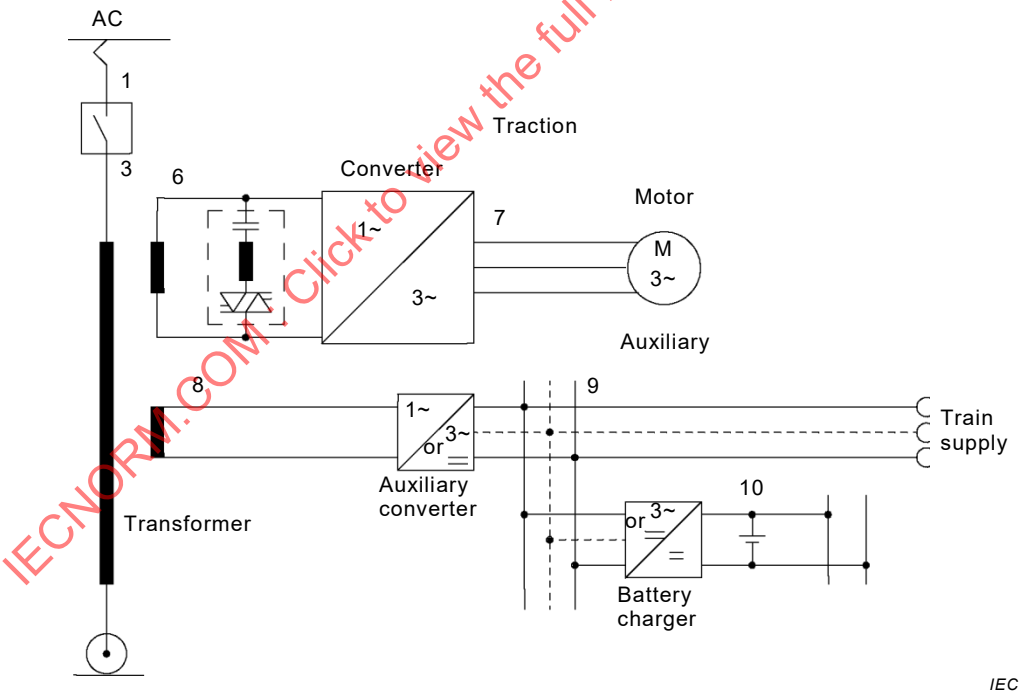


Figure A.2 – AC/AC system with power factor correction filter on the converter side and with DC or three-phase auxiliary and train power supply

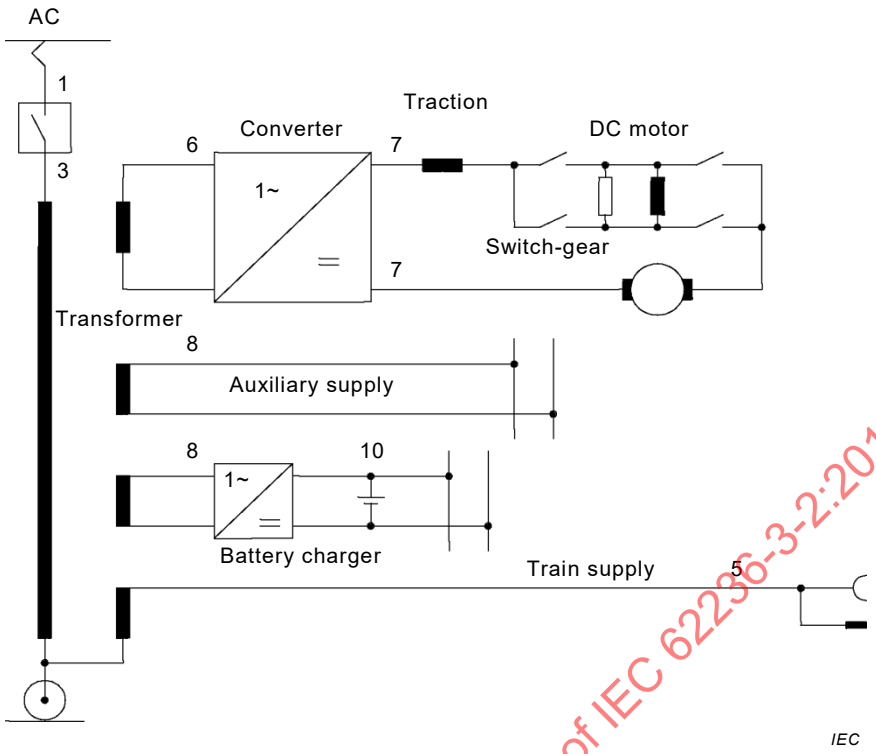


Figure A.3 – Conventional system with AC input and DC traction motors fed by phase control converter

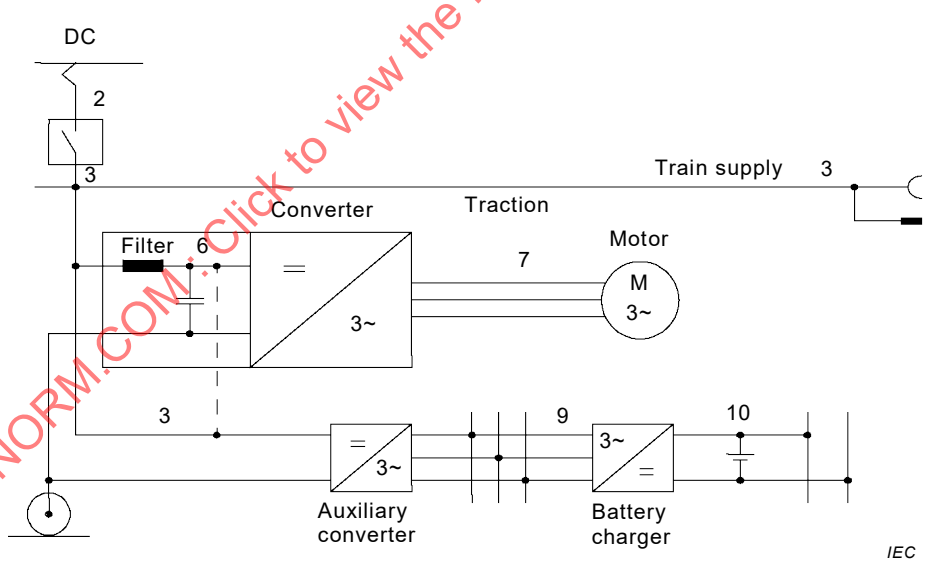


Figure A.4 – DC fed system with AC traction drive

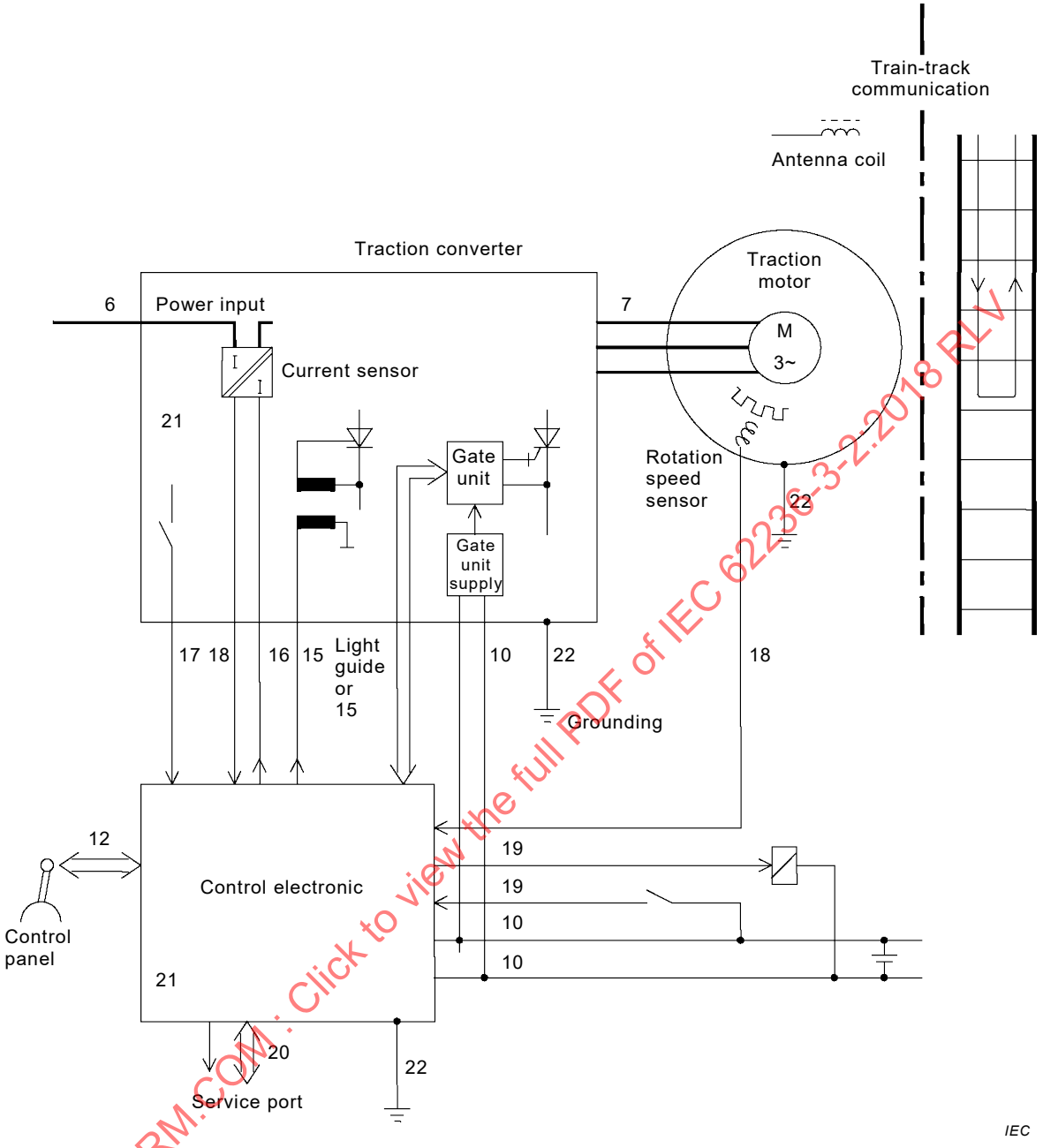


Figure A.5 – Additional ports of converter and control electronics

Annex B
(informative)

Conducted disturbances generated by power converters ~~in the range of 9 kHz to 30 MHz~~

~~B.1 General~~

~~This procedure concerns switched mode power conversion devices connected to the main traction d.c. port (catenary or conductor rail) with or without a main line filter.~~

~~B.2 Measuring method~~

~~The measurements should be carried out using the CISPR 16 series. The following adjustments should be set:~~

~~– 200 Hz on 6 dB bandwidth, in the range 9 kHz to 150 kHz;~~

~~– 9 kHz on 6 dB bandwidth, in the range 150 kHz to 30 MHz;~~

~~– quasi-peak detection with appropriate weighting for each frequency range.~~

~~Care should be taken of possible saturation caused by the main current which may affect the probe transfer characteristics. Correct impedance matching should be ensured from the probe to the measuring apparatus.~~

~~B.3 Test procedure~~

~~The organisation of the test is presented in Figure B.1 with appropriate recommendations.~~

~~The common mode impedance and grounding conditions should be as close as possible to the actual conditions on both input and output of the converter.~~

~~The levels should be measured for each measuring point and for each working condition recognised as providing the maximum disturbing currents.~~

~~B.4 Limits~~

~~No conducted radio frequency limits are applied. The apparatus when installed with other surrounding equipment must satisfy the radiated emission limits of IEC 62236-3-1 for trains. This test is offered to quantify the emission of apparatus, for example for data sheets.~~

No limits apply for laboratory tests. Emission requirements for this type of equipment are tested during the emission test of the complete rolling stock.

Table B.1 reminds the requirements for AC and DC ports.

Table B.1 – Emission requirements for AC and DC power ports

	Port	Test specification		Remarks
B.1	**AC** (port 3 on Figures A.1, A.2, A.3)	Signalling and telecommunication frequencies	See national requirements, contractual requirements	NOTE 1
	DC (port 3 on Figure A.4)	150 kHz to 30 MHz	IEC 62236-3-1:2018, 6.3.3	NOTE 2
NOTE 1 Homologation tests are performed on the complete train. NOTE 2 The requirement in IEC 62236-3-1:2018 is expressed at the train level as a radiated emission limit.				

Some preliminary tests during the design phase could provide helpful information about the emission expected.

Figure B.1 shows a possible test set-up.

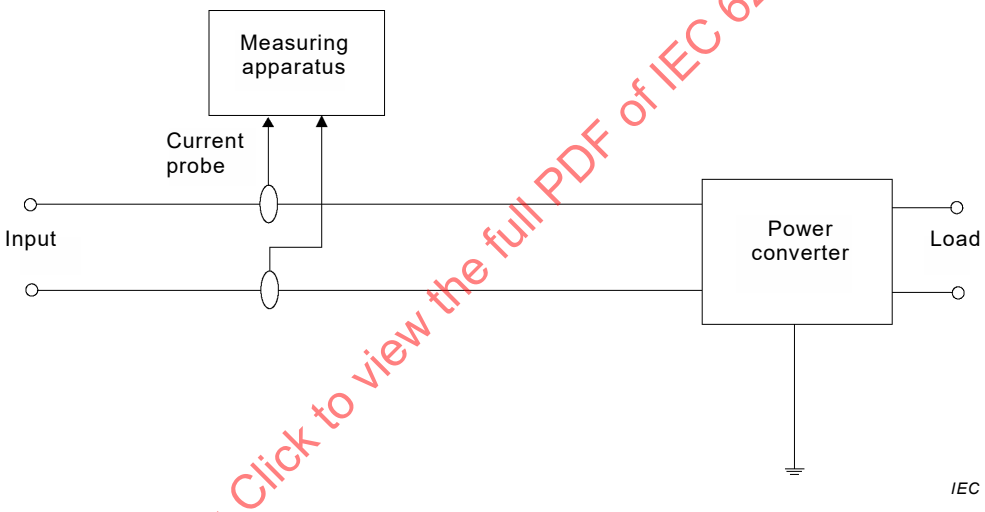


Figure B.1 – Test set-up

IEC 62236-3-2

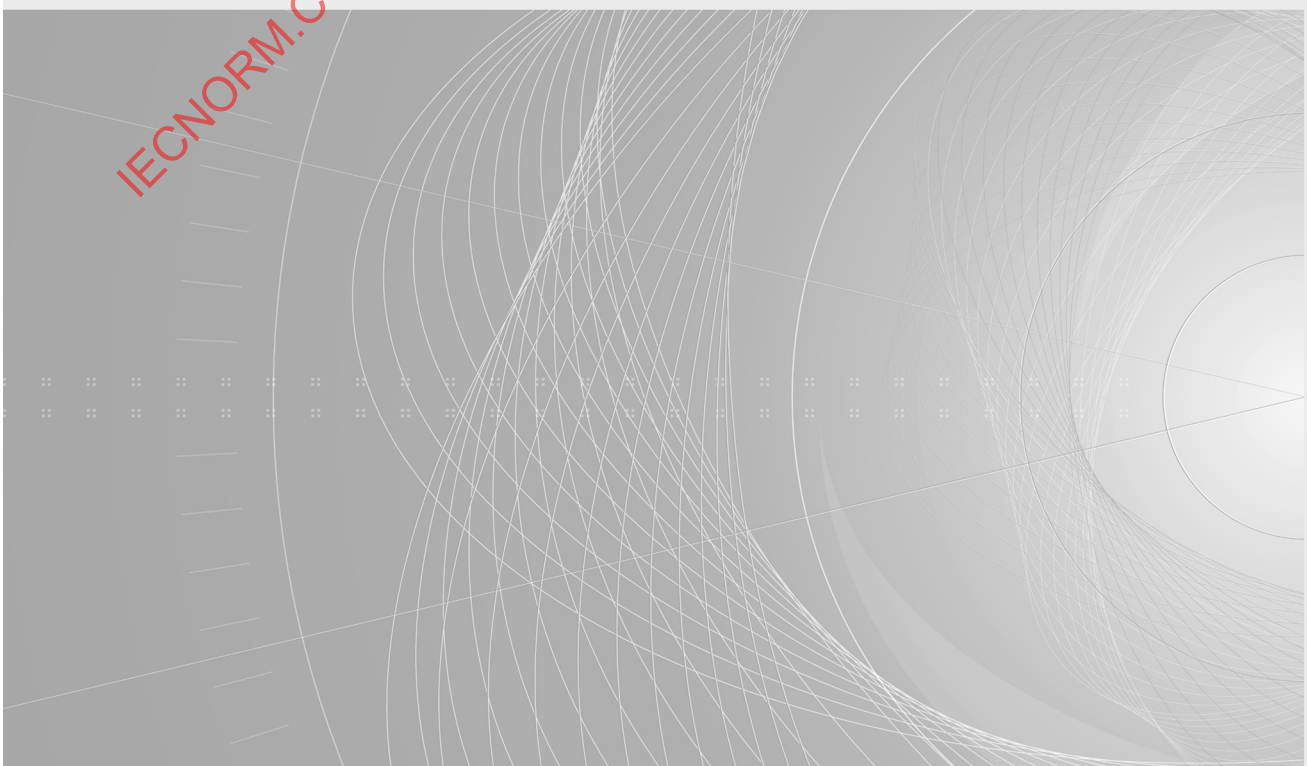
Edition 3.0 2018-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Railway applications – Electromagnetic compatibility –
Part 3-2: Rolling stock – Apparatus

Applications ferroviaires – Compatibilité électromagnétique –
Partie 3-2: Matériel roulant – Appareils



IEC 62236-3-2:2018-02(en-fr)

CONTENTS

FOREWORD 3
1 Scope 5
2 Normative references 6
3 Terms, definitions and abbreviated terms 6
3.1 Terms and definitions 6
3.2 Abbreviated terms 7
4 Performance criteria 8
5 Conditions during testing 8
6 Applicability 8
7 Emission tests and limits 8
8 Immunity requirements 11
Annex A (informative) Examples of apparatus and ports 15
Annex B (informative) Conducted disturbances generated by power converters 21

Figure 1 – Main categories of ports 7
Figure A.1 – AC fed traction unit with AC traction drive and psophometric filter on the line side 18
Figure A.2 – AC/AC system with power factor correction filter on the converter side and with DC or three-phase auxiliary and train power supply 18
Figure A.3 – Conventional system with AC input and DC traction motors fed by phase control converter 19
Figure A.4 – DC fed system with AC traction drive 19
Figure A.5 – Additional ports of converter and control electronics 20
Figure B.1 – Test set-up 21

Table 1 – Emission – Auxiliary AC or DC power ports (input and output) 10
Table 2 – Emission – Battery power supply (input and output) 10
Table 3 – Immunity – Battery referenced ports (except at the output of energy sources), auxiliary AC power input ports (rated voltage ≤ 480 $V_{r.m.s.}$) 12
Table 4 – Immunity – Signal and communication, process measurement and control ports 13
Table 5 – Immunity – Enclosure ports 14
Table A.1 – Typical examples of apparatus 16
Table A.2 – Typical port descriptions 17
Table B.1 – Emission requirements for AC and DC power ports 21

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

RAILWAY APPLICATIONS – ELECTROMAGNETIC COMPATIBILITY –

Part 3-2: Rolling stock – 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.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 62236-3-2 has been prepared by IEC technical committee 9: Electrical equipment and systems for railways.

This third edition cancels and replaces the second edition published in 2008. It constitutes a technical revision and has been developed on the basis of EN 50121-3-2:2015.

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

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

e) revision of Annex B.

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
9/2338/FDIS	9/2368/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.

RAILWAY APPLICATIONS – ELECTROMAGNETIC COMPATIBILITY –

Part 3-2: Rolling stock – Apparatus

1 Scope

This part of IEC 62236 applies to emission and immunity aspects of EMC for electrical and electronic apparatus intended for use on railway rolling stock. IEC 62236-3-2 applies for the integration of apparatus on rolling stock.

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

The application of tests depends on the particular apparatus, its configuration, its ports, its technology and its operating conditions.

This document takes into account the internal environment of the railway rolling stock and the external environment of the railway, and interference to the apparatus from equipment such as hand-held radio-transmitters.

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 requirement in this document is not intended to be applicable to the intentional transmission from a radio-transmitter as defined by the ITU.

Immunity limits do not apply in the exclusion bands as defined in the corresponding EMC related standard for radio equipment.

This document does not apply to transient emissions when starting or stopping the apparatus.

The objective of this document is to define limits and test methods for electromagnetic emissions and immunity test requirements in relation to conducted and radiated disturbances.

These limits and tests represent essential electromagnetic compatibility requirements.

Emission requirements have been selected so as to ensure that disturbances generated by the apparatus operated normally on railway rolling stock do not exceed a level which could prevent other apparatus from operating as intended. The emission limits given in this document take precedence over emission requirements for individual apparatus on board the rolling stock given in other standards.

Likewise, the immunity requirements have been selected so as to ensure an adequate level of immunity for rolling stock apparatus.

Test requirements are specified for each port considered.

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 60571:2012, *Railway applications – Electronic equipment used on rolling stock*

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 61000-4-3:2006/AMD1:2007
IEC 61000-4-3:2006/AMD2:2010

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 61000-4-5:2014/AMD1:2017

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 61000-4-30:2015, *Electromagnetic compatibility (EMC) – Part 4-30: Testing and measurement techniques – Power quality measurement methods*

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 62236-3-1:2018, *Railway applications – Electromagnetic compatibility – Part 3-1: Rolling stock – Train and complete vehicle*

CISPR 16-2-1:2014, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-1: Methods of measurement of disturbances and immunity – Conducted disturbance measurements*

CISPR 32:2015, *Electromagnetic compatibility of multimedia equipment – Emission requirements*

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
rolling stock apparatus
finished product with an intrinsic function intended for implementation into the rolling stock installation

3.1.2
port <in electromagnetic compatibility>
particular interface of an equipment which couples this equipment with the external electromagnetic environment (161-01-01) and through which the equipment is influenced by this environment

EXAMPLE Auxiliary AC or DC power port, I/O (input/output) port, earth port.

Note 1 to entry: The main categories of ports for rolling stock apparatus are presented in Figure 1.

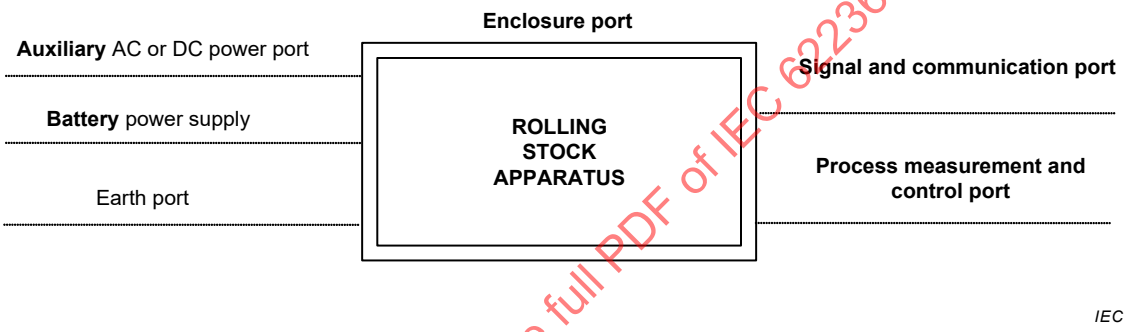


Figure 1 – Main categories of ports

Note 2 to entry: Typical examples of rolling stock apparatus with their ports are listed in Annex A.

Note 3 to entry: Traction power ports are not covered in IEC 62236-3-2:2018, see Annex B.

[SOURCE: IEC 60050-161:1990, AMD4:2014 161-01-27, modified]

3.1.3
enclosure port
physical boundary of the apparatus through which electromagnetic fields may radiate or impinge

3.2 Abbreviated terms

AC	Alternating current
AM	Amplitude modulation
CISPR	Comité international spécial des perturbations radioélectriques
DC	Direct current
EMC	Electromagnetic compatibility
I/O	Input / Output
ITU	International Telegraph Union
PC	Personal computer
r.m.s.	Root mean square
THD	Total harmonic distortion
TV	Television

4 Performance criteria

The variety and the 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.

A functional description and a definition of performance criteria, during or as a consequence of the EMC testing, shall be provided by the manufacturer and noted in the test report, based on the criteria A, B, C defined in IEC 62236-1:2018.

5 Conditions during testing

It is not always possible to test every function of the apparatus. The tests shall be made at a typical operating mode considered by the manufacturer to produce the largest emission or maximum susceptibility to disturbance as appropriate in the frequency band being investigated consistent with normal applications. The conditions during testing shall be defined in a test plan (see basic standard of IEC 61000-4 series).

If the apparatus is part of a system, or can be connected to auxiliary apparatus, then the apparatus shall be tested while connected to the minimum configuration of auxiliary apparatus necessary to exercise the ports in accordance e.g. with CISPR 32:2015, Clause 6.

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.

If the apparatus has a large number of similar ports or ports with many similar connections, then a sufficient number shall be selected to simulate actual operating conditions and to ensure that all the different types of termination are covered (e.g. 20 % of the ports or at least four ports).

The tests shall be carried out within the specified operating range for the apparatus and at its nominal supply voltage, unless otherwise indicated.

6 Applicability

The measurements in this document shall be made on the relevant ports of the apparatus.

It may be determined from consideration of the electrical characteristics, the connection and the usage of a particular apparatus that some of the tests are not applicable (e.g. radiated immunity of induction motors, transformers). In such cases, the decision not to test has to be recorded in the test plan and test report.

If not otherwise specified, the EMC tests shall be type tests.

7 Emission tests and limits

The emission tests and limits for apparatus covered by this document are given on a port by port basis.

Measurements shall be performed in well-defined and reproducible conditions for each type of disturbance.

The radiated emission limits defined for enclosure port in IEC 61000-6-4:2006, Table 1 shall be complied with. The description of the test, the test methods and the test set-up are given in Basic Standards which are referred to in IEC 61000-6-4:2006.

Measurement distance is 10 m according to line 1.1 in IEC 61000-6-4:2006, Table 1. A measurement distance of 3 m may be used with the limit increased by 10 dB.

Traction converters and auxiliary converters over 50 kVA need not be tested individually, but when the vehicle is tested as a whole in accordance with IEC 62236-3-1.

The description of the conducted emission tests, the test methods and the test set-up are given in Basic Standards which are referred to in Tables 1 and 2.

The contents of these Basic Standards are not repeated herein, however, modifications or additional information needed for the practical application of the tests are given in this document.

NOTE The reference to “Basic Standard“ is intended to be limited to those parts of the standard that give the description of the test, the test methods and the test set-up.

Table 1 – Emission – Auxiliary AC or DC power ports (input and output)

	Port	Test specification		Basic Standard	Test set-up	Applicability note	Remarks
1.1	**Auxiliary supply sinusoidal AC or DC** (port 9 on Figures A.1, A.2 and A.4)	150 kHz to 500 kHz 500 kHz to 30 MHz	99 dBµV quasi-peak 93 dBµV quasi-peak	CISPR 16-2-1	CISPR 16-2-1	See [a, b] and [c]	For the time being there are no limits for shore supply mode. Therefore the limits given in this table are valid. Other limits may apply if connected e.g. to the public low voltage power supply and should be specified by the train operator.
1.2	**AC power outlet port for public use**	50 Hz to 2 kHz	THD < 8 % (THD: total harmonic distortion)	IEC 61000-4-30			230 V AC power outlet ports for public use shall offer a power quality, which is sufficient for the use of intended equipment like PC and mobile telephone chargers. The harmonic distortion in differential mode shall be limited by a sine-filter to < 8 %.

[a] Wherever applicable the method defined by CISPR 16-2-1 is to be used. At present the existing method of measuring conducted emissions (CISPR 16-2-1) has limitations in terms of voltage and current rating of coupling networks. In addition, the method of measuring voltage has safety implications for testing high power systems. Limiting conducted emissions from apparatus connected to external cable systems will prevent excessive radiated emissions.

[b] This requirement refers to the industrial limit values, but considering they have been defined to protect radio and TV sets and as the objective is not the same here, the applicable limit for railway applications has been relaxed by 20 dB to be more representative of potential problems.

[c] This requirement is not applicable to power ports which are connected to other dedicated, compatible ports.

Table 2 – Emission – Battery power supply (input and output)

	Port	Test specification		Basic standard	Test set-up	Applicability note	Remarks
2.1	**Battery power supply** (port 10 on Figures A.1 to A.5)	150 kHz to 500 kHz 500 kHz to 30 MHz	99 dBµV quasi-peak 93 dBµV quasi-peak	CISPR 16-2-1	CISPR 16-2-1	See [a]	

[a] This requirement refers to the industrial limit values, but considering they have been defined to protect radio and TV sets and as the objective is not the same here, the applicable limit for railway applications has been relaxed by 20 dB to be more representative of potential problems.

8 Immunity requirements

The immunity requirements for apparatus covered by this document are given on a port by port basis.

The levels do not however cover all cases which may occur with an extremely low probability of occurrence in any location. Specific requirements which deviate from this document shall be specified.

To ensure the immunity of the complete vehicle, the requirements shall be applicable to all relevant apparatus.

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 test, the test generator, the test methods and the test set-up are given in Basic Standards which are referred to in Tables 3 to 5.

The contents of these Basic Standards are not repeated herein, however, modifications or additional information needed for the practical application of the tests are given in this document.

When installing new apparatus in existing rolling stock or replacing apparatus, special care should be taken to ensure that EMC is maintained, e.g. in the EMC plan.

Table 3 – Immunity – Battery referenced ports (except at the output of energy sources), auxiliary AC power input ports (rated voltage ≤ 480 $V_{r.m.s.}$)

	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	**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]	Direct coupling	**A**
3.3	**Surges**	1,2 / 50 µs ±2 kV 42 Ω, 0,5 µF ±1 kV 42 Ω, 0,5 µF	 Open circuit test voltage, line to ground Open circuit test voltage, line to line	IEC 61000-4-5	IEC 61000-4-5	See [b, c]	All severity levels below the given severity level have to be tested with each 5 pulses and a test sequence not alternating but first one polarity, then the other polarity Test with maximum permanent supply voltage as defined in IEC 60571	**B**

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

[b] The test applies to the power supply ports and the battery control input output ports, with direct coupling, positive and negative polarity.

[c] The test applies to the power supply ports and the battery control input output ports. This test is intended to replicate the phenomenon known as direct coupling; hence, an output impedance of 42 Ω (40 Ω and 2 Ω generator) and a coupling capacitance of 0,5 µF is specified. This value is accepted as a compromise, as the impedance of battery referenced network inside a rolling stock can vary up to a few hundred ohms depending on its length.

Table 4 – Immunity – Signal and communication, process measurement and control 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 [b, c]	The test level specified is the r.m.s. value of the unmodulated carrier	**A**
4.2	**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 [a, b]	Capacitive clamp used	**A**

[a] Capacitive coupling, positive and negative polarity. Battery referenced control ports are covered by requirements in Table 3.

[b] Applicable only to ports interfacing with cables whose total length according to the manufacturer's functional specification may exceed 3 m.

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

Table 5 – Immunity – Enclosure ports

	Environmental phenomena	Test specification		Basic Standard	Test set-up	Applicability note	Remarks	Performance criteria
5.1	**Radio-frequency electromagnetic field. Amplitude modulated**	80 MHz to 800 MHz 20 V/m (r.m.s.) 80 % AM, 1 kHz	Unmodulated carrier	IEC 61000-4-3	IEC 61000-4-3	See [a] and [b]	The test level specified is the r.m.s. value of the unmodulated carrier	**A**
5.2	**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	See [b]	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					
5.3	**Electrostatic discharge**	± 6 kV ± 8 kV	Contact discharge Air discharge	IEC 61000-4-2	IEC 61000-4-2	See [c]		**B**

[a] This limit applies to equipment mounted in the passenger compartments, drivers cab or external to the rolling stock (roof, underframe). For equipment mounted in all other areas, a severity level of 10 V/m may be used.

[b] For large apparatus (e.g. traction drives, auxiliary converters), it is often not practical to perform the immunity test to radiated electromagnetic fields on the complete unit. In such cases the manufacturer should test susceptible sub-systems (e.g. control electronics). The test report should justify the selection or not of sub-systems and any assumptions made (e.g. reduction of field due to case shielding).

[c] Only applicable to equipment accessible to passengers and operational staff (not maintenance).

Annex A
(informative)

Examples of apparatus and ports

The purpose of this annex is to provide examples of the different types of rolling stock apparatus together with their ports. Examples of apparatus which may be placed on the market as a single commercial unit are given in Table A.1. However, these items of apparatus may also form a sub-system in a larger apparatus (e.g. control electronics in an auxiliary converter). In this case, the requirements of the standard apply only to the apparatus which is placed on the market. A port is defined in the standard as the interface of an apparatus with the external environment. The matrix in the table indicates whether the particular apparatus is relevant to emission, immunity or neither. This guidance is offered for the benefit of users of this document, but it is not intended to be definitive. It is for the user of the document to make the necessary technical judgements in determining whether or not a test is applicable.

The following figures clarify the most essential ports. They show examples of different arrangements.

Figure A.1 applies for an AC fed traction unit with AC traction drive and psophometric filter on the line side.

Figure A.2 shows another AC/AC system with power factor correction filter on the converter side and with DC or three-phase auxiliary and train power supply.

Figure A.3 shows a more conventional system with AC input and DC traction motors fed by phase control converter.

Figure A.4 is a DC fed system with AC traction drive.

Figure A.5 shows some additional ports of converter and control electronics.

Of course, many other different system arrangements are possible.

Table A.1 – Typical examples of apparatus

Apparatus	Test requirements
Traction converter	Emission and immunity
Main circuit breaker	No test requirements
Traction transformers	No test requirements
Traction motor	No test requirements
Auxiliary motor (e.g. induction motor for fans)	No test requirements
DC auxiliary supply (battery)	Emission and immunity
Signalling and communication equipment	Emission and immunity
Electronic man-machine interface	Emission and immunity
Environmental conditioning equipment	Emission and immunity
Passenger information equipment	Emission and immunity
Door control	Emission and immunity
Auxiliary equipment for train operation	Emission and immunity
Auxiliary equipment for passenger services	Emission and immunity
Train management systems	Emission and immunity
Electronic power supply	Emission and immunity
Braking control system	Emission and immunity

In Tables 1 to 5, tests are specified for application to a specific port (interface of an apparatus). Table A.2 lists some more typical descriptions used for these ports and the type of apparatus which may have such a port. Examples of these ports are given in the accompanying figures, except for ports No. 11, 13 and 14.

Table A.2 – Typical port descriptions

Port No. on figures	Typical port name	Typical apparatus
	Traction AC power ports	
1	Pantograph line terminal	Main circuit breaker
3	High voltage connection (before filter)	Filter
4	Connection filter-transformer, HV side	Filter
5	Train power line single phase	Auxiliary converter
6	Connection transformer-converter	Propulsion converter
7	Traction motor cables	Traction motors
8	Auxiliary feed windings of transformer	DC auxiliary supply
	Traction DC power ports	
2	DC conductor input	Main circuit breaker
3	High voltage connection (before filter)	Filter
6	Connection filter-converter	Propulsion converter
7	Traction motor cables	Traction motors
	Auxiliary AC ports	
9	Auxiliary AC supply	Environmental conditioning equipment
	Auxiliary DC ports	
9	Auxiliary DC supply	
	Battery referenced ports	
10	Battery power supply	Electronic power supply
11	Train control bus (conventional battery voltage)	Train management system
19	Relay logic input/output	Electronic control system
	Signal and communication ports	
12	Databus within vehicle	Electronic control system
13	Databus within train	Train management system
14	Passenger entertainment network	Passenger entertainment equipment
15	Firing control line	Electronic control system
17, 18	Sensor/transducer signal (digital or analog)	Electronic control system
20	Communication interface (maintenance)	Electronic control system
	Process measurement and control ports	
16	Internal electronic supply	Electronic control system
18	Sensor/transducer signal (analog)	Electronic control system
	Enclosure port	
21	Equipment enclosure	All apparatus
	Earth port	
22	Earth connection	All apparatus

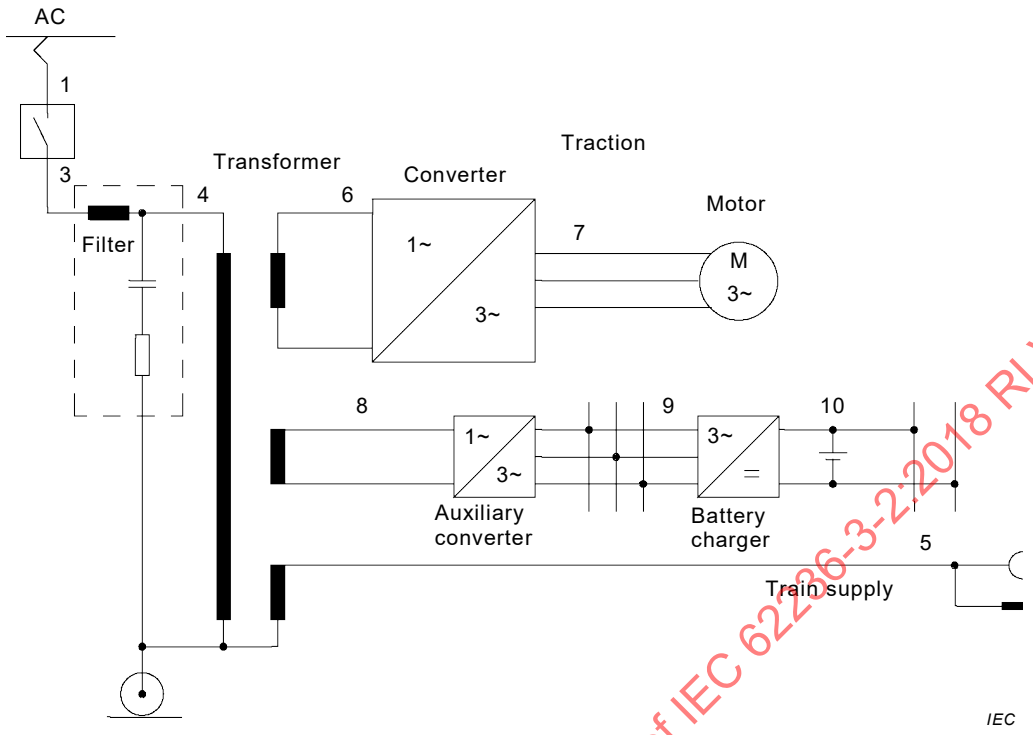


Figure A.1 – AC fed traction unit with AC traction drive and psophometric filter on the line side

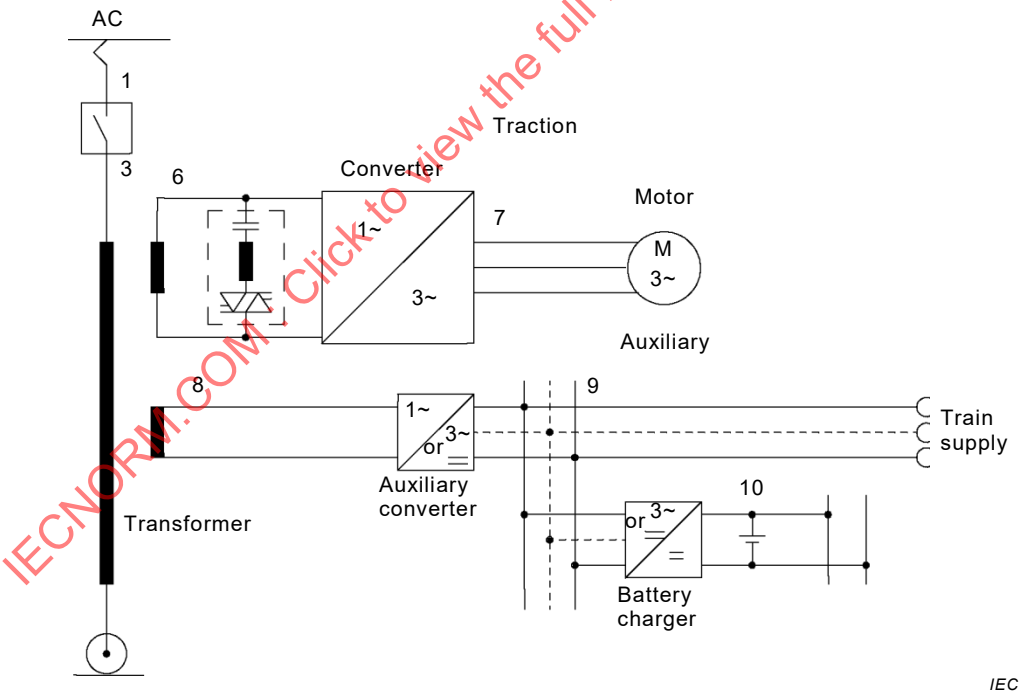


Figure A.2 – AC/AC system with power factor correction filter on the converter side and with DC or three-phase auxiliary and train power supply

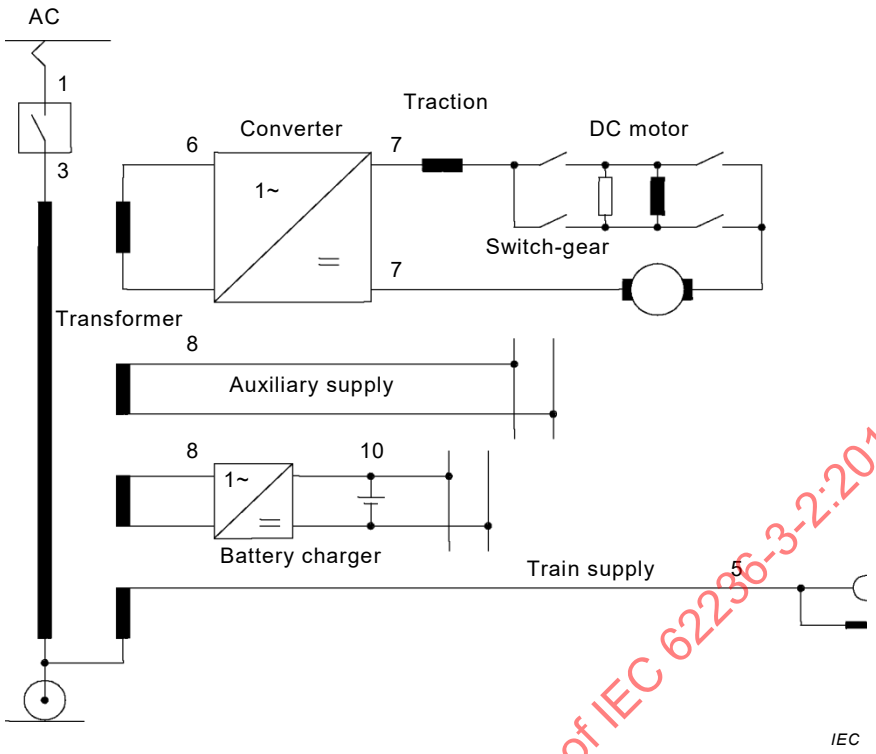


Figure A.3 – Conventional system with AC input and DC traction motors fed by phase control converter

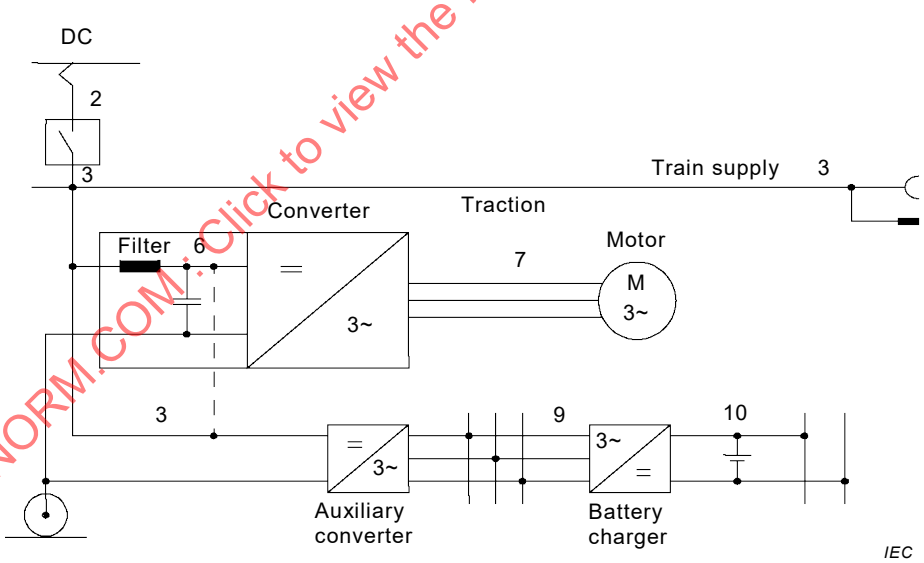


Figure A.4 – DC fed system with AC traction drive

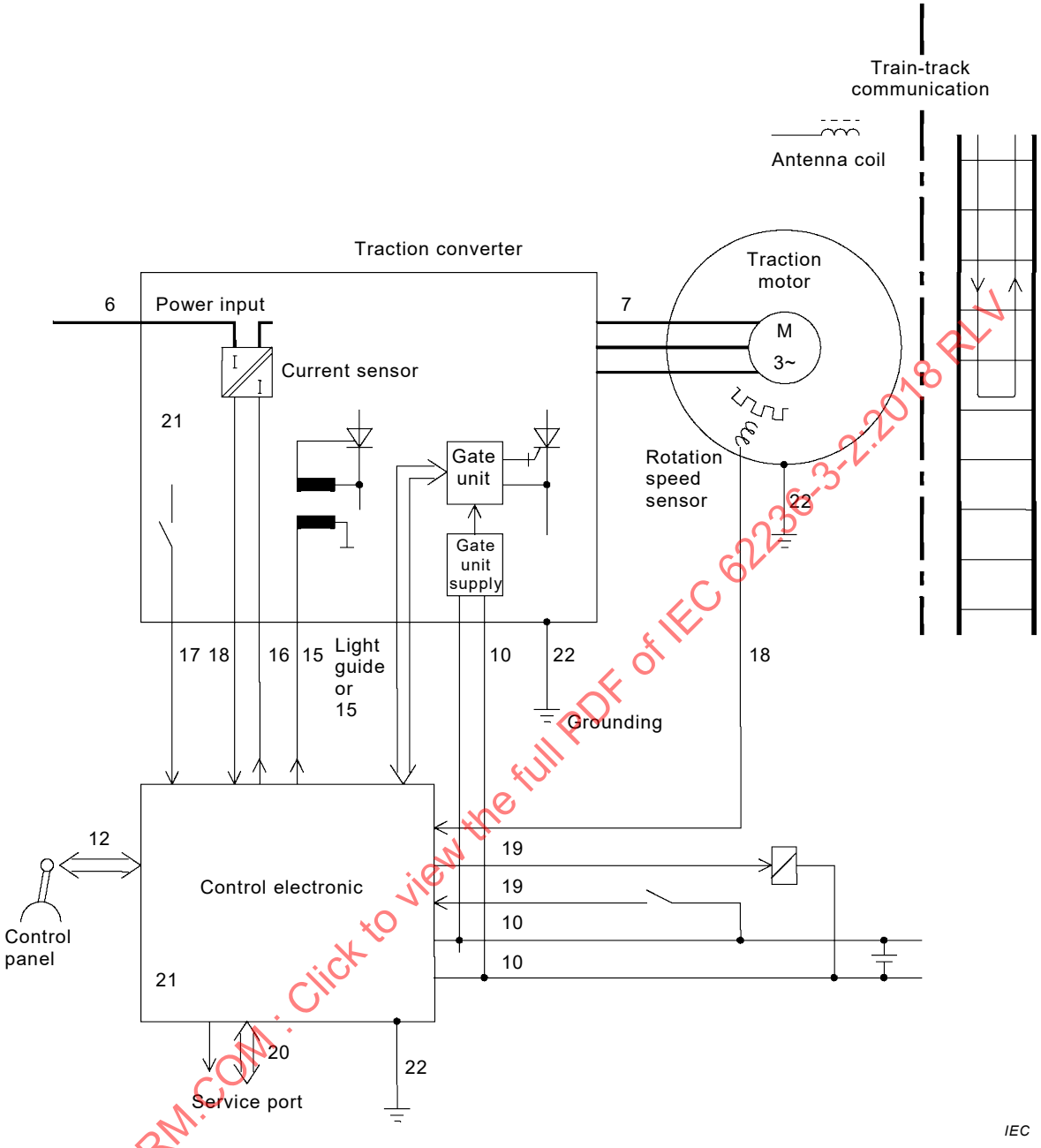


Figure A.5 – Additional ports of converter and control electronics

Annex B
(informative)

Conducted disturbances generated by power converters

No limits apply for laboratory tests. Emission requirements for this type of equipment are tested during the emission test of the complete rolling stock.

Table B.1 reminds the requirements for AC and DC ports.

Table B.1 – Emission requirements for AC and DC power ports

	Port	Test specification		Remarks
B.1	**AC** (port 3 on Figures A.1, A.2, A.3)	Signalling and telecommunication frequencies	See national requirements, contractual requirements	NOTE 1
	DC (port 3 on Figure A.4)	150 kHz to 30 MHz	IEC 62236-3-1:2018, 6.3.3	NOTE 2
NOTE 1 Homologation tests are performed on the complete train. NOTE 2 The requirement in IEC 62236-3-1:2018 is expressed at the train level as a radiated emission limit.				

Some preliminary tests during the design phase could provide helpful information about the emission expected.

Figure B.1 shows a possible test set-up.

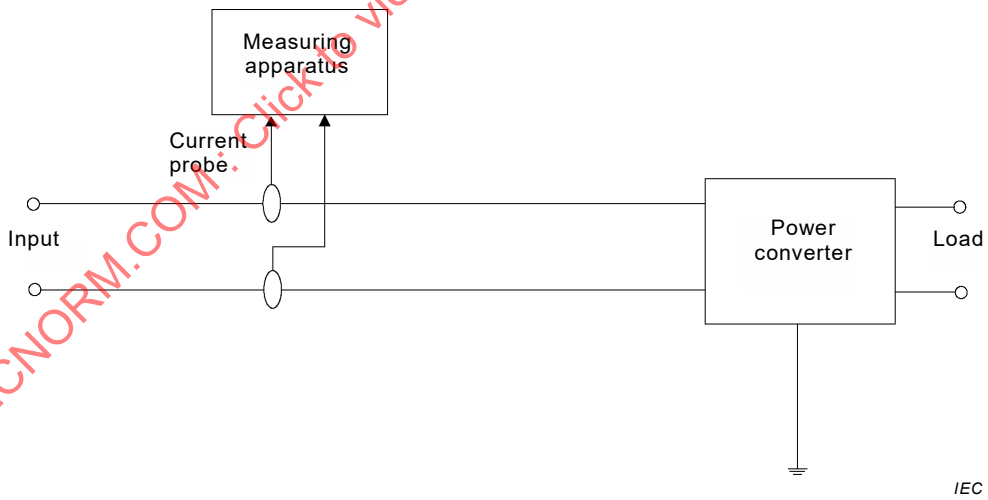


Figure B.1 – Test set-up

SOMMAIRE

AVANT-PROPOS 23
1 Domaine d'application 25
2 Références normatives 26
3 Termes, définitions et termes abrégés 27
3.1 Termes et définitions 27
3.2 Termes abrégés 27
4 Critères d'aptitude à la fonction 28
5 Conditions pendant les essais 28
6 Applicabilité 28
7 Essais d'émission et limites 29
8 Exigences d'immunité 32
Annexe A (informative) Exemples d'appareils et d'accès 37
Annexe B (informative) Perturbations conduites générées par les convertisseurs de puissance 43

Figure 1 – Principales catégories d'accès 27
Figure A.1 – Unité motrice alimentée en courant alternatif avec traction en courant alternatif et filtre psophométrique côté ligne 40
Figure A.2 – Système en courant alternatif/courant alternatif avec filtre d'amélioration du facteur de puissance côté convertisseur et avec réseau d'alimentation train et auxiliaire en courant continu ou triphasé 40
Figure A.3 – Système conventionnel avec entrée en courant alternatif et moteurs de traction en courant continu alimentés par convertisseur à contrôle de phase 41
Figure A.4 – Système d'alimentation en courant continu avec traction en courant alternatif 41
Figure A.5 – Autres accès de convertisseur et électronique de commande 42
Figure B.1 – Montage d'essai 43

Tableau 1 – Émission – Accès par les bornes d'alimentation auxiliaire en courant alternatif et en courant continu (entrée et sortie) 30
Tableau 2 – Émission – Alimentation batterie (entrée et sortie) 31
Tableau 3 – Immunité – Accès référencés à la batterie (sauf en sortie des sources d'énergie), accès par les bornes d'entrée d'alimentation auxiliaire en courant alternatif (tension assignée ≤ 480 V_{eff}) 33
Tableau 4 – Immunité – Accès par les lignes de commande et de mesure de processus, de communication et de signalisation 34
Tableau 5 – Immunité – Accès par l'enveloppe 35
Tableau A.1 – Exemples types d'appareils 38
Tableau A.2 – Descriptions des accès types 39
Tableau B.1 – Exigences relatives aux émissions pour les accès par les bornes d'alimentation en courant alternatif et en courant continu 43

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

_____

APPLICATIONS FERROVIAIRES – COMPATIBILITÉ ÉLECTROMAGNÉTIQUE –

Partie 3-2: Matériel roulant – Appareils

AVANT-PROPOS

1) La Commission Electrotechnique Internationale (IEC) est une organisation mondiale de normalisation composée de l'ensemble des comités électrotechniques nationaux (Comités nationaux de l'IEC). L'IEC a pour objet de favoriser la coopération internationale pour toutes les questions de normalisation dans les domaines de l'électricité et de l'électronique. A cet effet, l'IEC – entre autres activités – publie des Normes internationales, des Spécifications techniques, des Rapports techniques, des Spécifications accessibles au public (PAS) et des Guides (ci-après dénommés "Publication(s) de l'IEC"). Leur élaboration est confiée à des comités d'études, aux travaux desquels tout Comité national intéressé par le sujet traité peut participer. Les organisations internationales, gouvernementales et non gouvernementales, en liaison avec l'IEC, participent également aux travaux. L'IEC collabore étroitement avec l'Organisation Internationale de Normalisation (ISO), selon des conditions fixées par accord entre les deux organisations.
2) Les décisions ou accords officiels de l'IEC concernant les questions techniques représentent, dans la mesure du possible, un accord international sur les sujets étudiés, étant donné que les Comités nationaux de l'IEC intéressés sont représentés dans chaque comité d'études.
3) Les Publications de l'IEC se présentent sous la forme de recommandations internationales et sont agréées comme telles par les Comités nationaux de l'IEC. Tous les efforts raisonnables sont entrepris afin que l'IEC s'assure de l'exactitude du contenu technique de ses publications; l'IEC ne peut pas être tenue responsable de l'éventuelle mauvaise utilisation ou interprétation qui en est faite par un quelconque utilisateur final.
4) Dans le but d'encourager l'uniformité internationale, les Comités nationaux de l'IEC s'engagent, dans toute la mesure possible, à appliquer de façon transparente les Publications de l'IEC dans leurs publications nationales et régionales. Toutes divergences entre toutes Publications de l'IEC et toutes publications nationales ou régionales correspondantes doivent être indiquées en termes clairs dans ces dernières.
5) L'IEC elle-même ne fournit aucune attestation de conformité. Des organismes de certification indépendants fournissent des services d'évaluation de conformité et, dans certains secteurs, accèdent aux marques de conformité de l'IEC. L'IEC n'est responsable d'aucun des services effectués par les organismes de certification indépendants.
6) Tous les utilisateurs doivent s'assurer qu'ils sont en possession de la dernière édition de cette publication.
7) Aucune responsabilité ne doit être imputée à l'IEC, à ses administrateurs, employés, auxiliaires ou mandataires, y compris ses experts particuliers et les membres de ses comités d'études et des Comités nationaux de l'IEC, pour tout préjudice causé en cas de dommages corporels et matériels, ou de tout autre dommage de quelque nature que ce soit, directe ou indirecte, ou pour supporter les coûts (y compris les frais de justice) et les dépenses découlant de la publication ou de l'utilisation de cette Publication de l'IEC ou de toute autre Publication de l'IEC, ou au crédit qui lui est accordé.
8) L'attention est attirée sur les références normatives citées dans cette publication. L'utilisation de publications référencées est obligatoire pour une application correcte de la présente publication.
9) L'attention est attirée sur le fait que certains des éléments de la présente Publication de l'IEC peuvent faire l'objet de droits de brevet. L'IEC ne saurait être tenue pour responsable de ne pas avoir identifié de tels droits de brevets et de ne pas avoir signalé leur existence.

La Norme internationale IEC 62236-3-2 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 50121-3-2:2015.

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

a) clarification du domaine d'application (Article 1);
b) nouvelles définitions des accès et clarification dans les Tableaux 1 à 5;
c) exigences d'émissions étendues dans la plage de fréquences 1 GHz à 6 GHz, suivant l'IEC 61000-6-4;

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

e) révision de l'Annexe B.

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

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

FDIS	Rapport de vote
9/2338/FDIS	9/2368/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.

APPLICATIONS FERROVIAIRES – COMPATIBILITÉ ÉLECTROMAGNÉTIQUE –

Partie 3-2: Matériel roulant – Appareils

1 Domaine d'application

La présente partie de l'IEC 62236 s'applique aux aspects d'émission et d'immunité de CEM des appareils électriques et électroniques destinés à être utilisés à bord du matériel roulant ferroviaire. L'IEC 62236-3-2 s'applique pour l'intégration des appareils à bord du matériel roulant.

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.

L'application des essais dépend des appareils eux-mêmes, de leur configuration, de leurs accès, de leur technologie et de leurs conditions de fonctionnement.

Le présent document prend en compte l'environnement interne du matériel roulant ferroviaire et l'environnement externe du système ferroviaire, ainsi que les perturbations affectant les appareils provenant d'équipements tels que les émetteurs radioélectriques portables.

Si un accès est destiné à émettre ou recevoir des communications radio (émetteurs intentionnels de rayonnement, par exemple, systèmes de balise), alors les exigences relatives aux émissions rayonnées du présent document ne s'appliquent pas à la transmission intentionnelle à partir d'un émetteur radio tel que défini par l'UIT.

Les limites d'immunité ne s'appliquent pas dans les bandes d'exclusion telles que définies dans la norme CEM correspondante pour les équipements radio.

Le présent document ne s'applique pas aux émissions de transitoires lors du démarrage ou de l'arrêt des appareils.

L'objectif du présent document est de définir les limites et les méthodes d'essai concernant les émissions électromagnétiques et les exigences relatives aux essais d'immunité en matière de perturbations conduites et rayonnées.

Ces limites et ces essais représentent les exigences essentielles de compatibilité électromagnétique.

Les exigences relatives aux émissions ont été choisies pour assurer que les perturbations générées par l'appareil qui fonctionne normalement à bord du matériel roulant ferroviaire ne dépassent pas un niveau qui pourrait empêcher d'autres appareils de fonctionner comme prévu. Les limites d'émission données dans le présent document l'emportent sur les exigences relatives aux émissions des appareillages individuels embarqués sur le matériel roulant données dans les autres normes.

De la même manière, les exigences relatives à l'immunité ont été choisies pour assurer un niveau approprié d'immunité pour les appareils du matériel roulant.

Les exigences relatives aux essais sont spécifiées pour chaque accès considéré.

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 60571:2012, *Applications ferroviaires – Équipements électroniques utilisés sur le matériel roulant*

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 61000-4-3:2006/AMD1:2007
IEC 61000-4-3:2006/AMD2:2010

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 salve*

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 61000-4-5:2014/AMD1:2017

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 61000-4-30:2015, *Compatibilité électromagnétique (CEM) – Partie 4-30: Techniques d'essai et de mesure – Méthodes de mesure de la qualité de l'alimentation*

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 62236-3-1:2018, *Applications ferroviaires – Compatibilité électromagnétique – Partie 3-1: Matériel roulant – Trains et véhicules complets*

CISPR 16-2-1:2014, *Spécifications des méthodes et des appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques – Partie 2-1: Méthodes de mesure des perturbations et de l'immunité – Mesures des perturbations conduites*

CISPR 32:2015, *Compatibilité électromagnétique des équipements multimédia – Exigences d'émission*

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 embarqué
produit fini ayant une fonction intrinsèque destiné à être monté dans une installation de matériel roulant

3.1.2
accès <en compatibilité électromagnétique>
interface particulière d'un matériel qui assure son couplage avec l'environnement électromagnétique (161-01-01) extérieur et à travers laquelle il est influencé par cet environnement

EXEMPLE Accès par les bornes d'alimentation en courant alternatif ou en courant continu auxiliaire, accès par les E/S (Entrée/Sortie), accès par la borne de masse.

Note 1 à l'article: Les principales catégories d'accès pour les appareils embarqués sont données à la Figure 1.

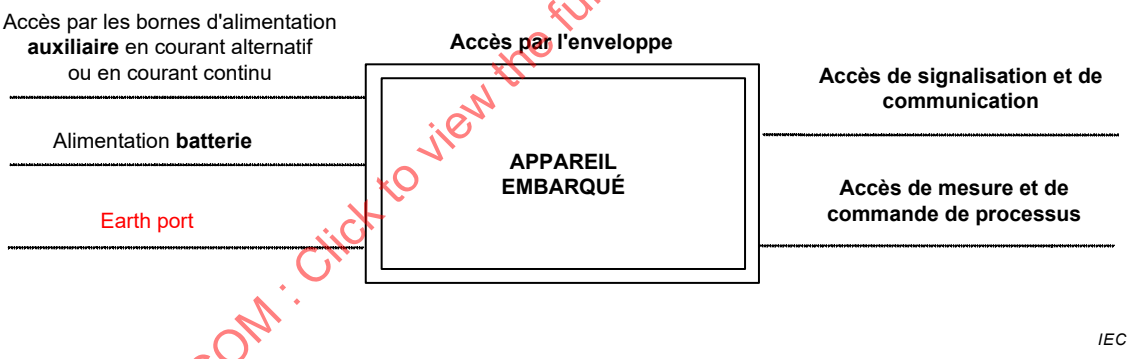


Figure 1 – Principales catégories d'accès

Note 2 à l'article: Des exemples types d'appareils embarqués avec leurs accès sont énumérés à l'Annexe A.

Note 3 à l'article: Les accès par l'alimentation de traction ne sont pas couverts par l'IEC 62236-3-2:2018, voir Annexe B.

[SOURCE: IEC 60050-161:1990, AMD4:2014 161-01-27, modifiée]

3.1.3
accès par l'enveloppe
frontière physique de l'appareil à travers laquelle les champs électromagnétiques peuvent rayonner ou à laquelle ils peuvent se heurter

3.2 Termes abrégés

CA	courant alternatif
MA	Modulation d'amplitude
CISPR	Comité international spécial des perturbations radioélectriques
CC	courant continu

CEM	Compatibilité électromagnétique
E/S	Entrée/Sortie
UIT	Union Internationale des Télécommunications
PC	Personal computer (Ordinateur personnel)
r.m.s.	root mean square (valeur efficace)
THD	Total harmonic distortion (Taux de distorsion harmonique totale)
TV	Télévision

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.

Une description fonctionnelle et une définition des critères d'aptitude à la fonction, pendant ou suite aux essais de CEM, doivent être fournies par le fabricant et notées dans le rapport d'essai sur la base des critères A, B et C définis dans l'IEC 62236-1:2018.

5 Conditions pendant les essais

Il n'est pas toujours possible de soumettre aux essais chaque fonction de l'appareil. Les essais doivent être effectués dans le mode de fonctionnement type considéré par le fabricant comme étant celui qui produit l'émission la plus importante ou la susceptibilité maximale aux perturbations selon le cas dans la bande de fréquences à l'étude tout en restant compatible avec les applications normales. Les conditions pendant l'essai doivent être définies dans un plan d'essai (voir la norme fondamentale de la série IEC 61000-4).

Si l'appareil est une partie d'un système, ou s'il peut être connecté à des appareils auxiliaires, il doit alors être soumis à essai dans la configuration minimale d'appareils auxiliaires permettant de vérifier les accès conformément à CISPR 32:2015, Article 6, par exemple.

La configuration et le mode de fonctionnement doivent être spécifiés dans le plan d'essai et les conditions réelles d'essai doivent être notées avec précision dans le rapport d'essai.

Si l'appareil a un grand nombre d'accès similaires ou d'accès comportant plusieurs connexions similaires, un nombre suffisant d'entre eux doit être choisi pour simuler les conditions de fonctionnement réelles et pour s'assurer que tous les différents types de terminaisons sont couverts (par exemple: 20 % des accès ou au moins quatre accès).

Les essais doivent être effectués dans les conditions de fonctionnement spécifiées pour l'appareil et à sa tension nominale d'alimentation, sauf indication contraire.

6 Applicabilité

Les mesures du présent document doivent être réalisées sur les accès appropriés de l'appareil.

L'étude des caractéristiques électriques, de la connexion et de l'utilisation d'un appareil particulier peuvent révéler que certains des essais ne sont pas applicables (par exemple: l'immunité rayonnée des moteurs à induction, des transformateurs). Dans de tels cas, la décision de ne pas effectuer l'essai doit être notée dans le plan d'essai et le rapport d'essai.

Sauf spécification contraire, les essais de CEM doivent être des essais de type.

7 Essais d'émission et limites

Les essais d'émission et les limites pour les appareils couverts par le présent document sont donnés accès par accès.

Les mesures doivent être effectuées dans des conditions bien définies et reproductibles pour chaque type de perturbation.

Les limites d'émissions rayonnées définies pour l'accès par l'enveloppe dans l'IEC 61000-6-4:2006, Tableau 1, doivent être respectées. La description de l'essai, les méthodes de l'essai et les montages d'essai sont données dans les Normes Fondamentales qui sont référencées dans l'IEC 61000-6-4:2006.

La distance de mesurage est de 10 m selon la ligne 1.1 dans l'IEC 61000-6-4:2006, Tableau 1. Une distance de mesurage de 3 m peut être utilisée avec une limite augmentée de 10 dB.

Les convertisseurs de traction et les convertisseurs auxiliaires au-delà de 50 kVA n'ont pas besoin d'être testés individuellement, mais quand le véhicule entier est testé comme indiqué dans l'IEC 62236-3-1.

La description des essais d'émission conduite, les méthodes d'essai et le montage d'essai sont donnés dans les normes fondamentales indiquées dans les Tableaux 1 et 2.

Le contenu des normes fondamentales n'est pas répété ici; cependant, des modifications ou des informations complémentaires nécessaires pour l'application pratique des essais sont données dans le présent document.

NOTE La référence à la "Norme fondamentale" est limitée aux parties de la norme qui donnent la description des essais, des méthodes d'essai et des montages d'essai.

Tableau 1 – Émission – Accès par les bornes d'alimentation auxiliaire en courant alternatif et en courant continu (entrée et sortie)

	Accès	Spécification d'essai		Norme fondamentale	Montage d'essai	Note d'applicabilité	Remarques
1.1	**Courant alternatif ou courant continu sinusoïdal d'alimentation auxiliaire** (accès 9 sur les Figures A.1, A.2 et A.4)	150 kHz à 500 kHz 500 kHz à 30 MHz	99 dBµV quasi-crête 93 dBµV quasi-crête	CISPR 16-2-1	CISPR 16-2-1	Voir [a, b] et [c]	Pour le moment, le mode d'alimentation par le quai ne fait l'objet d'aucune limite. Les limites données dans ce tableau sont donc valides. D'autres limites peuvent s'appliquer en cas de raccordement, par exemple, à l'alimentation publique basse tension et il convient que l'opérateur du train les spécifie.
1.2	**Accès par prises d'alimentation en courant alternatif destinées au public**	50 Hz à 2 kHz	THD < 8 % (THD: taux de distorsion harmonique totale)	IEC 61000-4-30			Les accès par prises d'alimentation 230 V en courant alternatif destinées au public doivent offrir une qualité d'alimentation suffisante pour l'utilisation des équipements prévus tels que les ordinateurs personnels et les chargeurs de téléphone mobile. La distorsion harmonique en mode différentiel doit être limitée par un filtre sinusoïdal à < 8 %.

[a] Dans la mesure du possible, la méthode définie par CISPR 16-2-1 doit être utilisée. Actuellement, la méthode de mesure qui existe pour les émissions conduites (CISPR 16-2-1) présente certaines limites en termes de caractéristiques assignées de tension et de courant des réseaux de couplage. De plus, la méthode de mesure de la tension a des implications de sécurité pour les essais de systèmes à puissance élevée. Limiter les émissions conduites des appareils raccordés à des câbles extérieurs empêchera les émissions rayonnées excessives.

[b] Cette exigence fait référence aux valeurs limites industrielles, mais comme elles ont été définies pour protéger les appareils de radio et de télévision et que l'objectif n'est pas le même ici, la limite applicable pour les applications ferroviaires a été augmentée de 20 dB pour être plus représentative des problèmes potentiels.

[c] Cette exigence n'est pas applicable aux accès par les bornes d'alimentation qui sont connectés à d'autres accès dédiés compatibles.

Tableau 2 – Émission – Alimentation batterie (entrée et sortie)

	Accès	Spécification d'essai		Norme fondamentale	Montage d'essai	Note d'applicabilité	Remarques
2.1	**Alimentation batterie** (accès 10 sur les Figures A.1 à A.5)	150 kHz à 500 kHz 500 kHz à 30 MHz	99 dBµV quasi-crête 93 dBµV quasi-crête	CISPR 16-2-1	CISPR 16-2-1	Voir [a]	
[a] Cette exigence fait référence aux valeurs limites industrielles, mais comme elles ont été définies pour protéger les appareils de radio et de télévision et que l'objectif n'est pas le même ici, la limite applicable pour les applications ferroviaires a été augmentée de 20 dB pour être plus représentative des problèmes potentiels.							