BS EN 50124-2:2017

BSI Standards Publication

Railway applications — Insulation coordination

Part 2: Overvoltages and related protection

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National foreword

This British Standard is the UK implementation of EN 50124-2:2017. It supersedes BS EN 50124-2:2001 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee GEL/9, Railway Electrotechnical Applications.

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European foreword

This document (EN 50124-2:2017) has been prepared by CLC/TC 9X, “Electrical and electronic applications for railways.”

The following dates are fixed:

• latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2018–02–06
• latest date by which the national standards conflicting with this document have to be withdrawn	(dow)	2020–02–06

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This document has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For the relationship with EU Directive(s) see informative Annex ZZ, which is an integral part of this document.

Introduction

This European Standard is part of the EN 50124 series, Railway applications – Insulation coordination.

EN 50124 consists of two parts:

— EN 50124-1, *Railway applications - Insulation coordination - Part 1: Basic requirements - Clearances and creepage distances for all electrical and electronic equipment*;

— EN 50124-2, *Railway applications - Insulation coordination - Part 2: Overvoltages and related protection*.

This Part 2 deals with the shortest durations of overvoltages referred to as Zone A and Zone B in Figure A.1 in Annex A.

1 Scope

This European Standard applies to:

— fixed installations (downstream of the secondary of the substation transformer) and rolling stock equipment linked to the contact line of one of the systems defined in EN 50163;

— rolling stock equipment linked to a train line.

This European Standard gives simulation and/or test requirements for protection against transient overvoltages of such equipment.

Long-term overvoltages are not addressed in this document.

2 Normative references

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

EN 50163:2004, *Railway applications - Supply voltages of traction systems*

EN 50533, *Railway applications - Three-phase train line voltage characteristics*

EN 60099-4, *Surge arresters - Part 4: Metal-oxide surge arresters without gaps for a.c. systems (IEC 60099-4)*

3 Terms and Definitions

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

NOTE The definitions are in accordance with those of EN 50163 (see also Annex A). Long-term, medium-term and short-term overvoltages are equivalent to respectively temporary, switching and lightning overvoltages defined in EN 60664–1.

3.1 Voltages

3.1.1
overvoltage
voltage having a peak value exceeding the corresponding peak value of maximum steady-state voltage at normal operating conditions

[SOURCE: EN 60664-1]

3.1.2
long-term overvoltage
overvoltage at relatively long duration due to voltage variations

Note 1 to entry: A long-term overvoltage is independent of the network load. It is characterized by a voltage/time curve.

3.1.3
transient overvoltage
short duration overvoltage of a few milliseconds or less due to current transfer

Note 1 to entry: A transient overvoltage depends on the network load. It cannot be characterized by a voltage/time curve. Basically, a transient overvoltage is the result of a current transfer from a source to the load (network).

3.1.4
medium-term overvoltage
transient overvoltage at any point of the system due to specific switching operation or fault

3.1.5
short-term overvoltage
transient overvoltage at any point of the system due to a specific lightning discharge

3.2
network
set of conductors fulfilling a certain function, the overvoltages of which are likely to damage the equipment they are connected to

4 Contact line network

NOTE The provisions of this Clause 4 do not take into account rapid transient overvoltages in the multimegahertz range such as generated by operation of vacuum circuit breakers which may require a specific overvoltage protection.

4.1 Equipment not protected by a metal-oxide arrester

If the equipment is not protected by a metal-oxide arrester, the protection against overvoltages shall take into account overvoltages limited only by the intrinsic insulation of the contact line and the possible presence of other types of arrester or spark gaps.

4.2 Equipment protected by a metal-oxide arrester

4.2.1 General

If the supplier wants to benefit from the presence of a metal-oxide arrester for reducing constraints resulting from 4.1, the supplier shall perform a simulation of the behaviour of the equipment with its protection against overvoltages according to 4.2.2 and 4.2.3.

Long pulse overvoltages set out in 4.2.2 refers to Zone B in Figure A.1 for switching overvoltages and short pulse overvoltages set out in 4.2.3 refers to Zone A in Figure A.1 for lightning overvoltages.

The circuits of the protected equipment likely to modify the electrical behaviour of the protection shall also be simulated.

The equipment connected to the contact line shall be able to withstand the overvoltages without damage, with the exception of the protective fuse, if any.

4.2.2 Simulation for long pulse

4.2.2.1 Simulation of switching overvoltage scenarios

When specified by the purchaser, the supplier shall perform a simulation of the behaviour of its equipment when there is a transient overvoltage due to current transfer between the contact line and the on-board electrical equipment. The purchaser shall provide the necessary information.

EXAMPLE 1 The overvoltage is generated on the contact line in case of emergency disconnection of all traction converters of a train when they were running at full power.

EXAMPLE 2 The overvoltage is generated on the contact line when a short circuit, occurring in one of the on-board equipment input circuit, is cleared by a protection device (e.g. d.c. circuits breaker, fuse).

NOTE The parameters affecting such simulation are for example: line impedance (inductance and resistance per km), train architecture (e.g. number and type of converters, power diagram), converter power, converter input circuit characteristics (e.g. inductance, capacitance), characteristics of the protection device clearing the short-circuit current (e.g. tripping current or pre-arcing current, turned off current, arc voltage). EN 50388:2012, Clause 11 and Annex D provide limits for short circuit levels and typical values for the line and source impedances for TSI lines.

When the necessary information cannot be obtained from the purchaser, the supplier shall perform the simulation for the conventional long pulse as described in 4.2.2.2.

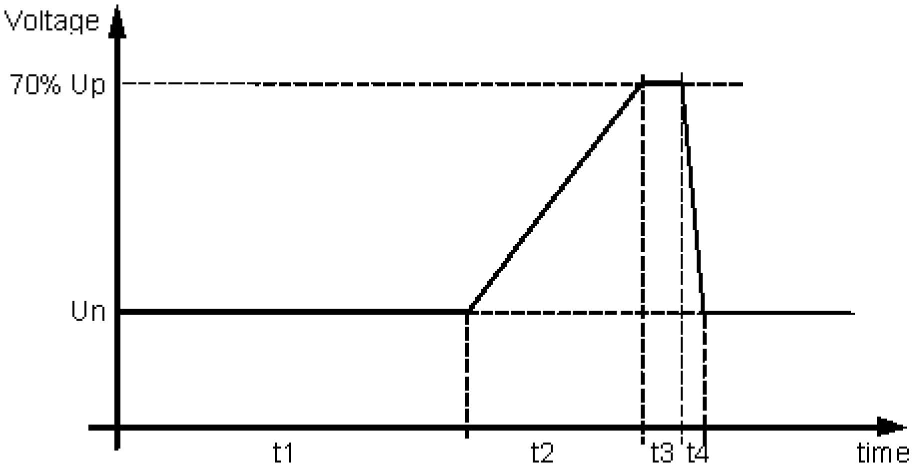
4.2.2.2 Conventional long pulse

The conventional long pulse is a voltage pulse of trapezoid shape. The pulse duration is 2 ms, with a rise time t_2 of 1,5 ms, a plateau time t_3 of 0,3 ms and a fall time t_4 of 0,2 ms. The peak value of the resulting overvoltage signal is equal to 70 % of the reference voltage U_p defined in Table 1. The overvoltage is applied to the equipment at the line contact as a null impedance voltage source and without considering the presence of its metal-oxide arrester.

Table 1 — Values of the reference voltage U_p

Nominal voltage according to EN 50163 U_n kV	**Reference voltage** U_p kV
0,75	4
1,5	6
3	12
15	60
25	100
NOTE The values of U_p take into account the values of U_{res} as given in IEC 60099–1 and EN 60099–4 and/or U_{pl} as given in EN 50526–1. But they relate to a theoretical arrester, for simulation purposes only, and present not any direct link to U_{res} of IEC 60099–1 and EN 60099–4 and/or U_{pl} of EN 50526–1.	

Figure 1 shows the conventional long pulse used for d.c. contact lines. The trapezoid shape is superimposed on the nominal d.c. line voltage and the starting time has no relevance.

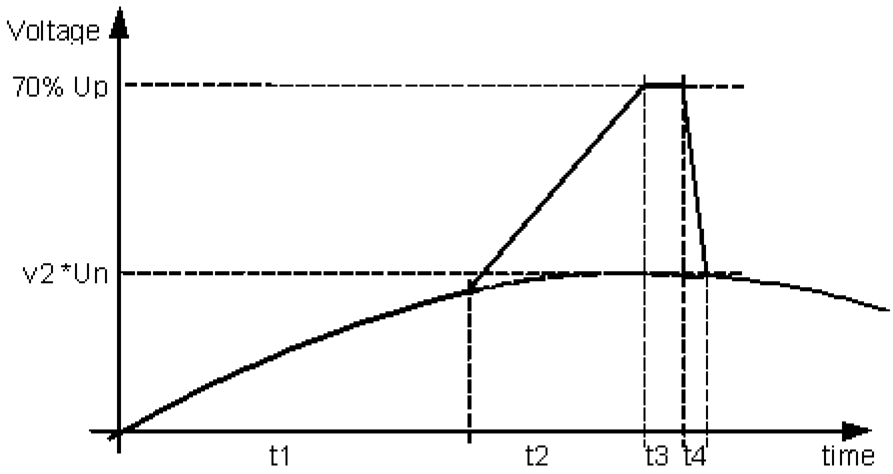


Key

t_1:	t.b.d	Time to beginning of long pulse
t_2:	1,5 ms	Rise time
t_3:	0,3 ms	Plateau time
t_4:	0,2 ms	Fall time
U_n:	see Table 1	Nominal voltage
U_p:	see Table 1	Reference voltage

Figure 1 — Conventional long pulse used for d.c. contact lines

Figure 2 shows the conventional long pulse used for a.c. contact lines. The trapezoid shape is superimposed on the nominal a.c. sinewave voltage and the starting time t_1 shall be varied within ± 45 electrical degrees around the peak voltage of the sine wave.



Key

t_1:	t.b.d	Time to beginning of long pulse
t_2:	1,5 ms	Rise time
t_3:	0,3 ms	Plateau time
t_4:	0,2 ms	Fall time
U_n:	see Table 1	Nominal voltage
U_p:	see Table 1	Reference voltage

Figure 2 — Conventional long pulse used for a.c. contact lines

4.2.3 Simulation for short pulse

The short pulse is the 4/10 µs current pulse defined in EN 60099-4.

Its amplitude value is 100 kA.

It is applied to the equipment including the arrester, where the metal-oxide arrester is replaced by a theoretical one the characteristic of which, in log(current in kA) versus log(voltage in kV), is a straight line which includes the two points:

$$(\log(10), \log(U_p)) \text{ and } (\log(100), \log(1{,}5 \times U_p)) \quad (1)$$

NOTE The safety margin 1,5 x U_p takes into account residual voltages of the surge arrester at lightning impulse currents higher than 10 kA, induced voltage drops along the arrester and the connection lines and voltage increases due to travelling wave effects on the line between the surge arrester and the equipment.

5 Train line network

5.1 Equipment not protected by a metal-oxide arrester

If the equipment is not protected by a metal-oxide arrester, EN 50533 shall be applied for 3phase train lines.

NOTE For single phase train line networks, UIC 550 can provide guidance.

5.2 Equipment protected by a metal-oxide arrester

If the equipment is protected by a metal-oxide arrester, the overvoltage can be limited according to the characteristics of the metal-oxide arrester and the train line network. In case of connection of several arresters to the train line, it shall be ascertained that their cascading will not lead to damage.

6 Tests

In case of doubt of the model and/or the parameters to be taken into account in the simulation, investigation tests shall be carried out and the simulation improved until an acceptable level of trust is reached.

The supplier shall ascertain that each component involved is chosen and tested in order to withstand the worst constraints resulting from the simulation.

If the simulation shows constraints on a component which are not covered by its product standard or data sheet, or if both documents are missing, a dedicated test shall be carried out upon agreement between purchaser and supplier.

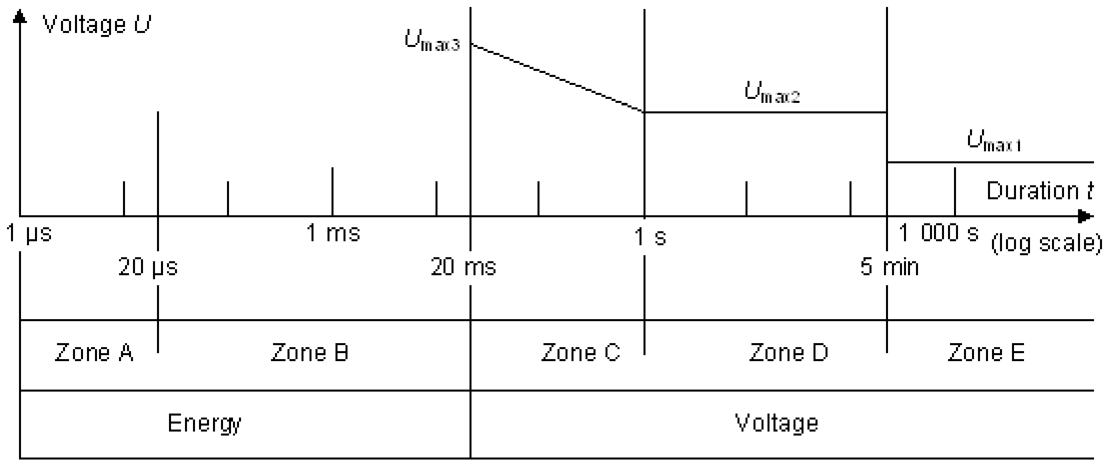
One or several tests on components may be replaced, if deemed preferable by the supplier, by a unique test on the assembled equipment.

Annex A
(informative)

Maximum value of voltage *U* according to duration

NOTE 1 This Annex A is cited in the introduction and Clause 3.

NOTE 2 This Annex A is derived from EN 50163:2004, Annex A.



Key

Zone A: Lightning overvoltages

Zone B: Switching overvoltages, due to high impedance phenomena (currents switched off in inductive circuits)

NOTE Voltages of zones A and B are not to be considered because they fundamentally depend on the source and line load characteristics

Zone C: Temporary overvoltages, due to low impedance phenomena (voltage variations on primary network)

NOTE The Term “temporary overvoltage” is identical to the term “long-term overvoltage” in EN 50163

The variation of the ratio U/U_{max2} versus duration is identified by $U = U_{max2} \times t^{-k}$ where

t is the time in seconds ($0{,}02 \text{ s} \le t \le 1 \text{ s}$);

k is the coefficient given in Table A.1

The representation in log coordinates of this equation is a line. the slope is given by k

Zone D: Highest non-permanent voltage U_{max2}

Zone E: Highest permanent voltage U_{max1}

Figure A.1 — Maximum value of voltage *U* according to duration

Table A.1 gives values for U_{max1}, U_{max2} and U_{max3} while the values between U_{max2} and U_{max3} are calculated using the formula given for Zone C in the key of Figure A.1.

Table A.1 — Overvoltages

Nominal voltage U_n V	**750**	**1 500**	**3 000**	**15 000**	**25 000**
Coefficient *K*	0,0611	0,0676	0,0673	0,0767	0,0741
*U*max 1 V	900	1 800	3 600	17 250	27 500
*U*max 2 V	1 000	1 950	3 900	18 000	29 000
*U*max 3 V	1 270	2 540	5 075	24 300	38 750

Annex ZZ
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 2008/57/EC

This European Standard has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and within its scope the standard covers all relevant essential requirements as given in Annex III of the EC Directive 2008/57/EC (also named as New Approach Directive 2008/57/EC Rail Systems: Interoperability).

Once this standard is cited in the Official Journal of the European Union under that Directive and has been implemented as a national standard in at least one Member State, compliance with the clauses of this standard given in Table ZZ.1 for “Locomotives and Passenger Rolling Stock”, Table ZZ.2 for “Energy” confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations.

Table ZZ.1 — Correspondence between this European Standard, the TSI “Locomotives and Passenger Rolling Stock” (REGULATION (EU) No 1302/2014 of 18 November 2014) and Directive 2008/57/EC

Clauses of this European Standard	Chapter / § / points of LOC and PAS RST TSI	Essential Requirements (ER) of Directive 2008/57/EC	Comments
The whole standard is applicable. (To be applied together with EN 50124–1)	4.2.8. Traction and electrical equipment 4.2.8.4. Protection against electrical hazards	2. Requirements specific to each sub-subsystem 2.4. Rolling Stock 2.4.1 Safety	

Table ZZ.2 — Correspondence between this European Standard, the TSI “Energy” (REGULATION (EU) No 1301/2014 of 18 November 2014) and Directive 2008/57/EC

Clauses of this European Standard	Chapter / § / points of ENE TSI	Essential Requirements (ER) of Directive 2008/57/EC	Comments
The whole standard is applicable. (To be applied together with EN 50124–1)	4.2.8. Harmonics and dynamic effects for AC traction power supply systems 4.2.18. Protective provisions against electric shock	1. General Requirements 1.1 Safety 1.5 Technical compatibility 2. Requirements specific to each sub-subsystem 2.2 Energy 2.2.1 Safety	

WARNING: Other requirements and other EU Directives may be applicable to the products falling within the scope of this standard.

Bibliography

EN 50526-1, *Railway applications - Fixed installations - D.C. surge arresters and voltage limiting devices - Part 1: Surge arresters*

IEC 60099-1:1991, *Surge arresters Part 1: Non-linear resistor type gapped surge arresters for a.c. systems*

EN 60664-1:2007, *Insulation coordination for equipment within low-voltage systems - Part 1: Principles, requirements and tests (IEC 60664-1)*

UIC 550:1994, *Power supply installations for passenger stock*

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