

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Railway applications – Fixed installations – Particular requirements for AC
switchgear –**

Part 1: Circuit-breakers with nominal voltage above 1 kV

**Applications ferroviaires – Installations fixes – Exigences particulières pour
appareillage à courant alternatif –**

Partie 1: Disjoncteurs avec tension nominale supérieure à 1 kV



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**Railway applications – Fixed installations – Particular requirements for AC
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**RAILWAY APPLICATIONS – FIXED INSTALLATIONS –
PARTICULAR REQUIREMENTS FOR AC SWITCHGEAR –****Part 1: Circuit-breakers with nominal voltage above 1 kV**

FOREWORD

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International Standard IEC 62505-1 has been prepared IEC technical committee 9: Electrical equipment and systems for railways.

This standard is based on EN 50152-1.

This second edition cancels and replaces the first edition issued in 2009. It constitutes a technical revision.

The main technical changes with regard to the previous edition are as follows:

This standard was revised to reflect the latest versions of standards referenced and to remove text already included in the IEC 62271 series. The scope was extended to include single-pole and two-pole circuit-breakers. Definitions were added to provide the necessary precision and to meet the needs of railway applications. Table 1 was reworked according to the changes of IEC 62497-1:2010, Table A.2 and Table B.1. Standard values of transient recovery voltage

have been taken from different tables to one, Table 2. Ratings of mechanical endurance previously given under the clause 'type tests' were moved to the new Table 4 'Mechanical endurance classes'. Standard values of prospective transient recovery voltage have been taken from different tables to one, Table 5. Table 6 'Coordination table of rated values for circuit-breakers' of the previous version was removed.

The text of this standard is based on the following documents:

FDIS	Report on voting
9/2097/FDIS	9/2133/RVD

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

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

A list of all parts of IEC 62505 series, under the general title *Railway applications – Fixed installations – Particular requirements for a.c. switchgear*, can be found on the IEC website.

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

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

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(standards.iteh.ai)
<https://standards.iteh.ai/catalog/standards/sist/c56f6469-d406-48d8-8469-d4f6e76057d7/iec-62505-1-2016>

INTRODUCTION

The IEC 62505 series under the generic title *Railway applications – Fixed installations – Particular requirements for a.c. switchgear*, is divided as follows:

- Part 1: Circuit-breakers with nominal voltage above 1 kV.
- Part 2: Disconnectors, earthing switches and switches with nominal voltage above 1 kV.
- Part 3-1: Measurement, control and protection devices for specific use in a.c. traction systems – Application guide.
- Part 3-2: Measurement, control and protection devices for specific use in a.c. traction systems – Single-phase current transformers.
- Part 3-3: Measurement, control and protection devices for specific use in a.c. traction systems – Single-phase inductive voltage transformers.

IEC 62505-1 has to be used in conjunction with IEC 62271-1:2007 and IEC 62271-100:2008 and its Amendment 1:2012.

References in subclauses of IEC 62271-1:2007 and IEC 62271-100:2008 need to be replaced by references to applicable subclauses in this standard as far as reasonably possible.

Where a particular clause of IEC 62271-1:2007 or IEC 62271-100:2008 is not mentioned in this standard, that clause applies as far as reasonable. Where requirements relate exclusively to three-phase systems or to voltages outside those in use in traction systems, they are not applicable. Where this standard states "addition" or "replacement", the relevant text of IEC 62271-1:2007 and IEC 62271-100:2008 needs to be adapted accordingly.

The numbering of clauses in the IEC 62271 series is not used in this Standard. The numbering in square brackets refers to the numbering of clauses in IEC 62271.

Where terms defined in IEC 62271-1:2007 and IEC 62271-100:2008 conflict with definitions of the same terms as given in IEC 60050-811:1991 or of the other railway applications documents listed in the normative references, the definitions in IEC 62271-1:2007 and IEC 62271-100:2008 need to be used.

NOTE The suffix N which appears in this Standard for rated values is not present in IEC 62271-100.

RAILWAY APPLICATIONS – FIXED INSTALLATIONS – PARTICULAR REQUIREMENTS FOR AC SWITCHGEAR –

Part 1: Circuit-breakers with nominal voltage above 1 kV

1 Scope

This part of IEC 62505 is applicable to single-pole and two-pole alternating current (a.c.) circuit-breakers which are:

- designed for indoor or outdoor fixed installations in tractions systems, and
- operated with an a.c. line voltage and frequency as specified in IEC 60850:2014.

NOTE 1 IEC 60850 specifies the a.c. traction systems:

15 kV 16,7 Hz,

12 kV 25 Hz,

12,5 kV, 20 kV also 25 kV with 50 Hz and

12,5 kV, 20 kV, 25 kV also 50 kV with 60 Hz.

NOTE 2 As rails of a.c. traction systems are typically connected to earth and included in the return current path all phase to earth voltages will be within the tolerances as specified in IEC 60850. Nevertheless phase to phase voltages are sometimes higher, e.g. in autotransformer systems.

This Standard is also applicable to the operating devices of circuit-breakers and to their auxiliary equipment.

[IEC 62505-1:2016](https://standards.iteh.ai/catalog/standards/sist/c56ff469-d406-48d8-8469-d416e76057d7/iec-62505-1-2016)

This Standard does not address circuit-breakers with dependent manual operating mechanism.

NOTE 3 It is impossible to specify a short-circuit making current for these circuit-breakers and it is likely that such dependent manual operation is not meeting safety considerations.

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.

IEC 60850:2014, *Railway applications – Supply voltages of traction systems*

IEC 62236-5:2008, *Railway applications – Electromagnetic compatibility – Part 5: Emission and immunity of fixed power supply installations and apparatus*

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

NOTE IEC 62271-1 A1:2011 is not referenced. It refers to voltage levels beyond those used in railway systems.

IEC 62271-100:2008, *High-voltage switchgear and controlgear – Part 100: Alternating-current circuit-breakers*
Amendment 1:2012

IEC 62497-1:2010, *Railway applications – Insulation co-ordination – Part 1: Basic requirements – Clearances and creepage distances for all electrical and electronic equipment*
Amendment 1:2013

IEC 62498-2:2010, *Railway applications – Environmental conditions for equipment – Part 2: Fixed electrical installations*

IEC 62505-2:2016, *Railway applications – Fixed installations – Particular requirements for a.c. switchgear – Part 2: Disconnectors, earthing switches and switches with nominal voltage above 1 kV*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62271-1:2007 and IEC 62271-100:2008, as well as the following apply:

NOTE The index of definitions is the same as in 3.8 of IEC 62271-100:2008, but amended according to the definitions below.

3.1

single-pole circuit-breaker

circuit-breaker with one electrically separated conducting path for the main circuit suitable for use in a single phase circuit

3.2

two-pole circuit-breaker

circuit-breaker with two independent electrically separated conducting paths for the main circuit

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Note 1 to entry: In some cases the two paths are connected in series for use in a single-phase circuit where the establishment and the separation of the two paths are simultaneous.

3.3

nominal voltage

U_n

suitable approximate voltage value used to designate or identify a given supply system

IEC 62505-1:2016

<https://standards.iteh.ai/catalog/standards/sist/c56f6469-d406-48d8-8469-d4f6e76057d7/iec-62505-1-2016>

Note 1 to entry: This value is also assigned to the circuit-breaker to show its usability in the supply system.

Note 2 to entry: An AT-System which is supplied with 2 phases, having a phase shift of 180° between them, is commonly named $2 \times U_n$ according to the U_n supplied to the catenary system.

[SOURCE: IEC 62497-1:2010, 3.4.1]

3.4

rated voltage

U_{ne}

value of voltage assigned by the manufacturer to the equipment or part of it and to which operating and performance characteristics are referred

Note 1 to entry: This value is also used to determine its dielectric characteristics and will be used instead of the rated insulation voltage (U_{Nm}) as defined and used in IEC 62497-1.

Note 2 to entry: The abbreviation U_r is not used for railway circuit-breakers.

[SOURCE: IEC 62497-1:2010, 3.4.3, modified: "to a component, device or equipment" replaced by "equipment or part of it"]

3.5

Over Voltage category

OV

classification of the circuit protection against internal and external overvoltages

3.6

Pollution Degree

PD

classification of the pollution to be considered due to the micro climate

4 Service conditions [2]

Clause 2 of IEC 62271-1:2007 is applicable except as follows:

The preferred values of minimum ambient air temperature under normal service conditions for indoor circuit-breakers are -5 °C , -15 °C and -25 °C .

NOTE 1 These values are the same as in IEC 62271-1.

The typical value for indoor circuit-breakers is -5 °C . Nevertheless it needs to be considered that more severe conditions could occur in rare cases and equipment design is most likely similar to outdoor equipment.

For special service conditions, agreement shall be made between purchaser and supplier. IEC 62498-2:2010 should be taken as guidance to select appropriate classifications.

NOTE 2 The altitude reference of IEC 62497-1 (up to 2 000 m) applies to insulation coordination only and is not considered in this standard.

5 Rating [4]

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5.1 General

Clause 4 of IEC 62271-100:2008 is applicable except as noted in 5.2 to 5.14 below.

<https://standards.iteh.ai/catalog/standards/sist/c56f6469-d406-48d8-8469-d4f6e76057d7/iec-62505-1-2016>

5.2 Nominal voltage (U_n)

The nominal voltage U_n shall be one of the a.c. voltages listed in Table 1 or Table B.1 of IEC 60850:2014.

5.3 Rated voltage (U_{Ne})

Subclause 4.1 of IEC 62271-1:2007 is replaced by the following:

The rated voltage U_{Ne} shall be chosen taking into consideration the maximum voltage level suitable to be permanently applied to the circuit-breaker (i.e. highest permanent voltage U_{max1} as defined in IEC 60850:2014).

The value of U_{Ne} shall be used whenever IEC 62271-1:2007 or IEC 62271-100:2008 make reference to U_r unless another value is named explicitly.

NOTE 1 The insulation characteristics determined by applying U_{max1} are expected to be suitable to allow the highest non-permanent voltage U_{max2} taken from IEC 60850.

NOTE 2 The rated voltage for fixed installations in railway applications is a phase to earth value.

5.4 Insulation coordination

5.4.1 General

Insulation coordination shall be conducted according to IEC 62497-1:2010 e.g. selection of values for overvoltage category (OV) and pollution degree (PD).

The rated voltage U_{Ne} shall be used when IEC 62497-1:2010 refers to the rated insulation voltage U_{Nm} .

The definition of the four overvoltage categories shall be as in IEC 62497-1:2010, 4.2.3.2.

The definition of the seven pollution degrees shall be as in IEC 62497-1:2010, 4.4 and Table A.4.

5.4.2 Rated insulation level [4.2]

Subclause 4.2 of IEC 62271-1:2007 is applicable except as follows:

The value of the rated impulse withstand voltage U_{Ni} and of the power-frequency withstand voltage U_d shall be as given in Table 1, taken from the values listed in IEC 62497-1:2010.

Table 1 – Nominal voltages (U_n), rated impulse voltages (U_{Ni}) and short-duration power-frequency withstand voltage U_d for circuits connected to the contact line

U_n kV	U_{Ne} kV	OV	U_{Ni} (1,2/50 μ s) kV	U_d kV
IEC 60850:2014		IEC 62497-1:2010		
15	17,25	3 ^a 4	95 125	38 ^b 50
	17,25 ^c	3 ^a 4	145 170	70 70 ^b
20 ^d	24 ^d	3 4	125 150 ^e	50 50 ^e
		3 4	170 200	70 ^b 95
25	27,5	3 4	200 250	95 95
		3 4	170 200	70 ^b 70 ^e
	30 ^d	3 4	170 200	70 ^b 70 ^e
	30 ^{d, f}	4	325	140

NOTE The rated short-duration power-frequency withstand voltage is represented by U_d as used in IEC 62271-1 not by U_a as used in IEC 62497- 1. U_a is used in IEC 62271-1 for the rated auxiliary voltage.

- ^a Not commonly used.
- ^b Values taken from Table 1a of IEC 62271-1:2007 as being well-established practice.
- ^c For higher requirements on insulation system. This is common practice in some countries with larger number of installations at altitude up to 2 000 m without additionally applying an altitude correction factor.
- ^d Values taken from table B.1 of IEC 60850:2014.
- ^e Values taken from experience and being well-established practice.
- ^f For higher requirements on insulation in systems with a phase shift of 180°. Increased test voltages could be favourable for these terminals (e. g. between phases of an AT-system with $U_n = 25$ kV).

In special cases isolation may be requested across the open breaking contacts. In this case values shall be selected from IEC 62505-2:2016, Table 1.

All test voltages for dielectric tests on the main circuit shall be taken from Table 1.

5.5 Rated frequency [4.3]

Subclause 4.3 of IEC 62271-1:2007 is applicable.

5.6 Rated supply voltage of closing and opening devices and auxiliary and control circuits (U_a) [4.8]

Subclause 4.8 of IEC 62271-1:2007 is applicable with the following addition.

The relative tolerance as specified in 4.8.3 of IEC 62271-1:2007 does not apply to a.c. power supplies fed from a transformer connected to the traction line voltage. This tolerance shall be agreed upon between purchaser and supplier.

NOTE In this case the relative tolerance of 4.8.3 of IEC 62271-1:2007 will not be sufficient due to the high fluctuation of the traction line voltage.

5.7 Rated short-circuit breaking current (I_{SC}) [4.101]

Subclause 4.101 of IEC 62271-100:2008 is applicable except as follows:

The transient recovery voltage shall equal to the value specified in 5.8 of this standard.

The reference in paragraph b) shall be to 5.12 of this standard.

Only the standard value of 45 ms for the d.c. time constants is used for railway applications.

5.8 Transient recovery voltage (TRV) related to the rated short-circuit breaking current [4.102]

5.8.1 General

Subclause 4.102 of IEC 62271-100:2008 is applicable except as follows:

Reference to short circuit breaking current shall be to 5.7 in this standard.

5.8.2 Representation of TRV [4.102.2]

Subclause 4.102.2 of IEC 62271-100:2008 is applicable except as follows:

a) not applicable;

b) the formula is

$$\begin{aligned}
 u_c &= k_{af} \times k_{pp} \times U_n \sqrt{2} & \text{for } U_n &= 12 \text{ kV or } 12,5 \text{ kV} \\
 u_c &= k_{af} \times k_{pp} \times U_{max2} \sqrt{2} & \text{for } U_{max1} &= 17,25 \text{ kV or } 27,5 \text{ kV} \\
 u_c &= k_{af} \times k_{pp} \times U_n \sqrt{2} & \text{for } U_n &= 20 \text{ kV} \\
 u_c &= k_{af} \times k_{pp} \times U_{max1} \sqrt{2} & \text{for } U_{max1} &= 30 \text{ kV}
 \end{aligned}$$

d) not applicable.

5.8.3 Standard values of TRV related to the rated short-circuit breaking current [4.102.3]

Subclause 4.102.3 of IEC 62271-100:2008 shall be replaced by the following:

Standard values of TRV are given in Table 2.

The table also indicates values of rate of rise, taken as u_c/t_3 , which together with TRV peak values u_c may be used for purposes of specification of TRV.

The values given in the table are prospective values. They apply to railway circuit-breakers in traction systems consisting of transformers, lines and cables.

Where a circuit-breaker has to operate under more severe conditions of TRV than those in Table 2, these shall be identified in the purchaser's specification.

NOTE More severe conditions apply e.g. to circuit-breakers connected to capacitor banks.

Table 2 – Standard values of transient recovery voltage – Representation by two parameters

Nominal voltage U_n kV	Maximum permanent voltage U_{max1} ^a kV	Maximum non-permanent voltage U_{max2} ^a kV	Type of test	First-pole-to-clear-factor k_{pp} p.u.	Amplitude factor K_{af} p.u.	TRV peak value u_c kV	Time t_3 µs	Time delay t_d µs	Voltage u' kV	Time t' µs	RRRV u_c/t_3 kV/µs
12 also 12,5	N/A	N/A	Terminal fault	1	1,4	25	91	14	8,4	44	0,27
			Out-of-phase 120°	1,73	1,25	38	182	28	12,7	89	0,21
			Out-of-phase 180°	2	1,25	44	182	28	14,7	89	0,24
15	17,25	18	Terminal fault	1	1,4	36	108	16,0	12	52	0,33
			Out-of-phase 120°	1,73	1,25	55	216	32	18	104	0,25
			Out-of-phase 180°	2	1,25	64	216	32	21	104	0,30
20	24,0	N/A	Terminal fault	1	1,4	41	123	12,3	14	40	0,50
			Out-of-phase 120°	1,73	1,25	61	164	24,6	20	80	0,37
			Out-of-phase 180°	2	1,25	70	164	24,6	23	80	0,43
25	27,5	29	Terminal fault	1	1,4	57	132	20,0	19	64	0,43
			Out-of-phase 120°	1,73	1,25	88	264	40	29	128	0,33
			Out-of-phase 180°	2	1,25	102	264	40	34	128	0,39
25	30,0	N/A	Terminal fault	1	1,4	62	103	15,5	21	50	0,60
			Out-of-phase 120°	1,73	1,25	92	206	31	31	100	0,45
			Out-of-phase 180°	2	1,25	106	206	31	35	100	0,51

^a See IEC 60850.

N/A not applicable.

NOTE 1 The formulae of 4.102.2 of IEC 62271-100:2008 have been used to determine the values in this table. The conditions for class 1 circuit-breakers have been deemed most suitable for railway applications.

NOTE 2 The parameter k_{pp} has been kept to make use of the formulae of IEC 62271-100:2008. However k_{pp} in traction systems reflects the more severe voltage conditions from interconnection of supply systems with 120° or 180° phase shift.

NOTE 3 TRV values as specified in this table are sufficient to cover all likely conditions, including AT systems as phase to earth faults are the large majority in this system.

NOTE 4 Out-of-phase 120° does not exist as normal operating condition in 15 kV railways.

5.8.4 Standard values of initial transient recovery voltage [4.102.4]

Subclause 4.102.4 of IEC 62271-100:2008 is not applicable.

5.9 Rated short-circuit making current [4.103]

Subclause 4.103 of IEC 62271-100:2008 is replaced by the following.

The rated short-circuit making current (see Figure 8 of IEC 62271-100:2008) of a circuit-breaker is that which corresponds to the rated voltage, and shall be 2,5 times the r.m.s. value of the a.c. component of its rated short-circuit breaking current (see 5.7).

5.10 Rated operating sequence [4.104]

Subclause 4.104 of IEC 62271-100:2008 is applicable with the following addition.

c) O – t''' – CO

where:

$t''' = 60$ s, for circuit-breakers used in conjunction with a line test system.

d) O – t'''' – CO

where

$t'''' = 5$ s, for 16,7 Hz circuit-breakers

e) same as a)

except where

$t = 5$ s and $t' = 60$ s, for 16,7 Hz circuit-breakers

5.11 Characteristics for short line faults [4.105]

Subclause 4.105 of IEC 62271-100:2008 is not applicable.

NOTE This fault condition is covered by the values given for terminal faults in Table 2 of this standard.

5.12 Rated out-of-phase breaking current [4.106]

Subclause 4.106 of IEC 62271-100:2008 shall be replaced by the following.

The purchaser should identify if out-of-phase conditions apply. If so the purchaser shall specify the out-of-phase making and breaking current for the system.

If rated out-of-phase making and breaking currents are assigned the following applies:

- the power frequency recovery voltage shall be $\sqrt{3} \times U_{Ne}$ for 120° conditions and $2 \times U_{Ne}$ for 180° conditions;
- the transient recovery voltage shall be as given in Table 2;
- the rated out-of-phase breaking current shall be determined according to the maximum possible failure current of the fault loop. The rated short circuit making current shall be the crest value of the rated out-of-phase breaking current.

5.13 Rated capacitive switching currents [4.107]

Subclause 4.107 of IEC 62271-100:2008 is applicable except as follows:

Table 9 of IEC 62271-100:2008 shall be replaced by Table 3.