

# INTERNATIONAL STANDARD

**Railway applications – Fixed installations – Particular requirements for AC  
switchgear –  
Part 3-3: Measurement, control and protection devices for specific use in AC  
traction systems – Voltage transformers**

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INTERNATIONAL  
ELECTROTECHNICAL  
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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**RAILWAY APPLICATIONS – FIXED INSTALLATIONS –  
PARTICULAR REQUIREMENTS FOR AC SWITCHGEAR –****Part 3-3: Measurement, control and protection devices  
for specific use in AC traction systems – Voltage transformers**

## FOREWORD

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International Standard IEC 62505-3-3 has been prepared by IEC technical committee 9: Electrical equipment and systems for railways.

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

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

- This standard was revised to reflect the latest versions of standards referenced and to remove text already included in the IEC 61869 series.
- The structure of the document was adapted to that of IEC 62505-1 and IEC 62505-2.
- Ratings have been added to provide designations in line with other railway standards, for example IEC 62497.

- Tests requirements have been detailed to meet operating conditions of railway applications.
- Partial discharge voltages have been specified in Table 2.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
9/2556/FDIS	9/2562/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.

This document has to be read in conjunction with IEC 61869-1:2007 and IEC 61869-3:2011 (see Introduction).

A list of all parts in the IEC 62505 series, published under the general title *Railway applications – Fixed installations – Particular requirements for AC switchgear*, 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.

A bilingual version of this publication may be issued at a later date.

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## INTRODUCTION

Where a particular clause/subclause of IEC 61869-3 is not mentioned in this standard, that clause/subclause 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 61869-3 is to be adapted accordingly.

The numbering of clauses in the IEC 61869 series is similar to that in the IEC 62505 series.

Where terms defined in IEC 61869-1 and IEC 61869-3 conflict with definitions of the same terms as given in IEC 60050-811:2017 or of the other railway applications documents listed in the normative references, the definitions in IEC 61869-1 and IEC 61869-3 are to be used.

NOTE The suffix N which appears in this standard for rated values is not present in IEC 61869-1 and IEC 61869-3.

References in subclauses of IEC 61869-1 and IEC 61869-3 have to be replaced by references to applicable subclauses in this standard as far as reasonably possible.

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

## Part 3-3: Measurement, control and protection devices for specific use in AC traction systems – Voltage transformers

### 1 Scope

This part of IEC 62505 is applicable to new voltage transformers which are:

- intended for use in indoor or outdoor fixed installations in traction systems, and
- operated with an AC line voltage and frequency as specified in IEC 60850.

NOTE 1 IEC 60850 specifies the AC 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 AC traction systems are typically connected to earth and included in the return current path, all phase to earth voltages are subject to the limits as given in IEC 60850. Nevertheless, conductor to conductor voltages are sometimes higher, e.g. in autotransformer systems.

This document does not provide specific requirements for AC traction systems supplied with a frequency of 25 Hz or with a nominal voltage of 12,5 kV or 50 kV. Nevertheless, requirements set out in this document can be used as a guidance also for these systems.

Voltage transformers are mainly used with:

- measuring instruments,
- protective devices.

This document also applies to voltage transformers other than inductive types as far as reasonably possible. Requirements of this document have priority.

NOTE 3 Combined current and voltage transformers, also capacitive voltage transformers are typically not used in fixed installations in traction systems.

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

IEC 61869-1:2007, *Instrument transformers – Part 1: General requirements*

IEC 61869-3:2011, *Instrument transformers – Part 3: Additional requirements for inductive voltage transformers*

IEC 62497-1:2010, *Railway applications – Insulation coordination – Part 1: Basic requirements – Clearances and creepage distances for all electrical and electronic equipment*  
IEC 62497-1:2010/AMD1:2013

### 3 Terms, definitions and abbreviated terms

#### 3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61869-1:2007 and IEC 61869-3:2011, except 3.2.1 to 3.2.9, and the following 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>

NOTE Terms 3.2.1 to 3.2.3 of IEC 61869-1:2007 address voltage definitions which are differently defined in railway systems. Terms 3.2.4 to 3.2.9 of IEC 61869-1:2007 address aspects specific to three-phase systems.

##### 3.1.1

##### nominal voltage

$U_n$

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

Note 1 to entry: This value is also assigned to the voltage transformer to show its usability in the supply system.

Note 2 to entry: An autotransformer-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 contact line system.

[SOURCE: IEC 62497-1:2010, 3.4.1, modified – The notes 1 and 2 to entry have been added.]

##### 3.1.2

##### 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 abbreviations  $U_{pr}$  and  $U_{sr}$  are used as specified in IEC 61869-3, e.g. to determine the rated transformation ratio.

[SOURCE: IEC 62497-1:2010, 3.4.3, modified – Symbol added, wording of definition adopted and NOTE replaced by Note 1 to entry and Note 2 to entry.]

##### 3.1.3

##### overvoltage category

OV

numeral defining a transient overvoltage condition

Note 1 to entry: This definition uses different wording as in other parts of IEC 62505.

[SOURCE: IEC 60050-581:2008, 581-21-02 modified: Note 1 to entry has been added.]

##### 3.1.4

##### pollution degree

PD

numeral characterizing the expected pollution of the micro-environment

Note 1 to entry: This definition uses different wording as in other parts of IEC 62505.

[SOURCE: IEC 60050-581:2008, 581-21-07 modified: Note 1 to entry has been added.]

### 3.2 Abbreviated terms

For the purposes of this document, the abbreviated terms given in 3.7 of IEC 61869-3:2011 apply, but are amended by the following.

EMC	Electromagnetic compatibility
OV	Overtoltage category
PD	Pollution Degree
$U_d$	Power-frequency withstand voltage
$U_m$	Highest voltage for equipment
$U_{max1}$	Highest permanent voltage
$U_{max2}$	Highest non-permanent voltage
$U_n$	Nominal voltage
$U_{Ne}$	rated voltage
$U_{Nm}$	Rated insulation voltage

## 4 Service conditions

Clause 4 of IEC 61869-1:2007 is applicable with the following modifications:

- the minimum ambient air temperature under normal service conditions for indoor voltage transformers shall be  $-5\text{ °C}$ ;
- subclause 4.4 does not apply;

NOTE 1 This subclause specifies possible scenarios of three-phase system's star-point earthing.

- for special service conditions, agreement shall be made between purchaser and supplier. IEC 62498-2 should be taken as guidance for the selection of appropriate classifications.

NOTE 2 The altitude reference condition is 1 000 m as per IEC 61869-1. The altitude reference of IEC 62497-1 (up to 2 000 m) applies to insulation coordination only and is not considered as reference condition in this document.

## 5 Rating

### 5.1 General

Clause 5 of IEC 61869-3:2011 is applicable except as noted in 5.2 to 5.10 below:

NOTE References in this document typically name IEC 61869-3:2011 only. Nevertheless, clauses of IEC 61869-3:2011 normally reference IEC 61869-1:2007 and specify the deviations from it.

### 5.2 Nominal voltage ( $U_n$ )

The nominal voltage  $U_n$  shall be one of the AC voltages listed in Table 1 of this document or Table B.1 of IEC 60850:2014.

### 5.3 Rated voltage ( $U_{Ne}$ )

Subclause 5.2 of IEC 61869-1:2007 is not applicable.

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

The value of  $U_{Ne}$  shall be used whenever IEC 61869-1 or IEC 61869-3 make reference to  $U_m$  unless another value is named explicitly.

NOTE 1 The insulation characteristics determined by applying  $U_{max1}$  are considered 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, for example selection of values for Over Voltage category (OV) and Pollution Degree (PD).

The rated voltage  $U_{Ne}$  shall be used when IEC 62497-1 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

Subclause 5.3 of IEC 61869-1:2007 is replaced by the following:

The values of the rated impulse withstand voltage  $U_{Ni}$  and of the power-frequency withstand voltage  $U_d$  for circuits connected to the contact line shall be as given in Table 1, taken from the values listed in IEC 62497-1:2010/AMD1:2013.

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

$U_n$ kV	$U_{Ne}$ kV	OV	$U_{Ni}$ (1,2/50 $\mu$ s) kV	$U_d$ kV	
<b>IEC 60850:2014</b>		<b>IEC 62497-1:2010/AMD1:2013</b>			
15	17,25	3 <sup>a</sup>	95	38 <sup>b</sup>	
		4	125	50	
	17,25 <sup>c</sup>	3 <sup>a</sup>	145	70	
		4	170	70 <sup>b</sup>	
20 <sup>d</sup>	24 <sup>d</sup>	3	125	50	
		4	150 <sup>e</sup>	50 <sup>e</sup>	
25	27,5	3	170	70 <sup>b</sup>	
		4	200	95	
	27,5 <sup>c</sup>	3	200	95	
		4	250	95	
	30 <sup>d</sup>	30 <sup>d</sup>	3	170	70 <sup>b</sup>
			4	200	70 <sup>e</sup>
30 <sup>d, f</sup>	4	325	140		

NOTE The rated 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.

$U_n$ kV	$U_{Ne}$ kV	OV	$U_{Ni}$ (1,2/50 $\mu$ s) kV	$U_d$ kV
IEC 60850:2014	IEC 62497-1:2010/AMD1:2013			
<p><sup>a</sup> Not commonly used.</p> <p><sup>b</sup> Values taken from Table 1 of IEC 62271-1:2017 as being well-established practice.</p> <p><sup>c</sup> 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.</p> <p><sup>d</sup> Values taken from Table B.1 of IEC 60850:2014.</p> <p><sup>e</sup> Values taken from experience and being well-established practice.</p> <p><sup>f</sup> For higher requirements on insulation in systems with a phase shift of 180°. An increased test voltage could be favourable for these terminals (e. g. between phases of an AT-system with <math>U_n = 25</math> kV).</p>				

Subclauses 5.3.4 and 5.3.5 of IEC 61869-1:2007 apply.

NOTE These subclauses specify the power-frequency withstand voltage of 3 kV between-section and for secondary terminals.

## 5.5 Rated frequency

Subclause 5.4 of IEC 61869-1:2007 is replaced by the following:

The standard values of the rated frequency shall be 16,7 Hz, 50 Hz and 60 Hz as specified in IEC 60850:2014, 4.2.

## 5.6 Rated output

Subclause 5.5 of IEC 61869-3:2011 is applicable except as follows:

Subclauses 5.5.303 and 5.5.304 of IEC 61869-3:2011 are not applicable.

NOTE 1 It is likely that only low rated outputs can be achieved due to relevant requirements on other ratings.

NOTE 2 These subclauses specify requirements related to residual voltage windings (earth fault) which are not used in railway applications.

## 5.7 Rated accuracy class

Subclause 5.6 of IEC 61869-3:2011 is applicable except as follows:

Subclauses 5.6.302.4 of IEC 61869-3:2011 is not applicable.

## 5.8 Standard values of rated voltages

Subclause 5.301 of IEC 61869-3:2011 is applicable except as follows:

Subclauses 5.301.3 of IEC 61869-3:2011 is not applicable.

## 5.9 Standard values of rated voltage factor

Subclause 5.302 of IEC 61869-3:2011 is applicable except as follows:

Only the rated voltage factors for effectively earthed neutral systems apply.

## 5.10 Ferroresonance

Voltage transformers with a rated frequency of 50 Hz or 60 Hz and used in fixed installations shall conform with the following requirements to withstand possible ferroresonance phenomenon.

- The minimum resistance of the primary winding at 20 °C shall be 50 kΩ.
- The magnetic circuit shall be designed such that the saturation point is not reached when the voltage transformer is operated at rated voltage and 1/3 of the rated frequency.

NOTE 1 Ferroresonance may easily occur in 50 Hz and 60 Hz systems.

NOTE 2 It is recognized that ferroresonances in most cases include a significant content of voltage in square wave form with a frequency below nominal frequency. Primary winding resistance and magnetic circuit are having an influence on magnitude and frequency.

There may also be lower values of the resistance of the primary winding providing sufficient strength against the ferroresonance phenomenon. If so this value needs to be specified by the infrastructure manager.

There are other mitigation measures known for voltage transformers to withstand the ferroresonance phenomenon, for example secondary resistors in series with saturable reactors. In this case the afore stated requirements may become redundant and will then not apply. The proposed mitigation method and testing procedure shall be clearly described and agreed upon between purchaser and supplier.

If voltage transformers used in 15 kV, 16,7 Hz fixed installations are required to withstand ferroresonances, requirements shall be agreed upon between purchaser and supplier.

NOTE 3 Relevant ferroresonance phenomena are not known in 15 kV, 16,7 Hz fixed installations.

## 6 Design and construction

### 6.1 General

Clause 6 of IEC 61869-3:2011 is applicable except as follows below in 6.2 to 6.4.

### 6.2 Transformer construction

Subclauses 6.1 and 6.2 of IEC 61869-1:2007 are not applicable.

Voltage transformers with integrated electronic devices, for example digital interfaces shall also comply with the requirements of the applicable standard of the IEC 61869 series. The requirements of this document shall have priority.

### 6.3 Requirements for the external insulation

Subclause 6.6 of IEC 61869-1:2007 is replaced by:

All creepage distances in air shall be based on the rated voltage  $U_{Ne}$  and determined according to 4.4 of IEC 62497-1:2010.

Creepage distances other than in air are fixed by the manufacturer according to the insulation system.

Altitude correction shall be carried out as specified by 5.4 of IEC 62497-1:2010.

## 6.4 Nameplates

Subclause 6.13 of IEC 61869-1:2007 is applicable with the following exception:

The abbreviation of the rated voltage shall be  $U_{Ne}$  as defined in this document.

## 7 Tests

### 7.1 General

Clause 7 of IEC 61869-3:2011 is applicable except as follows below in 7.2 to 7.3.

All test voltages for dielectric tests on the main circuit shall be taken from Table 1 of this document specified for  $U_{Ni}$  respectively  $U_d$ .

### 7.2 Ferroresonance withstand test

To prove compliance with 5.10 additional type tests shall be performed.

The minimum resistance of the primary winding shall be measured. The value obtained by the measurement and corrected to 20 °C by calculation shall not be lower than 50 kΩ. The resistance value shall be recorded in the test report.

A temperature rise test shall be carried out in accordance with the test requirements and in addition to the tests of 7.2.2 of IEC 61869-3:2011. The temperature rise shall not exceed by more than 10 K the values specified in Table 5 of IEC 61869-1:2007.

For voltage transformers used in 50 Hz or 60 Hz fixed installations this temperature rise test shall be carried out at rated voltage, rated burden and 1/3 of the rated frequency.

NOTE Testing with 1/3 of the rated frequency prevents undue voltage stress to the equipment.

For voltage transformers used in 16,7 Hz fixed installations this temperature rise test shall be carried out at rated burden. The combination of test voltage and test frequency shall be selected:

- to provide the same flux density as resulting from the requirements as agreed between purchaser and supplier,
- not to cause undue voltage stress to the equipment, and
- in respect of the frequency which can be supplied by the test equipment.

This resistance measurement shall also be carried out as a routine test.

When other mitigation measures for voltage transformers to withstand the ferroresonance phenomenon have been agreed upon between purchaser and supplier testing shall be performed as agreed. The aforementioned tests do not apply in this case.

### 7.3 Partial discharge test

Subclause 7.3.2 of IEC 61869-1:2007 is applicable except as follows:

For voltage transformers with a nominal voltage as specified in 5.2, Table 3, of IEC 61869-1:2007 is replaced by Table 2.

**Table 2 – Partial discharge test voltages and permissible levels**

Test arrangement	Partial discharge test voltage (RMS) kV	Maximum permissible partial discharge level	
		Solid insulation pC	Immersed in liquid or gas pC
Phase to earth	$\sqrt{3} \times U_{Ne}$	50	10
	$1,2 \times U_{Ne}$	20	5
Phase to phase	$1,2 \times 2 \times U_{Ne}$	20	5

NOTE 1 Values are derived from Table 3 of IEC 61869-1:2007 by replacing  $U_m$  with  $\sqrt{3} \times U_{Ne}$ .

NOTE 2 Phase to phase conditions only apply to a double pole voltage transformer which is connected to both phases of an autotransformer systems. The voltage reference is  $2 \times U_{Ne}$  instead of  $\sqrt{3} \times U_{Ne}$ .

## 8 Rules for transport, storage, erection, operation and maintenance

Clause 8 of IEC 61869-1:2007 is applicable.

## 9 Safety

Clause 9 of IEC 61869-1:2007 is applicable.

## 10 Influence of the product on the environment

Clause 10 of IEC 61869-1:2007 is applicable.

## 11 Information to be given with enquiries, tenders and orders

Information to be given with enquiries, tenders and orders shall be as specified for the rating plate markings of the specific type of voltage transformer in 6.13.202 of IEC 61869-3:2011.

## Bibliography

IEC 60050-151, *International Electrotechnical Vocabulary (IEV) – Part 151: Electrical and magnetic devices* (available at <http://www.electropedia.org>)

IEC 60050-441, *International Electrotechnical Vocabulary (IEV) – Chapter 441: Switchgear, controlgear and fuses* (available at <http://www.electropedia.org>)

IEC 60050-581, *International Electrotechnical Vocabulary – Part 581: Electromechanical components for electronic equipment* (available at <http://www.electropedia.org>)

IEC 60050-605:1983, *International Electrotechnical Vocabulary (IEV) – Chapter 605: Generation, transmission and distribution of electricity – Substations* (available at <http://www.electropedia.org>)

IEC 60050-811:2017, *International Electrotechnical Vocabulary (IEV) – Part 811: Electric traction* (available at <http://www.electropedia.org>)

IEC 60060-1, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60068 (all parts), *Environmental testing*

IEC 60137:2017, *Insulated bushings for alternating voltages above 1 000 V*

IEC 60270, *High-voltage test techniques – Partial discharge measurements*

IEC 60507:2013, *Artificial pollution tests on high-voltage ceramic and glass insulators to be used on a.c. systems*

IEC 60721 (all parts), *Classification of environmental conditions*

IEC TS 60815 (all parts), *Selection and dimensioning of high-voltage insulators intended for use in polluted conditions*

IEC 60913:2013, *Railway applications – Fixed installations – Electric traction overhead contact lines*

IEC 61000 (all parts), *Electromagnetic compatibility (EMC)*

IEC TS 61869-102:2014, *Instrument transformers – Part 102: Ferroresonance oscillations in substations with inductive voltage transformers*

IEC 62128-1:2013, *Railway applications – Fixed installations – Electrical safety, earthing and the return circuit – Part 1: Protective provisions against electric shock*

IEC 62236 (all parts), *Railway applications – Electromagnetic compatibility*

IEC 62271-1:2017, *High-voltage switchgear and controlgear – Part 1: Common specifications for alternating current switchgear and controlgear*

IEC 62278 (all parts), *Railway applications – Specification and demonstration of Reliability, Availability, Maintainability and Safety (RAMS)*

IEC 62497-2:2010, *Railway applications – Insulation coordination – Part 2: Overvoltages and related protection*