

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE



**Railway applications – Rolling stock equipment – Capacitors for power electronics –  
Part 3: Electric double-layer capacitors**

**Applications ferroviaires – Matériel roulant – Condensateurs pour électronique de puissance –  
Partie 3: Condensateurs électriques à double couche**

<https://standards.iteh.ai/catalog/standards/iec/d7701942-7555-4183-9c6e-9cfa7f705944/iec-61881-3-2012>



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**RAILWAY APPLICATIONS –  
ROLLING STOCK EQUIPMENT –  
CAPACITORS FOR POWER ELECTRONICS –**

**Part 3: Electric double-layer capacitors**

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**IEC 61881-3 edition 1.1 contains the first edition (2012) [documents 9/1680/FDIS and 9/1708/RVD] and its amendment 1 (2013) [documents 9/1819/FDIS and 9/1843/RVD].**

**In this Redline version, a vertical line in the margin shows where the technical content is modified by amendment 1. Additions and deletions are displayed in red, with deletions being struck through. A separate Final version with all changes accepted is available in this publication.**

International Standard IEC 61881-3 has been prepared by subcommittee 9: Electrical equipment and systems for railways.

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

A list of all parts of IEC 61881 series, under the general title *Railway applications – Rolling stock equipment – Capacitors for power electronics*, can be found on the IEC website.

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

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# RAILWAY APPLICATIONS – ROLLING STOCK EQUIPMENT – CAPACITORS FOR POWER ELECTRONICS –

## Part 3: Electric double-layer capacitors

### 1 Scope

This part of IEC 61881 applies to d.c. electric double-layer capacitors (cell, module and bank) for power electronics intended to be used on rolling stock.

This standard specifies quality requirements and tests, safety requirements, and describes installation and operation information.

NOTE Example of the application for capacitors specified in this Standard; d.c. energy storage, etc.

Capacitors not covered by this Standard:

- IEC 61881-1: Paper/plastic film capacitors;
- IEC 61881-2: Aluminium electrolytic capacitors with non-solid electrolyte.

Guidance for installation and operation is given in Clause 9.

### 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 60068-1:1988, *Environmental testing – Part 1: General and guidance*  
and Amendment 1:1992

IEC 60068-2-14:2009, *Environmental testing – Part 2-14: Tests – Test N: Change of temperature*

IEC 60068-2-17:1994, *Environmental testing – Part 2-17: Tests. Test Q: Sealing*

IEC 60068-2-20, *Environmental testing – Part 2-20: Tests – Test T: Test methods for solderability and resistance to soldering heat of devices with leads*

IEC 60068-2-21, *Environmental testing – Part 2-21: Tests – Test U: Robustness of terminations and integral mounting devices*

IEC 60068-2-78, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

IEC 60571:1998, *Electronic equipment used on rail vehicles*  
and Amendment 1:2006

IEC 60721-3-5, *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – Section 5: Ground vehicle installations*

IEC 61373:2010, *Railway applications – Rolling stock equipment – Shock and vibration tests*

IEC 62236-3-2, *Railway applications – Electromagnetic compatibility – Part 3-2: Rolling stock – Apparatus*

IEC 62391-1:2006, *Fixed electric double-layer capacitors for use in electronic equipment – Part 1: Generic specification*

IEC 62391-2:2006, *Fixed electric double-layer capacitors for use in electronic equipment – Part 2: Sectional specification – Electric double-layer capacitors for power application*

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

IEC 62498-1:2010, *Railway applications – Environmental conditions for equipment – Part 1: Equipment on board rolling stock*

IEC 62576:2009, *Electric double-layer capacitors for use in hybrid electric vehicles – Test methods for electrical characteristics*

### 3 Terms and definitions

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

#### 3.1 capacitor element

indivisible part of a capacitor consisting of two electrodes (typically made of carbon) separated by an electrolyte impregnated separator

Note 1 to entry: In the literature this type of capacitor element is often called EDLC (Electric double layer capacitor) element. An electric double-layer capacitor element utilizes the ability to accumulate electric charge in an electric double layer which is formed at the boundary surface between an electrode material (electronic conductor) and an electrolyte. This capacitor is essentially designed for operation with direct current voltage.

#### 3.2 capacitor cell

one or more capacitor elements, packaged in the same enclosure with terminals brought out

SEE: Annex A

#### 3.3 capacitor module

assembly of two or more capacitor cells, electrically connected to each other with or without additional electronics

SEE: Annex A

#### 3.4 capacitor bank

assembly of two or more capacitor modules

SEE: Annex A

#### 3.5 capacitor

general term used when it is not necessary to state whether a reference is made to capacitor cell, module or bank

[SOURCE: IEC 61881-1:2010, 3, modified]

### 3.6

#### **capacitor equipment**

assembly of capacitor banks and their accessories intended for connection to a network

SEE: Annex A

### 3.7

#### **capacitor for power electronics**

capacitor intended to be used in power electronic equipment and capable of operating continuously under sinusoidal and non-sinusoidal current and voltage

Note 1 to entry: Capacitor in this standard is d.c. capacitor.

### 3.8

#### **pressure relief structure**

mechanism to release internal pressure of capacitor cell when exceeding specified value

### 3.9

#### **discharge device**

device capable of reducing the voltage between the terminals practically to zero, within a given time, after the capacitor has been disconnected from a network

### 3.10

#### **rated voltage (d.c.) ( $U_R$ )**

maximum d.c. voltage which may be applied continuously to a capacitor at any temperature between the lower category temperature and the upper category temperature

[SOURCE: IEC 60384-1:2008, 2.2.16, modified]

Note 1 to entry: In typical traction application, the maximum voltage is the sum of the d.c. voltage and peak a.c. voltage or peak pulse voltage applied to the capacitor.

### 3.11

#### **insulation voltage ( $U_i$ )**

r.m.s. value of the sine wave voltage designed for the insulation between terminals of capacitors to case or earth. If not specified, r.m.s. value of the insulating voltage is equivalent to the rated voltage divided by  $\sqrt{2}$

### 3.12

#### **maximum peak current ( $I_P$ )**

maximum peak current that can occur during continuous operation

### 3.13

#### **rated current ( $I_R$ )**

r.m.s. value of the maximum allowable current at which the capacitor may be operated continuously at a specified temperature

Note 1 to entry: The cooling conditions of the module should be defined by the manufacturer.

### 3.14

#### **maximum surge current ( $I_S$ )**

peak non-repetitive current induced by switching or any other disturbance of the system which is allowed for a limited number of times

### 3.15

#### **operating temperature**

temperature of the hottest point on the case of the capacitor when in steady-state conditions of temperature

SEE: 3.22

**3.16****ambient temperature**

temperature of the air surrounding the non-heat dissipating capacitor or temperature of the air in free air conditions at such a distance from the heat dissipating capacitor that the effect of the dissipation is negligible

**3.17****upper category temperature**

highest ambient temperature including internal heating in which a capacitor is designed to operate continuously

Note 1 to entry: Depending on the application the upper category temperature can be different. For traction energy storage application the continuous operation is based on the rated current, for other applications like board net stabilising it is based on the rated voltage.

**3.18****lower category temperature**

lowest ambient temperature including internal heating in which a capacitor is designed to operate continuously

Note 1 to entry: Depending on the application the lower category temperature can be different. For traction energy storage application the continuous operation is based on the rated current, for other applications like board net stabilising it is based on the rated voltage.

~~**3.19**~~~~**case temperature rise ( $\Delta T_{\text{case}}$ )**~~

~~difference between the temperature of the hottest point of the case and the temperature of the cooling air under the steady-state conditions of temperature~~

~~**3-203.19**~~~~**cooling air temperature ( $T_{\text{amb}}$ )**~~

~~temperature of the cooling air measured at the inlet, under the steady-state conditions of temperature~~

~~**3-213.20**~~~~**maximum operating temperature ( $T_{\text{max}}$ )**~~

~~highest temperature of the case at which the capacitor cell may be operated~~

Note 1 to entry: The operating temperature is different from upper category temperature.

~~**3-223.21**~~~~**steady-state conditions of temperature**~~

~~thermal equilibrium attained by the capacitor at constant output and at constant coolant temperature~~

~~**3-233.22**~~~~**internal resistance ( $R_s$ )**~~

~~d.c resistance causing losses in a capacitor due to termination jointing, electrolyte, electrodes, etc.~~

**4 Service conditions**

NOTE See IEC 60077-1.

**4.1 Normal service conditions****4.1.1 General**

This standard gives requirements for capacitors intended for use in the following conditions: