

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

AMENDMENT 1  
AMENDEMENT 1

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

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IEC 61881-3

Edition 1.0 2013-09

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INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

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ELECTROTECHNIQUE  
INTERNATIONALE

PRICE CODE  
CODE PRIX

F

ICS 45.060

ISBN 978-2-8322-1092-5

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## FOREWORD

This amendment has been prepared by IEC technical committee 9: Electrical equipment and systems for railways.

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

FDIS	Report on voting
9/1819/FDIS	9/1843/RVD

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

The committee has decided that the contents of this amendment and the base publication 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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### Contents

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*Replace the title of 5.7 by the following:*

### **5.7 Short-circuit test**

### **3 Terms and definitions**

*Delete definition 3.19.*

#### **Definition 3.21**

*Replace definition 3.21 by the following new definition:*

#### **3.21**

**maximum operating temperature ( $T_{\max}$ )**

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.

**Table 1 – Classification of tests****No. 5 Surge discharge test**

*Replace:* Surge discharge test *by:* Short-circuit test

**5.7 Surge discharge test (under consideration)**

*Replace subclause 5.7 by the following:*

**5.7 Short-circuit test****5.7.1 General**

Unless otherwise specified, the short-circuit test for the capacitor cell shall be carried out by the following procedure.

**5.7.2 Preconditioning**

The capacitor shall be treated according to 5.1.4 and 5.1.5.

**5.7.3 Initial measurement**

The capacitance and internal resistance of the capacitor shall be measured in accordance with 5.3.

**5.7.4 Test method**

The capacitor shall be charged by means of a d.c. source up to  $U_R$  within 5 min and be held for 5 min then short-circuited through appropriate discharge circuit. The test shall be repeated 5 times. The test should be repeated after the capacitor temperature reaches thermal equilibrium with surrounding temperature.

The resistance of the discharge circuit (cables, switches, shunts or electronic) shall be equal to or less than the internal resistance of the capacitor or 1 m $\Omega$ , whichever is lower. Capacitor cells can be connected in series for this test.

**5.7.5 Post treatment**

The capacitor shall be treated according to 5.1.5 and discharged through the suitable discharge device.

**5.7.6 Final measurement**

The capacitance and internal resistance of the capacitor shall be measured in accordance with 5.3.

**5.7.7 Acceptance criteria**

The capacitance change and internal resistance change shall be within the values as agreed between the manufacturer and the purchaser.

No visible damage and no electrolyte leakage shall be observed.

## 5.11 Endurance cycling test

Replace subclause 5.11 by the following:

## 5.11 Endurance cycling test

### 5.11.1 General

Unless otherwise specified, the endurance cycling test for the capacitor shall be carried out by the following procedure. For capacitor module or bank, this test may be substituted by capacitor cell test, when agreed between the manufacturer and the purchaser.

NOTE The purpose of the endurance cycling test is to demonstrate the performance of the capacitor under the conditions which will actually occur in service.

### 5.11.2 Preconditioning

The capacitor shall be treated according to 5.1.4 and 5.1.5.

### 5.11.3 Initial measurements

The capacitance and internal resistance of the capacitor shall be measured in accordance with 5.3.

### 5.11.4 Test method

#### 5.11.4.1 Test temperature

Test temperature shall be 10 °C lower than the maximum operating temperature specified by the manufacturer.

Test temperature shall be measured at the capacitor cell case for capacitor cell and at the hottest cell in the module or bank for capacitor module or bank.

#### 5.11.4.2 Apparatus

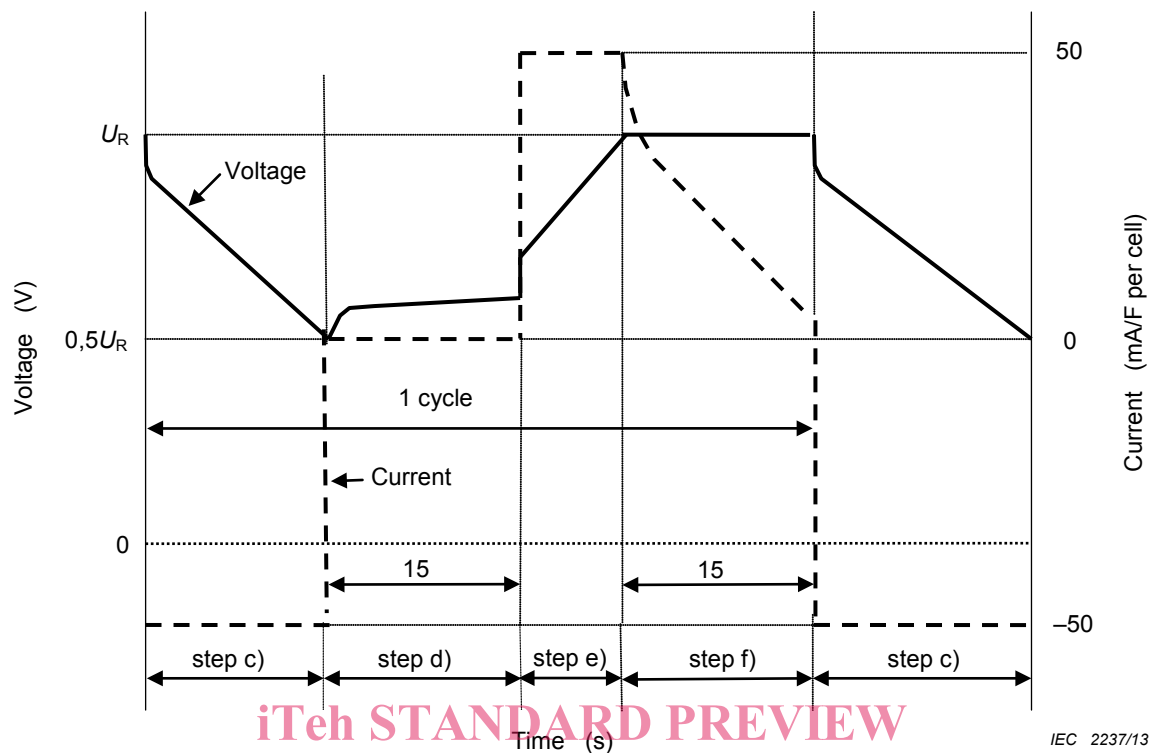
The charge and discharge device shall be capable of charging and discharging the capacitor with the constant current as specified in 5.11.4.3.

At the charge and discharge cycles, monitoring the voltage-time curves of the all capacitor cells within the test set-up should be carried out.

#### 5.11.4.3 Test steps

Unless otherwise specified, the test shall consist of the following steps, repeating c) through f) continuously (see Figure 3) until the end of test criteria is reached:

- a) charge up to  $U_R$  with constant current of 5 mA/F per cell;
- b) continue charging at  $U_R$  for 30 min;
- c) discharge down to  $0,5U_R$  with constant current of 50 mA/F per cell;
- d) pause for 15 s without charging current;
- e) charge up to  $U_R$  with constant current of 50 mA/F per cell;
- f) hold for 15 s at constant voltage  $U_R$ .



NOTE Current curve in step f) is not the specified value, but shows the result of constant voltage applied.

**Figure 3 – Endurance cycling test steps**

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#### 5.11.4.4 Test

The capacitor shall be connected to the charge and discharge device, then start test steps as specified in 5.11.4.3. When the capacitor cell case has reached the test temperature, the cooling/heating conditions are constantly adjusted throughout the test so that the capacitor cell or the temperature of the hottest cell in a module or bank stays fixed at the test temperature.

The capacitance and internal resistance of the capacitor can be obtained while the test step (cycling) is in operation by monitoring voltage-time curves and analysing them. The initial capacitance and internal resistance during cycling shall be taken after the capacitor has reached the thermal equilibrium.

NOTE The capacitance and internal resistance measurements during cycling might differ from the initial measurement as specified in 5.11.3 and final measurement as specified in 5.11.7 due to a different measurement current.

#### 5.11.5 End of test criteria

The test is finished for a capacitor cell when the measured value during cycling reaches one of the following criteria:

- capacitance reaches 70 % of its initial value or;
- internal resistance reaches 200 % of its initial value;
- for a module or bank the end of life is reached when the first cell reaches the end of life criteria of a cell.

The test may be finished before the specified end of test criteria are achieved depending upon the agreement between manufacturer and purchaser.

#### **5.11.6 Post treatment**

The capacitor shall be treated according to 5.1.5.

#### **5.11.7 Final measurement**

The capacitance and internal resistance of the capacitor shall be measured in accordance with 5.3.

#### **5.11.8 Acceptance criteria**

The number of cycles reached shall be within the range as agreed between the manufacturer and the purchaser.

Unless otherwise specified, the capacitance shall not be less than 70 % of the initial measured value and the internal resistance shall not exceed 200 % of the specified value.

No visible damage and no electrolyte leakage shall be observed.

### **Bibliography**

Add the following standard:

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

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