INTERNATIONAL STANDARD

NORME INTERNATIONALE

Railway applications – Rolling stock equipment – Capacitors for power electronics –
Part 2: Aluminium electrolytic capacitors with non-solid electrolyte

Applications ferroviaires – Matériel roulant – Condensateurs pour électronique de puissance –
Partie 2: Condensateurs électrolytiques à l'aluminium, à électrolyte non solide
CONTENTS

FOREWORD ........................................................................................................................... 5

1 Scope .................................................................................................................................. 7

2 Normative references ......................................................................................................... 7

3 Terms and definitions ......................................................................................................... 8

4 Service conditions ............................................................................................................ 10
   4.1 Normal service conditions .......................................................................................... 11
      4.1.1 General ................................................................................................................ 11
      4.1.2 Altitude ................................................................................................................ 11
      4.1.3 Temperature ....................................................................................................... 11
   4.2 Unusual service conditions ....................................................................................... 11

5 Quality requirements and tests ......................................................................................... 12
   5.1 Test requirements ....................................................................................................... 12
      5.1.1 General ................................................................................................................ 12
      5.1.2 Test conditions .................................................................................................... 12
      5.1.3 Measurement conditions .................................................................................... 12
      5.1.4 Voltage treatment ............................................................................................. 12
      5.1.5 Thermal treatment ............................................................................................ 12
   5.2 Classification of tests ................................................................................................. 12
      5.2.1 General ................................................................................................................ 12
      5.2.2 Type tests .......................................................................................................... 13
      5.2.3 Routine tests ..................................................................................................... 13
      5.2.4 Acceptance tests ............................................................................................... 14
   5.3 Capacitance and tangent of loss angle \(\tan\delta\) .............................................................. 14
      5.3.1 Capacitance ....................................................................................................... 14
      5.3.2 Tangent of loss angle \(\tan\delta\) ................................................................................. 14
   5.4 Leakage current .......................................................................................................... 14
      5.4.1 Capacitor cell .................................................................................................... 14
      5.4.2 Capacitor module or bank ............................................................................... 14
   5.5 Insulation test between terminals and case ............................................................... 14
      5.5.1 Capacitor cell .................................................................................................... 14
      5.5.2 Capacitor module or bank ............................................................................... 15
   5.6 Sealing test .................................................................................................................. 15
   5.7 Surge discharge test (under consideration) ............................................................... 15
      5.7.1 General ................................................................................................................ 15
      5.7.2 Preconditioning ................................................................................................. 15
      5.7.3 Initial measurement ............................................................................................ 15
      5.7.4 Test methods ..................................................................................................... 15
      5.7.5 Post treatment .................................................................................................. 16
      5.7.6 Final measurement ............................................................................................ 16
      5.7.7 Acceptance criteria ......................................................................................... 16
   5.8 Environmental testing .................................................................................................. 16
      5.8.1 Change of temperature .................................................................................... 16
      5.8.2 Damp heat, steady state .................................................................................. 17
   5.9 Mechanical testing ...................................................................................................... 18
      5.9.1 Mechanical tests of terminals ............................................................................ 18
5.9.2 External inspection ................................................................. 18
5.9.3 Vibration and shocks ............................................................ 18
5.10 Endurance test ........................................................................ 18
  5.10.1 General .......................................................... 18
  5.10.2 Preconditioning .......................................................... 18
  5.10.3 Initial measurements .................................................. 18
  5.10.4 Test methods ............................................................ 18
  5.10.5 Post treatment ........................................................... 19
  5.10.6 Final measurement ..................................................... 19
  5.10.7 Acceptance criteria .................................................... 19
5.11 Pressure relief test ................................................................. 19
5.12 Passive flammability ............................................................. 19
6 Overloads .................................................................................. 19
  6.1 Maximum permissible voltage ........................................... 19
  6.2 Maximum permissible current ........................................... 20
7 Safety requirements .................................................................... 20
  7.1 Discharge device ............................................................... 20
  7.2 Case connections (grounding) ............................................ 20
  7.3 Protection of the environment .......................................... 20
  7.4 Other safety requirements ................................................. 20
8 Marking ....................................................................................... 21
  8.1 Marking of the capacitor ..................................................... 21
    8.1.1 Capacitor cell ......................................................... 21
    8.1.2 Capacitor module or bank ......................................... 21
  8.2 Data sheet ............................................................................ 21
9 Guidance for installation and operation ....................................... 22
  9.1 General ............................................................................. 22
  9.2 Choice of rated voltage ..................................................... 22
  9.3 Operating temperature ..................................................... 22
    9.3.1 Life time of capacitor ............................................... 22
    9.3.2 Installation ............................................................... 22
    9.3.3 Unusual cooling conditions ....................................... 23
  9.4 Over voltages ................................................................. 23
  9.5 Overload currents ............................................................ 23
  9.6 Switching and protective devices ....................................... 23
  9.7 Dimensioning of creepage distance and clearance ............... 24
  9.8 Connections ................................................................. 24
  9.9 Parallel connections of capacitors ...................................... 24
  9.10 Series connections of capacitors ...................................... 24
  9.11 Magnetic losses and eddy currents .................................... 24
  9.12 Guide for unprotected capacitors ..................................... 24
Annex A (informative) Terms and definitions of capacitors ............. 25
Bibliography .............................................................................. 26

Figure 1 – Examples of preferred vent and anode position ............... 23
Figure A.1 – Example of capacitor application in capacitor equipment 25

Table 1 – Classification of tests ................................................. 13
FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.

3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.

4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.

5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.

6) All users should ensure that they have the latest edition of this publication.

7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.

8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.

9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61881-2 has been prepared by technical committee 9: Electrical equipment and systems for railways.

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

<table>
<thead>
<tr>
<th>FDIS</th>
<th>Report on voting</th>
</tr>
</thead>
<tbody>
<tr>
<td>9/1679/FDIS</td>
<td>9/1707/RVD</td>
</tr>
</tbody>
</table>

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 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 this 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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.
IEEE 61881-2 © IEC:2012 – 7 –

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

Part 2: Aluminium electrolytic capacitors with non-solid electrolyte

1 Scope

This part of IEC 61881 applies to d.c. aluminium electrolytic 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. filtering, etc.

Capacitors not covered by this Standard:
– IEC 61881-1: Paper/plastic film capacitors;
– IEC 61881-3: Electric double-layer capacitors.

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 60062:2004, Marking codes for resistors and capacitors


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


IEC 60384-4:2007, Fixed capacitors for use in electronic equipment – Part 4: Sectional specification – Aluminium electrolytic capacitors with solid (MnO₂) and non-solid electrolyte
IEC 60721-3-5:1997, *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 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*