IEC TR 63362-1

Edition 1.0 2022-02

TECHNICAL REPORT

colour inside

Application of fixed capacitors in electronic equipment – Part 1: Aluminium electrolytic capacitors

IEC TR 63362-1:2022-02(en)

IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ICS 31.060.50

ISBN 978-2-8322-1078-4

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

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IEC TR 63362-1 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment. It is a Technical Report.

This first edition cancels and replaces CLC/TR 50454 published in 2008. This edition constitutes a technical revision.

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

a) Complete technical revision, details of cleaning processes and failure modes added.

b) Inclusion of parts of JEITA RCR 2367D.

The text of this Technical Report is based on the following documents:

Draft	Report on voting
40/2881/DTR	40/2908/RVDTR

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

The language used for the development of this Technical Report is English.

A list of all parts in the IEC 63362 series, published under the general title *Application of fixed capacitors in electronic equipment*, can be found on the IEC website.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under 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- withdrawn,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.

APPLICATION OF FIXED CAPACITORS IN ELECTRONIC EQUIPMENT –

Part 1: Aluminium electrolytic capacitors

1 Scope

This document establishes guidelines for the application and use of aluminium electrolytic capacitors in electronic equipment.

The information given in this document applies to capacitors with non-solid electrolyte but can, in its appropriate clauses, apply to capacitors with solid electrolyte as well.

Electrolytic capacitors in general – and aluminium electrolytic capacitors in particular – are an exception in the capacitor field because of the components' close interaction of physics and chemistry. Therefore, aluminium electrolytic capacitors show, in various aspects, a technical behaviour unaccustomed to the user. That could easily lead to misapplications and even to endangering of persons and goods. The aim of this document is to minimize these risks by providing detailed information on the specific peculiarities of the component.

2 Normative references

There are no normative references in this document.

NOTE Further information about related standards can be found in Bibliography at the end of this document.

3 Terms and definitions

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

3.1
anode
positive electrode
aluminium (preferably aluminium foil) of extreme purity that is etched in most cases in order to increase the electrode's surface and, consequently, the capacitor's capacitance yield

3.2
cathode
negative electrode
working electrolyte that is a conductive material

Note 1 to entry: Working electrolyte in the case of capacitors with solid electrolyte is a layer of manganese dioxide MnO_2, conductive organic salt (e.g. TCNQ) or conductive polymer (e.g. polypyrrole, PEDOT).

Note 2 to entry: PEDOT is a thiophene-based doped polymer, which is used as a solid cathode in aluminium electrolytic capacitors, often combined with an additional liquid electrolyte.

3.3
dielectric
aluminium oxide (Al_2O_3) which is formed on the anode's surface by an anodizing process

3.4
contact element for the negative electrode
high-purity aluminium foil ("cathode foil") in the case of capacitors with non-solid electrolyte or silver paste on graphite or other conductive connections in the case of capacitors with solid electrolyte

3.5
separator
layers (preferably of special paper) that separate the anode foil from the "cathode foil" in the case of capacitors with non-solid electrolyte

Note 1 to entry: The other purpose of the separators is to retain the working electrolyte.

3.6
polarity
polarized electrolytic capacitor

Note 1 to entry: For special purposes, so-called non-polar (bipolar) capacitors can be provided. Such special types consist in principle of an internal back-to-back connection of two basically polarized elements.

3.7
sealing
polymer-based material to close the aluminium case

Note 1 to entry: The internal element of a non-solid electrolytic capacitor is normally encapsulated in an aluminium case closed with a sealing material which is never perfectly gas-tight. Because of using a non-solid electrolyte, of which, some constituents are slowly diffusing through the sealing, the electrical characteristics of the capacitor are changing gradually over its entire life.

4 Protection measures – insulation

Capacitors can be either completely or partially covered with sleeving or coating, or not covered at all. It should be noted that, in particular for capacitors with liquid electrolyte, the capacitor case is not insulated from the cathode terminal. The case can be connected to the electrolyte through the contact element for the negative electrode.

Axial leaded capacitors have a direct contact between the case and the cathode terminal. Radial leaded capacitors have an undefined electrical contact through electrolyte or other parts inside the case. Dummy pins are left potential-free or can be connected to the potential of the negative terminal. Metal parts other than terminals should never make contact to conducting tracks or metal parts of other components.

The standard sleeving must be considered as protection against contact only, and does not offer any functional insulation. If electrical insulation is required, an additional insulation is necessary.

Special care needs to be taken if the mounting requires electrical insulation, such as:

- other components are in touch with capacitors;
- unprotected live wires or PCB tracks are underneath the capacitors;
- capacitors are in contact with the enclosure;
- capacitors are mounted by metal clamps.

For such cases, the sleeving material needs to be agreed on case by case between the manufacturer and the customer.

The sleeving can deteriorate depending on the environmental conditions, e.g.:

- upon exposure to high temperature, polyvinyl chloride (PVC) sleeving can become brittle which could potentially lead to cracks;
- for polyethylene terephthalate (PET) based sleeving, exposure to high temperature and high humidity can lead to hydrolysis.

Operating conditions for which sleeving deterioration is expected need to be agreed on case by case between the manufacturer and the customer.

5 General application limits

5.1 Polarity – Reverse voltage

Electrolytic capacitors for DC applications require polarization.

The polarity of each capacitor is checked both in circuit design and in mounting. Polarity is clearly indicated on the capacitor. For short periods, a limited reverse voltage can be allowed as specified in the relevant specification by the manufacturer. Exceeding the specified reverse voltage can induce damage by causing overheating, over-pressure and dielectric breakdown and can be associated with open circuit or short-circuit conditions – it is the most severe failure mechanism with aluminium electrolytic capacitors. There could even be a destruction of the capacitor. Protections need to be used if there are reverse voltage risks (see Clause 10).

5.2 Voltage

5.2.1 General

Exceeding the capacitors' specified voltage limits can cause premature damage (e.g. by breakdown with open or short circuit) affecting the useful life. Even destruction of the capacitor can be the consequence.

5.2.2 Rated voltage

The rated voltage U_R given in the relevant specification or by the manufacturer is the value permitted for continuous operation in the rated temperature range.

5.2.3 Surge voltage

For short periods, the voltage can be increased up to the surge voltage value in accordance with IEC 60384-4, IEC 60384-18, IEC 60384-25, IEC 60384-26 and to the manufacturer's specification.

5.2.4 Transient voltages

The surge voltage value can be exceeded for very short periods or short pulses if allowed by the manufacturer and when in accordance with the relevant specification or detailed specification by the manufacturer. A test method is given in IEC 60384-4, IEC 60384-18, IEC 60384-25, IEC 60384-26.

Such special operating conditions need to be agreed on case by case between the customer and the manufacturer.

5.3 Temperature range

The capacitors are to be used within the specified temperature range (category temperature range).

Applicable temperature ranges are given in the relevant specifications and/or in manufacturer's data. A general principle is that lower ambient temperature means longer life. Therefore, electrolytic capacitors should be placed at the coolest positions wherever possible.

Exceeding the permitted temperature causes overheating and over-pressure, which can affect the useful life and induce damage. Even destruction of the capacitor can be the consequence.

5.4 Ripple current

The sum of DC voltage and superimposed ripple voltage is specified to be within rated voltage and 0 V at any time.

Electrolytic capacitors are not normally designed for AC application (see Clauses 1 and 17).

No excessive ripple current is allowed to pass. Exceeding the ripple current specification reduces life and can induce overheating and over-pressure. Even destruction of the capacitor can be the consequence.

The useful life of the capacitor is a function of the r.m.s. ripple current. Temperature, frequency and cooling conditions as well as applied DC voltage are other factors influencing the useful life.

5.5 Charge – Discharge

Under the conditions defined in IEC 60384-4, IEC 60384-18, IEC 60384-25, IEC 60384-26, or in the manufacturer's specifications, frequent charge/discharge operation is allowed.

Exceeding charge/discharge frequency leads to a high ripple current and induces damage by overheating and overpressure or breakdown with open circuit or short circuit, leading to a reverse voltage risk (see 5.1). Even destruction of the capacitor can be the consequence.

Rapid charge/discharge operating conditions in applications such as robotics or servo drives need to be agreed on case by case between customer and manufacturer.

6 Storage, transportation, and operation

It is recommended to store the capacitors at temperatures between 5 °C to 35 °C and a relative humidity of less than 75 %, and in original packaging.

Storage of the capacitors above recommended temperatures (5 °C to 35 °C) in off-duty condition can cause an increase of the leakage current to more than 10 times the maximum limit (see IEC 60384-4, IEC 60384-18, IEC 60384-25, IEC 60384-26). This is caused by the special characteristics of the dielectric material (e.g. aluminium oxide in case of aluminium electrolytic capacitors). This leakage current is not only dependent on the capacitor's design, but is also a function of time, the applied voltage, temperature, and the capacitor's history, such as storage conditions and duration. Although the initial leakage current can be significantly increased after storage, it will decrease to a stable value upon application of voltage.

Manufacturers' recommendations (reforming procedures, etc.) need to be considered after extended storage (for more details see IEC 60384-4, IEC 60384-18, IEC 60384-25, IEC 60384-26). High humidity and/or high temperature can impair solderability and taping.

Storage at conditions defined above has a negligible effect on capacitance, tangent of loss angle or equivalent series resistance, and impedance.

Special care needs to be taken with respect to exposure to halogenated chemicals (see also Clause 15). International shipments might be subjected to fumigation treatment with