

GUIDELINES FOR USING ALUMINUM ELECTROLYTIC CAPACITORS

1. DC Electrolytic Capacitors are polarized.

Make sure of the polarity. The polarity is marked on the body of the capacitor. Application of the reversed voltage may cause a short circuit or damage the capacitor. Use bipolar capacitors when the polarity is not determined or unknown. Note that DC electrolytic capacitors cannot be used for AC application.

2. Do not apply a voltage exceeding the rated voltage.

If a voltage exceeding the rated voltage is applied, the leakage current will increase, which may damage the capacitor. Using capacitors at recommended working voltage prolongs capacitor life.

3. Use specially designed capacitors for the circuits where charge and discharge are frequently repeated.

In the circuit subjected to rapid charge and discharge cycles, capacitors may be damaged. Be sure and use special capacitors in these applications.

4. Do not allow excessive ripple current through the capacitor.

The flow of ripple current over the permissible ripple current will cause heat of the capacitor, which may decrease the capacitance and damage the capacitor. Ripple current on the capacitor must be at or below allowable level.

5. Storage

The characteristics of electrolytic capacitors depend on temperature ; the higher the ambient temperature, the faster the deterioration proceeds (leakage current increases, $\tan\delta$ increases and capacitance drops). Humidity is another deteriorating factor. Capacitors may have their lead wires/terminals oxidized, impairing solderability, when stored in humid place for long periods of time. Aluminum electrolytic capacitors should be stored at room temperature in dry places out of direct sunlight.

Apply voltage treatment to the capacitor which has been stored for a long time.

If the electrolytic capacitor is allowed to stand for a long time, its working voltage is liable to drop, resulting in increased leakage current. If the rated voltage is applied to such a product, a leakage current occurs and this generates internal heat, which damages the capacitor.

If the electrolytic capacitor is allowed to stand for more than 2 years, apply a voltage treatment (applying the rated voltage for 30 minutes at room temperature)

before use.

Care should be used in selecting a storage area. If electrolytic capacitors are exposed to high temperature caused by such things as direct sunlight, the life of the capacitor may be adversely affected. Storage in a high humidity atmosphere may affect the solderability of lead wires and terminals.

6. Be sure of the temperature range.

The characteristics of capacitors change with the operating temperature.

The capacitance and leakage current increase and $\tan\delta$ decreases at higher temperature. The capacitance and leakage current decrease, and $\tan\delta$ increases at lower temperature. Usage at lower temperature will ensure longer life.

7. Tangent of loss angle increases at higher frequencies.

The tangent of loss angle ($\tan\delta$) increases as the applied frequency becomes higher whereas decreases as the ambient temperature becomes higher.

8. Capacitance decreases at higher frequencies.

The capacitance value is measured at 120Hz. The capacitance decreases as the applied frequency becomes higher whereas increases as the ambient temperature becomes high.

9. Do not apply excessive force to the terminals and leads.

The excessive strong force applied to the terminals and lead wires may break them and loosen the connections of the internal elements.

10. Hole positions on the circuit board.

Through-holes on the circuit board as well as lead holes of post-process parts can result in solder splashing onto the vinyl sleeve, causing damage. Consider hole positions carefully.

11. Be cautious of the temperature and duration when soldering

Incorrect soldering may shrink or break the sleeve. Please read the following information carefully, before soldering.

Too high a soldering temperature or too long a soldering time may cause secondary shrinking of the sleeve which unnecessarily exposes the container. No problems will be observed at a soldering temperature of 260°C or below for no more than 10 seconds.

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Soldering may melt or break the sleeve, if the sleeve is in contact with circuit patterns.

To avoid this problem, the capacitors should be mounted slightly raised from the circuit board. (Lead formed capacitors are recommended.)

Sleeve may be melted by solder which has migrated up through the terminal holes on the circuit board. To avoid this problem, the same application as stated in the foregoing paragraph is recommended.

When soldering, heated lead wires or terminals of adjacent components tear the sleeve if contacted. Please mount carefully so as not to bring adjacent components' terminals or lead wires into contact with the sleeve, particularly when mounting on through-hole circuit boards.

12. The capacitor case is not insulated from the cathode terminal.

The capacitor's case and cathode terminal connect through the electrolyte. If the case is to be completely insulated, that insulation must be at the capacitor's mounting point.

13. Adhesives and coating materials

When using a latex-based adhesive on the capacitor's rubber mouth seal for adhesion to a printed circuit board, corrosion may occur depending on the kind of solvent in the adhesive.

Select an adhesive as an organic solvent with dissolved polymer that is not halogenated. For polymer, avoid the use of chloroprene.

Also coating and dampproof materials are including halogenated hydrocarbon, so special case should be taken for use.

14. Cleaning of the circuit board after soldering

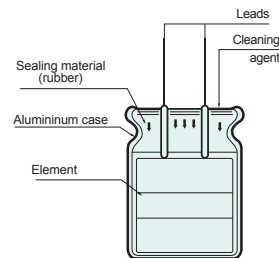
Aluminum can be aggressively attacked by halide ions, particularly by chloride ions.

Even small amounts of chloride ions inside the capacitor will cause corrosion accidents rapid capacitance drop and venting. Therefore, the prevention of chloride contamination is the most important check point for quality control in production lines. At present, the halogen organic solvent such as Freon are commonly used to remove soldering pastes from circuit boards.

When an aluminum electrolytic capacitor is immersed in a halogen organic solvent (e.g.; chlorosen, Freon TE, Freon TES, etc.), the halogen organic solvent (cleaning agent) infiltrates into the aluminum electrolytic capacitor where the halogen ions separate and react with the aluminum to cause corrosion. The infiltration mechanism of the cleaning agent and the corrosion mechanism are hypothesized below.

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Cleaning agent trapped inside sealing material (rubber packing, terminal board) when capacitor is cleaned.

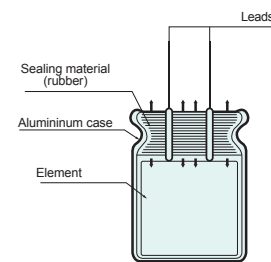


When a capacitor is immersed in a cleaning agent, it causes the rubber packing to swell, thus trapping the cleaning agent in the rubber packing.

The amount trapped is greatly dependent on not only the duration of immersion and the temperature, but also the type of cleaning agent

and the properties of the rubber packing.

Diffusion of cleaning agent trapped inside rubber packing.



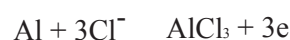
Even when the capacitor is removed from the cleaning agent and the cleaning agent adhering to the capacitor dries, that trapped inside the rubber packing does not immediately dry and it gradually diffuses from inside the rubber packing toward the element and the atmosphere. Therefore, not all

the cleaning agent trapped in the rubber packing infiltrates towards the element.

Corrosion mechanism

The cleaning agent infiltrating the element undergoes a decomposition reaction which frees chloride. This chloride reacts with aluminum, resulting in corrosion. When the capacitor is powered, the negative chloride ions migrate toward the anode. Therefore, corrosion occurs only at the anode.

Chloride ion can penetrate through imperfections and microcracks in the aluminum oxide dielectric layer to reach the underlying aluminum metal. At these points the metal is attacked with production of a soluble chloride in this anodic half-cell reaction ;



There is always at least 1~2% water in the electrolyte and this is sufficient to hydrolyze the AlCl_3 :



This reaction releases chloride ion for further attack of aluminum. The hydrogen ion increases the local acidity which causes oxide dielectric to dissolve. Thus localized

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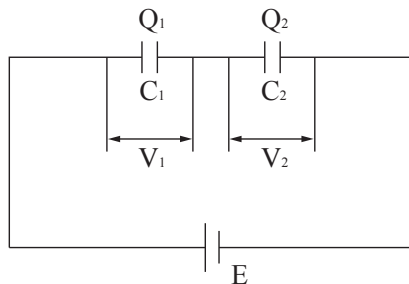
corrosion occurs at an accelerated pace with attack of both metal and dielectric. Therefore, with the exception of capacitors designated as solvent-proof, alcohol based solvents rather than chlorinated hydrocarbons are recommended for cleaning.

Some adhesives, dampproofing agents and dustproofing agents also contain halides and should be used with caution.

Recommended cleaning solvents

General name	Composition
Freon TF (Daiflon S3)	1 1.1.2 – trichloro 1.1.2 – trifluorethane
Freon TE (Daiflon S3-E)	2 ; 1 + ethanol
Freon TES (Daiflon S3-ES)	3 ; 1 + ethanol + stabilizer
Freon TP-35 (Daiflon S3-P35)	4 ; 1 + isopropyl alcohol
Freon TMS (-)	5 ; 1 + methanol + stabilizer

15. For series connection



Where

C_1 : The capacitance of A

C_2 : The capacitance of B

V_1 : The voltage between terminals of A

V_2 : The voltage between terminals of B

E : The voltage of power supply

Q : The magnitude of the stored charge ($Q=Q_1=Q_2$)

Analysis

$$Q_1 = Q = C_1 V_1, \quad Q_2 = Q = C_2 V_2 \quad \text{eq 1)}$$

From eq1)

$$V_1 = \frac{Q}{C_1} \quad V_2 = \frac{Q}{C_2} \quad \text{eq 2)}$$

$$E = V_1 + V_2 = \frac{Q}{C_1} + \frac{Q}{C_2} = \frac{C_1 + C_2}{C_1 \cdot C_2} \cdot Q$$

$$Q = \frac{C_1 \cdot C_2}{C_1 + C_2} \cdot E = C \cdot E$$

From eq 2)

$$C_1 V_1 = \frac{C_1 C_2}{C_1 + C_2} \cdot E \quad C_2 V_2 = \frac{C_1 C_2}{C_1 + C_2} \cdot E \quad \text{eq 3)}$$

From eq 3)

$$V_1 = \frac{C_2}{C_1 + C_2} \cdot E \quad V_2 = \frac{C_1}{C_1 + C_2} \cdot E$$

When capacitors are used in series connection, the voltage is divided reversal proportional to the ratio of the capacitance, when capacitors are being charged.

Thus, the voltage applied to the capacitor depends on the capacitance.

Unbalanced capacitance could cause the excessive voltage application and safety vent operation.

The applying voltage unbalancing can be reduced by choosing a couple of capacitors that have the capacitance within 5% differences.

16. Blank terminals must be mounted to an electrically isolated palce.

Blank terminals are not perfectly isolated from the element. It is important when planning the printed circuit board to electrically isolate the blank terminals.

The blank terminals are for added stability only, and should never be electrically connected to either the positive or negative terminal.

17. Mounting

The distance between the terminal holes on the circuit board should be the same as that between the lead wires or terminal of the capacitor.

Excessive force in mounting on circuit boards should be avoided.

Radial lead type

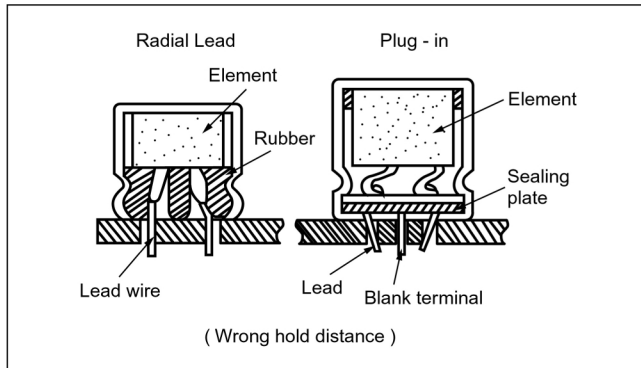
Improper insertion of the lead wires in circuit boards may cause electrolyte leakage or break the lead wires or impair their connection with the internal elements.

When the distance between the two terminal holes on the circuit board cannot be reduced to that between the lead wires, lead formed capacitors are recommended.

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Snap-in type

Improper insertion of the terminals in circuit boards may break the terminals or impair their connection with the internal elements.



18. Method for testing

The method shall comply with KS C6035, KS C6421(JIS C5102, JIS C5141). Except lead solderability. The lead solderability meets the requirements of MIL-STD 202, Method 208.

19. When Ordering

When you order aluminum electrolytic capacitors, selecting parts listed in this catalog will result in favorable prices and delivery schedules.

When ordering items not listed in this catalog, confirm the following points before notification

- (1) Type and/or series name, application.
- (2) Rated voltage and nominal capacitance
- (3) Usage temperature range and ripple current
- (4) Sizes and dimensions
- (5) Other special requirement