

Precautions and Guidelines for Using Organic Conductive Polymer Capacitors

Organic conductive polymer capacitor (OP-CAP) is specially structured using with a solid electrolyte of conductive polymers, has several advantages over non-solid aluminum capacitors due to its compact size, wide operation temperature range, high resistance against ripple current, and especially, low ESR. The only disadvantage, however, is their low working voltage. Over past few years, Lelon has developed a number of series of OP-CAPs. Please refer to following guidelines for obtaining the highest performance and stable quality by using OP-CAP series products.

1. Guidelines for Circuit design

(1) Polarity

OP-CAPs are basically nothing but aluminum electrolytic capacitors with solid electrolyte. Therefore, they must be installed with the correct polarity. Usage in the reverse polarity results into a short-circuit condition that may damage or even explode the capacitor.

In addition, it may affect circuit functionality.

(2) Operating Voltage

Applied DC voltage must not exceed rated voltage of an OP-CAP. Applying higher voltage across a capacitor terminals than its rated voltage will cause overheating due to higher leakage currents, and dielectric/insulation deterioration that will ultimately affect a capacitor's performance. The OPCAP, however, is capable of working under short-time transient voltages such as DC transients and peak AC ripples. Note that the result of DC voltage overlapped with peak ripple voltage should not exceed rated voltage.

(3) Ripple Current

One of the key functions of any capacitor is removal of the ripple current i.e. the RMS value of AC flowing through a capacitor. But, a ripple current higher than rated ripple current will drop resultant capacitance, cause undue internal heating and thus reduces life span of the capacitor. In extreme cases, internal high temperature will cause the pressure relief vent to operate while destroying the device. Overall, it is important to note that an electrolytic capacitor must be used within a permissible range of ripple current.

(4) Operating Temperature

Capacitors should be used within a permissible range of operating temperatures. Use of a capacitor at a higher temperature than maximum rated temperature will considerably shorten its life. Usage of capacitors at an ambient room temperature assure their longer life.

(5) Leakage Current

Leakage current flows through a capacitor when DC voltage is applied across it. Leakage current varies with changes in ambient temperature and applied DC voltage level and its time of application. Overvoltage situation, presence of moisture, and thermal stresses, especially occurring during the soldering process can enhance leakage current. Initial leakage current is usually higher and does not decrease until voltage is applied for a certain period of time. It is recommended to keep initial leakage current within specified levels.

(6) Charge and Discharge

OP-CAPs are unsuitable for rapid charging/discharging circuits. Such usage may either cause reduction in overall capacitance or damage due to overheating. **Note that a protection circuit is required when inrush current in an OP-CAP exceeds 10 A.**

(7) Condition of Use

OP-CAP shall not be used / exposed to:

- Fluids including water, saltwater spray, oil, fumes, highly humidity or condensed climates, etc.
- Ambient conditions containing hazardous gases/fumes like hydrogen sulfide, sulfurous acid, nitrous acid, chlorine or bromine gas, ammonia, etc.
- Ozone, ultraviolet rays and radiation.
- Severe vibrations or physical shocks that exceeding the in specifications.

(8) Consideration to Circuit Design

- Please ensure whether application, operating and mounting conditions satisfy the conditions specified in the catalog

before installation of an OP-CAP. Please consult Lelon, if any of the conditions are beyond the conditions specified in the catalog.

- Heat-generating components or heat sinks should not be placed closer to OP-CAPs on the PCB to avoid premature failure. A cooling system is recommended to improve their reliable working.
- Electrical characteristics and performance of OP-CAPs are affected by variation of applied voltage, ripple current, ripple frequency and operating temperature. Therefore, these parameters shall not exceed specified values in the catalog.
- OP-CAPs may be connected in the parallel fashion for increasing total capacitance and/or for achieving higher ripple current capability. But, such design may cause unequal current flow through each of the capacitors due to differences in their impedances.
- When two or more capacitors are connected in series, voltage across each capacitor may differ and fall below the applied voltage. A resistor should be placed across each capacitor so as to match applied voltage with voltage across a capacitor.
- Please consult Lelon while selecting a capacitor for high-frequency switching circuit or a circuit that undergoes rapid charging/ discharging.
- Standard outer sleeve/ coating material of the capacitor is not a perfect electrical insulator therefore is unsuitable for the applications that requires perfect electrical insulation. Please consult Lelon, if your application requires perfect electrical insulation.
- Tilting or twisting capacitor body is not recommended once it is soldered to the PCB.

2. Caution for Assembling Capacitors

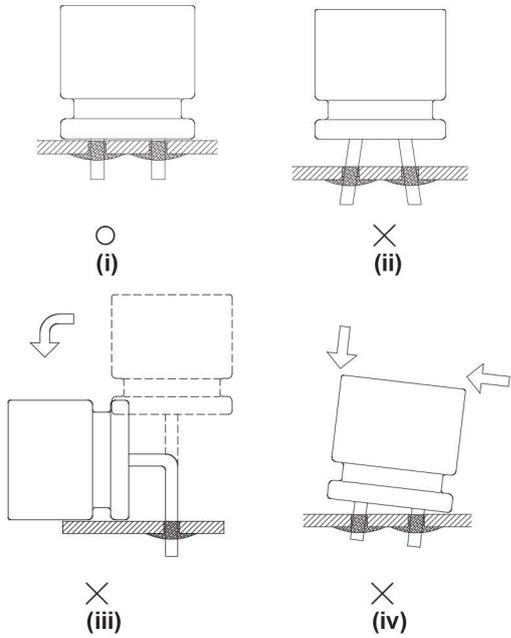
(1) Mounting

- OP-CAPs are not recommended to re-use in other circuits once they are mounted and powered in a circuit.
- OP-CAPs may hold static charge between its anode and cathode, which is recommended to be discharge through a 1kΩ resistor before use.
- A long storage of capacitors may result into its insulation deterioration. This can lead to a high leakage current when voltage is applied that may damage the capacitor. Capacitors following a long storage period must undergo voltage treatment/re-forming. Capacitors are charged by applying rated DC voltage through a resistor of 1kΩ in series at least for an hour. It is recommended to increase applied voltage gradually using a voltage regulator unit once capacitors are assembled on the board. The charging should be followed by discharging through a 1kΩ resistor.
- Please check capacitor rated voltage before mounting.
- Please check capacitor polarity before mounting.
- Please don't drop OP-CAPs on the floor/hard object.
- Please don't deform the capacitor during installation.
- Please confirm whether the lead spacing of the capacitors match with its pad spacing/footprint on PCB prior to installation.
- Please avoid excessive mechanical shocks to OP-CAPs during auto-insertion process, inspection or centering operations.

(Continued on next page)

(2) Soldering

- (a) Please confirm that soldering conditions, especially temperature and contact time are within our specifications. Dip or flow soldering temperature should be limited at 260 ± 5°C for 10 ± 1sec. Please do not dip capacitor body into molten solder. An OP-CAP's life will be negatively affected if these conditions are violated.
- (b) Storage of capacitors in *high humidity* conditions is likely to affect the solderability of lead wires and terminals
- (c) **Reflow soldering should ONLY be used for SMD type conductive polymer capacitors.** Please check the reflow profile prior to using such type of capacitors. The temperature and duration shall not exceed the specified temperature and duration in the catalogue. If required temperature or duration is higher than the value specified, please consult Lelon before use.
- (d) Usually OP-CAPs are not designed to withstand multiple reflow processes. Please consult Lelon if repeated reflowing is unavoidable.
- (e) Incorrect mounting on PCB with improper external strength applied on its lead wires or capacitor body after soldering may damage an OP-CAP's internal structure, cause short circuit, or lead to high leakage current. Do not bend or twist the capacitor body after soldering. Referring to the drawings below only case (i) is recommended.
 - (i) Correct soldering
 - (ii) Hole-to-hole spacing on PCB differs from the lead spacing of lead wires.
 - (iii) Lead wires are bent after soldering.
 - (iv) Capacitor body doesn't stand vertical on PCB after soldering.



(3) Cleaning PCBs After Soldering

- (a) Following chemicals are not recommended for cleaning: Solvent containing halogen ions, Alkaline solvent, Xylene, Acetone, Terpene, petro-based solvent.
- (b) Recommended cleaning conditions: Fatty-alcohol - Pine Alpha ST-100S, Clean Through-750H and IPA (isopropyl alcohol) are examples of the most acceptable cleaning agents. Temperature of the cleaning agent must not exceed 60°C. Flux content in the cleaning agents should be limited to 2 Wt. %. Overall length of cleaning process (e.g., immersion, ultrasonic or other) shall be within 5 minutes (5 ~ 7mm height within 3 minutes).

3. Maintenance Inspection

Periodic inspection of OP-CAPs is absolutely necessary, especially when they are used with industrial equipment. The following items should be checked:

- (1) Appearance: bloated, vent operated, leaked, etc.
 - (2) Electrical characteristic: Capacitance, Tan δ, leakage current, and other specified items listed in specifications.
- Lelon recommends replacement of the capacitors if any of the abovementioned items fail to meet the specifications.

4. Storage

- (1) The most suitable conditions for aluminum capacitor storage are 5°C ~ 35°C with indoor relative humidity less than 75%. High temperature and/or humidity storage is detrimental to the capacitors.
- (2) OP-CAPs shall not be stored in wet or damp atmospheres containing water, brine, fumes or oil.
- (3) Capacitors storage area shall neither be exposed to hazardous gases such as hydrogen sulfide, sulfurous acid, nitrous acid, chlorine, ammonium, etc. nor to acidic/ alkaline solutions.
- (4) OP-CAPs shall not be exposed to ozone, ultraviolet rays or radiation.
- (5) Storage bags shall be opened just before usage. Please restore unused capacitors as soon as possible. Sealed and secured capacitors are likely to provide better solderability in next usage. Shelf-life of OP-CAPs are as follows:

Series name	Before unseal	After unseal
OCV, OCVZ, OCVU, OVH, OVK, OVA, OVE, OVG, OVS, OVJ, OVD, OVB, OVI, OVJ	Within 1 year after delivery (Unopened condition)	Within 30 days from opening package
OCR, OCRZ, OCRK, OCRU, ORE, ORS, ORA, ORG, ORC, ORF, ORB, ORD, ORX	Within 1 year after delivery (Unopened condition)	Within 7 days from opening package

※ It is not applied to the regulation of JEDEC J-STD-020 (Rev. C).

(Continued on next page)

5. Estimation of life time

Formula 1	Formula 2
$L_r = L_0 \times 10^{\frac{T_0 - T_r}{20}}$	$L_r = L_0 \times 2^{\frac{T_{0\ max} - T_{r\ max}}{10}}$
Applicable products: ● OP-CAP OCV, OCVZ, OVH, OVK, OCVU, OVI, OCR, OCRZ, ORE, OCRK, OCRU, ORX series	Applicable products: ● OP-CAP OVA, OVE, OVG, OVS, OVF, OVD, OVB, OVJ, ORS, ORA, ORG, ORC, ORF, ORB, ORD series ● Conductive Polymer Hybrid Capacitors ● Aluminum Electrolytic Capacitors
Ex. OCV, 105°C, 2,000 Hours	Ex. OVA, 105°C, 15,000 Hours
95°C ≥ 6,324 Hours	95°C ≥ 30,000 Hours
85°C ≥ 20,000 Hours	85°C ≥ 60,000 Hours
75°C ≥ 63,245 Hours	75°C ≥ 120,000 Hours
65°C ≥ 200,000 Hours (max. 15 years)	65°C ≥ 240,000 Hours (max. 15 years)

Formula 1:

L_r : Estimated lifetime (hours)

L_0 : Base lifetime specified at maximum operating temperature with applied the DC voltage

T_0 : Rated maximum operating temperature (°C)

T_r : Actual ambient temperature (°C)

Formula 2:

L_r : Estimated lifetime (hours)

L_0 : Base lifetime specified at maximum operating temperature with applied the DC voltage and the ripple current (hours)

$T_{0\ max}$: The core temperature that rated ripple current applied at maximum operating temperature.

$T_{r\ max}$: The core temperature that applied actual ripple current at ambient temperature.

Please note that

(1) Maximum life is 15 years.

(2) Ripple current in application should be less than or equal to ripple current specified in catalogue.

6. Disposal

Please consult with a local industrial waste disposal specialist when disposing of aluminum electrolytic capacitors.

7. Environmental Consideration

Lelon already have received IECQ QC 080000 certificate.

Cadmium (Cd), Lead (Pb), Mercury (Hg), Hexavalent Chromium (Cr⁶⁺), PBB, PBDE, DEHP, BBP, DBP and DIBP have never been using in capacitor. If you need "Halogen-free" products, please consult with us.

8. AEC-Q200 Compliance

Automotive Electronics Counsel (AEC) has established various electronic component qualification/reliability standards in order to serve automotive electronics industry. AEC-Q200 standard is dedicated for passive components like capacitors, inductors, etc. and is widely adopted domestically as well as internationally. Lelon offers compliant product designs and support services to satisfy customers' product requirements, including the AEC-Q200 required criteria of the reliability tests. Lelon's capacitors are professionally designed to outperform all requirements of AEC-Q200.

For further details, please refer to the following industrial standards:

IEC 60384-4 - Fixed capacitors for use in electronic equipment – Part 4: Sectional specification – Fixed aluminum electrolytic capacitors with solid (MnO₂) and non-solid electrolyte (Edition 5.0 2016-08)

JEITA RCR-2367D – Safety application guide for fixed aluminum electrolytic capacitors for use in electronic equipment (Established in March 1995, Revised in October 2017)