



Application Guidelines for Aluminum Electrolytic Capacitors

1. Circuit Design

(1) Make sure the application and mounting conditions are within the conditions specified in the catalog or alternate product specification (Referred to as specification hereafter) The capacitor may be damaged, catch fire, or vent if it is used beyond the specified conditions in the catalog or alternate product specification.

(2) Operating temperature and applied ripple current shall be within specification.

① The capacitor shall not be used in an ambient temperature which exceeds the operating temperature specified.

② Do not apply ripple current which exceeds the allowable ripple current.

(3) Appropriate capacitors which comply with the life requirement of the products should be selected when designing the circuit.

(4) Aluminum electrolytic capacitors are polarized. Make sure no reverse voltage or AC voltage is applied to the capacitors. Please use bi-polar capacitors in a circuit that can possibly see reversed polarity.

Note: Even bi-polar capacitors cannot be used for AC voltage application.

(5) For a circuit that repeats rapid charging/discharging, a capacitor that is capable of enduring such conditions must be used. Welding machines and photo flash are a few examples of products that contain such a circuit. In addition, rapid charging/discharging may be repeated in control circuits for servomotors, in which the circuit voltage fluctuates substantially.

Selecting capacitors for circuits that have repeated rapid charging/discharging, please consult Nichicon.

If excess a rush current due to drastic charge/dis-charge was applied to conductive polymer aluminum solid electrolytic capacitors, and conductive polymer hybrid aluminum electrolytic capacitors, it may cause a short circuit or an increase in leakage current. Therefore, please do not apply a rush current that is larger than 10A.

(6) Make sure no voltage (higher than the rated voltage) is applied to the capacitor.

① The peak voltage, which is the DC voltage overlapped by ripple current, does not exceed the rated voltage.

② Where more than 2 aluminum electrolytic capacitors are used in series, make sure the applied voltage will be lower than rated voltage and voltage will be applied to each capacitor equally using a balancing resistor in parallel with the capacitors.

Please do not use conductive polymer aluminum solid electrolytic capacitors, and conductive polymer hybrid aluminum electrolytic capacitors for the application listed below, since the solid organic polymer aluminum electrolytic capacitor cannot reach it's maximum performance.

1) Coupling circuits

2) R-C timing circuit

3) High impedance voltage retention circuit

4) Circuits, which extremely low voltage in compared to the rated voltage is only applie

5) Circuits, which are greatly affected by leakage currents for special use such as multiple parts used in a series, please contact us for recommendations

(7) Aluminum electrolytic capacitors must be electrically isolated as follows:

(The aluminum case and the cathode foil are connected by the unstable resistance of a naturally formed oxide layer inside the aluminum case and the electrolyte.)

① (a) Case and negative terminal (except axisl leaded part such as JIS configuration 02 type)

(b) Case and positive terminal

(c) Case and circuit pattern

② Auxiliary terminal of can type such as JIS style symbol 693, 694 or 695 and negative and positive terminal, including the circuit pattern.

③ Case and both terminals of a bi-polarized capacitor.

(8) Outer sleeve of the capacitor is not guaranteed as an electrical insulator. Do not use a standard sleeve on a capacitor in applications that require the electrical insulation. When the application requires special insulation, please contact our sales office for details.

(9) Capacitors may fail if they are used under the following conditions:

① Environmental (climatic) conditions

- (a) Being exposed to water, high temperature & high humidity atmosphere, or condensation of moisture.
- (b) Being exposed to oil or an atmosphere that is filled with particles of oil.
- (c) Being exposed to salty water or an atmosphere that is filled with particles of salt.
- (d) In an atmosphere filled with toxic gasses (such as hydrogen sulfide, sulfurous acid, nitrous acid, chlorine, bromine, methyl bromide, ammonia, etc.)
- (e) Being exposed to direct sunlight, ozone, ultraviolet ray, or radiation
- (f) Being exposed to acidic or alkaline solutions

② Under severe conditions where vibration and/or mechanical shock exceed the applicable ranges of the specifications.

(10) When designing a P.C. board, please pay attention to the following:

- ① Have the hole spacing on the P.C. board match the lead spacing of the capacitor.
- ② There should not be any circuit pattern or circuit wire above the capacitor pressure relief vent.
- ③ Unless otherwise specified, following clearance should be made above the pressure relief vent.

Case Diameter	Clearance Required
φ 8 to 16mm	2mm or more
φ 18 to 35mm	3mm or more
φ 40mm or more	5mm or more

- ④ In case the vent side is placed toward P.C. board (such as end seal vented parts), make a corresponding hole on the P.C. board to release the gas when vent is operated. The hole should be made to match the capacitor vent position.
 - ⑤ Screw terminal capacitors must be installed with their end seal side facing up. When you install a screw terminal capacitor in a horizontal position, the positive terminal must be in the upright position.
- (11) The electrolyte is conductive. When it comes in contact with the P.C. board, there is a possibility of pattern corrosion. Smoking or a short circuit can occur when a circuit pattern is underneath the end seal. Do not locate any circuit pattern beneath the capacitor end seal.
- (12) Do not design a circuit board so that heat generating components are placed near an aluminum electrolytic capacitor or reverse side of P.C. board (under the capacitor).
- (13) Please refer to the pad size layout recommendations in our catalog when designing in surface mount capacitors.
- (14) Electrical characteristics may vary depending on changes in temperature and frequency. Please consider this variation when you design circuits.
- (15) When you mount capacitors on the double-sided P.C. boards, do not place capacitors on circuit patterns or over on unused holes.
- (16) The torque for terminal screw or brackets screws shall be within the specified value on Nichicon's drawings.
- (17) When you install more than 2 capacitors in parallel, consider the balance of current flowing though the capacitors. Especially, when a solid conductive polymer aluminum electrolytic capacitors, Conductive polymer hybrid aluminum electrolytic capacitors and a standard aluminum electrolytic capacitors are connected in parallel, special consideration must be given.

- (18) If more than 2 aluminum electrolytic capacitors are used in series, make sure the applied voltage will be lower than the rated voltage and that voltage will be applied to each capacitor equally using a balancing resistor in parallel with each capacitor. If one side is shorted, the other side may be applied an overvoltage.
- (19) When capacitors are connected in series or parallel, an imbalance current may cause to a short circuit on one side and an overvoltage on the other side.

2. Mounting

- (1) Once a capacitor has been assembled in the set and power applied, Even if a capacitor is discharged, an electric potential(restriking voltage) may exist between the terminals.
- (2) Electric potential between positive and negative terminal may exist as a result of returned electromotive force, so please discharge the capacitor using a 1k Ω resistor.
- (3) Leakage current of the parts that have been stored for more than 2 years may increase. If leakage current has increased, please perform a voltage treatment using 1k Ω resistor.
- (4) Please confirm ratings before installing capacitors on the P.C. board.
- (5) Please confirm polarity before installing capacitors on the P.C. board.
- (6) Do not drop capacitors on the floor, nor use a capacitor that was dropped.
- (7) Do not damage the capacitor while installing.
- (8) Please confirm that the lead spacing of the capacitor matches the hole spacing of the P.C. board prior to installation.
- (9) Snap-in can type capacitor such as JIS style symbol 692, 693, 694 and 695 type should be installed tightly to the P.C. board (allow no gap between the P.C. board and bottom of the capacitor).
- (10) Please pay attention that the clinch force is not applied on the main body of the capacitor when capacitors are placed and fixed by an automatic insertion machine.
- (11) Please pay attention to that the mechanical shock to the capacitor by suction nozzle of the automatic insertion machine or automatic mounter, or by product checker, or by centering mechanism.
- (12) Hand soldering.
 - ① Soldering condition shall be confirmed to be within the specification.
 - ② If it is necessary that the leads must be formed due to a mismatch of the lead space to hole space on the board, bend the lead prior to soldering without applying too much stress to the capacitor.
 - ③ If you need to remove parts which were soldered, please melt the solder enough so that stress is not applied to lead.
 - ④ Please pay attention so that solder iron does not touch any portion of capacitor body.
- (13) Flow soldering (Wave solder)
 - ① Aluminum capacitor body must not be submerged into the solder bath. Aluminum capacitors must be mounted on the "top side" of the P.C. board and only allow the bottom side of the P.C. board to come in contact with the solder.
 - ② Soldering condition must be confirmed to be within Nichicon specification.
Solder temperature: 260 $\pm$ 5 $^{\circ}$ C Immersing lead time:10 $\pm$ 1 second, Thickness of P.C. board : 1.6mm.
 - ③ Please avoid having flux adhere to any portion except the terminal.
 - ④ Please avoid contact between other components and the aluminum capacitor.

(14) Reflow soldering (SMD only)

- ① Soldering condition must be confirmed to be within Nichicon specification.
- ② When an infrared heater is used, please pay attention to the extent of heating since the absorption rate of infrared, will vary due to difference in the color of the capacitor body, material of the sleeve and capacitor size.

(15) Soldeing flux

There are non-halogen types of flux that do not contain ionic halides, but contain many non-ionic halides. When these non-ionic halides infiltrate the capacitor, they cause a chemical reaction that is just as harmful as the use of cleaning agents. Use soldering flux that dose not contain non-ionic halides.

(16) Shrinkage, bulging and/or cracking could be seen on the outer sleeve of the capacitor when capacitors are kept in for more than 2 minutes at 150°C ambient temperature during soldering at reflow process or resin curing process. Applying high temperature gas or heat ray to capacitor can cause the same phenomenon.

(17) Do not tilt lay down or twist the capacitor body after the capacitor are soldered to the P.C. board.

(18) Do not carry the P.C. board by grasping the soldered capacitor.

(19) Please do not allow anything to touch the capacitor after soldering. If P.C. board are stored in a stack, please make sure P.C. board or the other components do not touch the capacitor.

The capacitors shall not be effected by any radiated heat from the soldered P.C. board or other components after soldering.

(20) Recommended Cleaning Condition

Applicable : Any type, any ratings.

Cleaning Agents

Based Alcohol solvent cleaning agent

Isopropyl Alcohol

Based water solvent cleaning agent

- Higher alcohol solvent type

Pine Alpha ST-100S

NEWPOLE B-12

- Surfactant type

Clean Through 750HS, 750HN,
750K, 750J

Cleaning Conditions :

Total cleaning time shall be no greater than 5 minutes by immersion, ultrasonic or other method.

(Temperature of the cleaning agent shall be 60°C maximum.)

After the board cleaning has been completed, the capacitors should be dried using hot air for a minimum of 10 minutes.

If the cleaning solution is infiltrated between the case and the sleeve, the sleeve might soften and swell when hot air temperature is too high. Therefore, hot air temperature should not exceed softening temperature(80°C) of the sleeve.

Insufficient dries after water rinse may cause appearance problems, such as sleeve shrinking, bottom-plate bulging.

In addition, a monitoring of the contamination of cleaning agents (electric conductivity, pH, specific gravity, water content, etc.) must be implemented.

After the cleaning, do not keep the capacitors in an atmosphere containing the cleaning agent or in an air tight container.

In addition regarding jet washing, please use caution since the sleeve may expand cause of the angle and / or the strength of the water jet. Depending on the cleaning method, the marking on a capacitor may be erased or blurred.

Consult Nichicon before using a cleaning method or a cleaning agent other than those recommended.

(21) Fixing Material and Coating Material

- 1) Do not use any fixing or coating materials, which contain halide substance.
- 2) Remove flux and any contamination, which remains in the gap between the end seal and PC board.
- 3) Please dry the cleaning agent on the PC board before using fixing or coating materials.
- 4) Please do not apply any material all around the end seal when using fixing or coating materials.

There are variations of cleaning agents, fixing and coating materials, so please contact those manufacture or our sales office to make sure that the material would not cause any problems.

(22) Others

When halogen contained in a fumigation agent enters the capacitors, it may chemically react with the electrolytic solution, electrode foil, etc. inside. (Some gases mainly permeate the sealing parts of the capacitors and they enter the capacitors.)

When this chemical reaction progresses further, the capacitors may cause a leakage current failure, opening failure, pressure valve operation, etc. due to the corrosion of the aluminum materials inside.

The capacitors may be fumigated by halogen compounds, such as methyl bromide, when they are exported or being used to protect them against pests.

When fumigating capacitors and devices embedded with capacitors and when using packing materials, such as a pallet, that have been fumigated, be very careful so that the capacitors are not exposed to the halogen atmosphere.

3. In the equipment

- (1) Do not directly touch terminal by hand.
- (2) Do not short between terminals with conductor, nor spill conductible liquid such as alkaline or acidic solution on or near the capacitor.
- (3) Please make sure that the ambient conditions where the set is installed not have any of the following conditions:
 - ① Being exposed to water, high temperature & high humidity atmosphere, or condensation of moisture.
 - ② Being exposed to oil or an atmosphere that is filled with particles of oil.
 - ③ Being exposed to salty water or an atmosphere that is filled with particles of salt.
 - ④ In an atmosphere filled with toxic gasses (such as hydrogen sulfide, sulfurous acid, nitrous acid, chlorine, bromine, methyl bromide, ammonia, etc.).
 - ⑤ Being exposed to acidic or alkaline solutions.
 - ⑥ Since shrinkage, bulging and/or crack could be seen on outer sleeve of capacitor when capacitors are used in atmosphere where condensation of moisture occurs, please confirm their adaptation before the use.
The condensation of moisture could occur when temperature cycling test /Rapid change of temperature test is performed, in this case, aforementioned sleeve problem could be seen.

4. Maintenance Inspection

- (1) Please periodically inspect the aluminum capacitors that are installed in industrial equipment. The following items should be checked:
 - ① Appearance : Remarkable abnormality such as vent operation, leaking electrolyte etc.
 - ② Electrical characteristic: Capacitance, dielectric loss tangent, leakage current, and items specified in the specification.

5. In an Emergency

- (1) If you see smoke due to operation of safety vent, turn off the main switch or pull out the plug from the outlet.
- (2) Do not bring your face near the capacitor when the pressure relief vent operates. The gasses emitted from that are over 100°C.
If the gas gets into your eyes, please flush your eyes immediately in pure water.
If you breathe the gas, immediately wash out your mouth and throat with water.
Do not ingest electrolyte. If your skin is exposed to electrolyte, please wash it away using soap and water.

6. Storage

- (1) It is recommended to keep capacitors between the ambient temperatures of 5°C to 35°C and a relative humidity of 75% or below.
- (2) Please make sure the ambient storage conditions will be free from the conditions that are listed in clause 1. "Circuit Design" at (9).

In order to maintain the satisfactory soldering condition for conductive polymer aluminum solid electrolytic capacitors, the following items must be strictly adhered to.

- 1) Parts should be stored sealed in a bag until they are actually used.
- 2) Once the sealed bag is cut open, all the parts should be used at one time. If not, then the remaining parts should be placed in a bag and sealed with tape.
- 3) The storage period of products that can maintain good solderability should be within one year (in unopened package).

7. Disposal

- (1) Take either of the following methods in disposing of capacitors.
 - ① Make a hole in the capacitor body or crush capacitors and incinerate them.
 - ② If incineration is not applicable, hand them over to a waste disposal agent and have them buried in a landfill.
- (2) When removing a capacitor from the circuit board or when disposing of capacitor please ensure that the capacitor is properly discharged.

8. AEC-Q200 Qualified

The Automotive Electronics Council (AEC) is an organization created by U.S. automakers and electronic component manufacturers for the standardization of reliability and certification criteria for automotive electronic components. AEC-Q200 is a certification reliability test standard for passive components widely adopted as the standard for electronic components for automotive use in Europe and the United States.

Nichicon provides products that conform to AEC-Q200 requirements. Please contact us for details.

The above mentioned material according to JEITA RCR - 2367D (issued in March, 2019), titled "Safety Application Guide for fixed aluminium electrolytic capacitors for use in electronic equipment".
Please refer to the book for details.