PRECAUTIONS AND GUIDELINES OF ALUMINUM ELECTROLYTIC CAPACITOR (NON-CONDUCTIVE POLYMER)

A. Designing Device Circuits
1. Selecting

Select the capacitors to suit installation of circuit and operating conditions, and use the capacitors to meet the performance limits prescribed in this catalog or the product specifications.

2. Electrical Characteristic

a. Aluminum Electrolytic Capacitors are polarized. Please do not apply either reverse voltage or AC voltage to polarized capacitors. Using reversed polarity causes a short circuit or venting. Before use, please refer to this catalog, product specifications or capacitor body to identify the polarity marking. Use a bi-polar for a type of non-conductive polymer aluminum electrolytic capacitor for a circuit where the polarity is occasionally reversed. However, note that even a bi-polar aluminum electrolytic capacitor must not be used for AC voltage applications.

b. Do not apply a DC voltage which exceeds the specified rated voltage.

DC voltage + peak voltage of a superimposed ripple voltage ≤ specified rated voltage. A surge voltage value, is prescribed in this catalog, but it is a restricted for especially short periods of time.

c. Do not apply over-current which exceeds the specified rated ripple current. An exceed ripple current can increases the rate of heating within the capacitor, which may occur failure mode as shorten lifetime, open vent, short circuit etc. The rated ripple current has been specified at a certain frequency. The rated ripple current at several frequencies must be calculated by multiplying the rated ripple current at the original frequency using the frequency multipliers for each product series

d. For general purpose used capacitor, do not use capacitors in circuits where heavy charge and discharge cycles are frequently repeated. Frequent and sharp heavy discharging cycles will result in decreasing capacitance and damage to the capacitors due to generated heat. Specified capacitors can be designed to meet the requirements of charging-discharging cycles, frequency, operating temperature, etc. Please contact us if you need to install our product in this frequently repeated charge and discharge circuit.

3. Ambient Temperature

Do not apply over temperature which exceeds the maximum operating temperature. Applied under an ambient temperature which exceeds the maximum operating temperature, can considerably shorten the life or cause the capacitor to vent.

4. The life of Capacitor

Select the capacitors to meet the service life of a device. Please be reminded that, the result using the life calculating formula is not guaranteed. During your design stage, please select capacitor which is higher than your actual required life value. Apart from this, if your life calculation is exceeds 15 years, please consider 15 years as the maximum life level.

5. Failure mode of capacitors

Non-solid aluminum electrolytic capacitors, in general, have a lifetime which ends in an open circuit, but depending on conditions of usage or products type, failure mode of capacitors will be venting.

6. Insulating between positive and negative polar

Electrically isolate the following parts of a capacitor from the negative terminal, the positive terminal and the outer casing. The dummy terminal of a non-conductive polymer aluminum capacitor, which is designed for mounting stability, so is isolated with positive and negative terminal too.

7. The sleeve cover

The outer sleeve of a non conductive polymer capacitor is not assured as an insulator (Except for screw type), so please don’t use it as an insulator. Please contact our sales representative if you need any more details in this area.

8. Condition of application

Do not use / expose capacitors to the following conditions.
Usage Conditions

- Spay directly by water, salty water, Oil, or storage in damp location.
- Direct sunlight.
- Storage in location with toxic gases, such as hydrogen sulfide, sulfurous acid, nitrous acid, chlorine or its compounds, and ammonium.
- Ozone, ultraviolet rays or radiation condition.
- Severe vibration or mechanical shock conditions beyond the limits prescribed in the catalogs or the product specification.

9. Mounting

a. Non conductive polymer capacitor
   The paper separators and the electrolytic-conductive electrolytes in a non conductive polymer aluminum electrolytic capacitor are flammable. Leaking electrolyte on a printed circuit board can gradually erode the circuit on PCB board, possibly causing smoke or burning.
   Verify the following points when designing a PCB board.
   • Provide the appropriate holes spacing on the PCB board to match with the terminal pitch of the capacitor.
   • Make the following open space over the vent so that the vent can operate correctly.

   \[
   \begin{align*}
   \leq \phi 16\text{mm} & : 2\text{mm and above} \\
   \phi 18 ~ \phi 35\text{mm} & : 3\text{mm and above} \\
   \geq \phi 40\text{mm} & : 5\text{mm and above}
   \end{align*}
   \]
   • Do not place any wires or circuit traces over the vent of the capacitor.
   • If install a capacitor with the vent touching the PCB board, needs an appropriate ventilation hole in PCB board for vent open.
   • Do not pass any circuit traces under the seal side of a capacitor. The trace must pass 1 or 2mm to the side of the capacitor.
   • Avoid placing any heat-generating object adjacent to a capacitor or even on the reverse side of the PCB board.
   • Do not pass any via holes underneath a capacitor on double sided PCB board.
   • In designing double sided PCB board do not locate any copper trace under the seal side of a capacitor.

b. Screw type capacitor
   Do not tighten the screw of the terminals and mounting clamps over the specified torque prescribed in the catalog or the production specification. Do not mount the terminal side of a screw mount capacitor downwards.

c. Chip type capacitor
   For a surface mount capacitor design the solder point, please follow the dimension prescribed in the catalogs or the product specification.

10. Others in safety application
   Using capacitor for applications which always consider safety. Consult with our company sales representative before use in applications which can affect human life. (Space equipment, aerial equipment, nuclear equipment, medical equipment, vehicle control equipment, etc.)

11. Others
   a. The electrical characteristic of capacitors very in respect to temperature and frequency, design the device circuit by taking these changes into consideration.
   b. Capacitors mounted in parallel need the current to flow equally through the individual capacitors.
   c. Capacitors mounted in series require resistors in parallel with the individual capacitors to balance the voltage, or can install parallel protect resistor with it.
B. Notice of Installing Capacitors

1. Installing
   a. Used capacitors are not reusable, except in the case that the capacitor are detached from a device for periodic inspection to measure their electrical characteristics.
   b. If the capacitors have self charged, discharge in the capacitors through a resistor of approximately 1kΩ before use.
   c. If the capacitors are stored at a temperature of 35˚C or more and more than 75%RH, over the storage limit prescribed in the catalogs or the product specification, the leakage current may increase. In this case, they can be reformed by applying the rated voltage through a resistor of approximately 1kΩ.
   d. Verify the specification of the capacitor before installing (rated capacitance and voltage)
   e. Verify the polarity of the capacitors.
   f. Do not use the capacitors if they have been dropped on the floor.
   g. Do not deform the cases of capacitors.
   h. Verify that the lead pitch of the capacitor fits the holes spacing in the PC board before installing the capacitors. Some standard pre-formed leads are available for this fitting.
   i. For radial or snap in terminals, insert the terminals into PC board and press the capacitor downward until the bottom of the capacitor body reaches PC board surface.
   j. Do not apply any mechanical force in excess of the limits prescribed in the catalogs or the product specifications of the capacitors. Please notice that, the capacitors may be damaged by mechanical shocks caused by the vacuum / insertion head, component checker or centering operation of an automatic mounting or insertion machine.

2. Soldering heat and Solderbility
   a. When soldering with a soldering iron
      • Soldering conditions ( temperature and time ) should be within the limits prescribed in the catalogs or the product specifications.
      • If the terminal pitch of a capacitor does not fit the terminal hole spacing of the PC board, can reform the terminals in a manner to minimize a mechanical stress into the body of the capacitor.
      • Do not touch the capacitor body with the hot tip of the soldering iron.
   b. Flow soldering
      • Do not dips the body of a capacitor into the solder bath only dip the terminals in. The soldering must be done on the reverse side of PC board.
      • Soldering conditions ( preheat, solder temperature and dipping time ) should be within the limits prescribed in the catalogs or the product specifications.
      • Do not apply flux to any part of capacitors other than their terminals.
      • Make sure the capacitors do not come into contact with any other components while soldering.
   c. Reflow soldering
      • Soldering conditions ( preheat, solder temperature and soldering time ) should be within the limits prescribed in the catalogs or the product specifications.
      • When setting the temperature infrared heaters, consider that the infrared absorption causes material to be discolored and change in appearance.
      • The limit of reflow time is prescribed in the catalogs or the product specifications.
      • Make sure capacitors do not come into contact with copper traces.
      • Vapor phase soldering (VPS) is not used.
   d. Do not re-use surface mount capacitors which have already been soldered.
   e. Reflow soldering only for chip type capacitor, others types are not allowed.

3. Handling after soldering
   Do not apply any mechanical stress to the capacitor after soldering onto the PC board.
a. Do not lean or twist the body of the capacitor after soldering the capacitors onto the PC board.
b. Do not use the capacitor for lifting or carrying the assembly board.
c. Do not hit or poke the capacitor after soldering to PC board. When stacking the assembly board, be
careful that other components do not touch the aluminum electrolytic capacitors.
d. Do not drop the assembly PC board.

4. Cleaning PC boards
a. Do not wash capacitors by using the following cleaning agents.
   • Halogenated solvents; cause capacitors to fail due to corrosion.
   • Alkali system solvents; corrode (dissolve) an aluminum case.
   • Petroleum and terpene system solvents; cause the rubber seal material to deteriorate.
   • Xylene; causes the rubber seal material to deteriorate.
   • Acetone; erases the marking.
   • Ultrasound cleaning will accelerate damaging capacitors.
b. Wash capacitors by using the following agents if need.
   • Ethyl alcohol
   • Buthyl alcohol
   • Methyl alcohol
   • Propyl alcohol
   • Be sure not to expose the capacitor under solvent rich conditions or keep capacitor with an air dryer
     (temperature should be less than the maximum rate category temperature of the capacitor) over 10
     minutes, and be sure the PC board is dried.

5. Fumigation treatment
In many cases when exporting or importing electronic devices, wooden pallet packaging is used.
Fumigation treatment is using halogenated chemical, if capacitor body touch with the chemicals, such
status is same as cleaning PC board, halogen ion can cause capacitors to fail due to corrosion.
Our company is all using non-fumigation packaging to do exporting or importing.
Customer if need do any exporting or importing electronic devices, semi-product and aluminum electrolytic
 capacitor, please notice whether with or without fumigation treatment.
Final outer packaging, even using chipboard pallet with plastic bag cover, inner product still have a
possible be polluted by halogen gas. Please notice.

C. The Operation notice of Devices
1. Do not touch terminals of capacitor directly with bare hands.
2. Do not short-circuit the terminal of a capacitor by letting it come into contact with any conductive object.
   Also, do not spill electri-conductive liquid such as acid or alkaline solution over the capacitor.
3. Do not use capacitor in circumstance where they would be subject to exposure to the following materials
   exist or expose.
   a. Spray directly by water, salty water, Oil, or storage in damp location.
   b. Direct sunlight.
   c. Storage in location with toxic gases, such as hydrogen sulfide, sulfurous acid, nitrous acid, chlorine or
      its compounds, and ammonium.
   d. Ozone, ultraviolet rays or radiation condition.
   e. Severe vibration or mechanical shock conditions beyond the limits prescribed in the catalogs or the
      product specification.

D. Maintenance Inspection Notice
1. Make periodic inspections of capacitors that have been used in industrial applications. Before inspection,
turn off the power supply and carefully discharge the electricity in the capacitors. When measuring the
capacitors with a meter, do not apply any mechanical stress to the terminals of the capacitors.
2. The following item should be checked during the periodic inspections.
   • Visual appearance : venting and electrolyte leakage.
   • Electrical characteristics : leakage current(LC), capacitance(CAP), DF and other characteristics prescribed in our catalogs or product specifications.
   We recommend replacing the capacitors if the parts are out of the specification.

E. In Case of Emergency
   a. For reducing the effect of inner gas pressure exploded, a higher capacitor is with vent mark on top. When venting, it will discharge odors or smoke, please immediately turn off or unplug the main power supply of the device. If we do not switch off the power, PC board may be damaged by the capacitor short-circuit failure, the worst is burn out the device. The gas which comes out from the pressure vent of a capacitor, it is not smoke by flammable, this is the vaporized electrolyte.
   b. When venting, inner capacitor blows out gas with a temperature of over 100°C, never expose the face close to a venting capacitor. If yours eyes should inadvertently become exposed to the spouting gas or you inhale it, immediately flush the open eyes with large amounts of water and gargle with water respectively. If electrolyte is on the skin, wash the electrolyte away from the skin with soap and plenty of water.

F. Storage
   We recommend the following condition for storage.
   1. Store the capacitor indoors at a temperature of 5 ~35°C and a relative humidity ≤75%.
      The storage period is 1 years after production, and 2 years for Chip Type.
   2. Please keep capacitor in the original package.
   3. Please do not keep the capacitors in places,
      a. Spray directly by water, high temperature high humidity, or storage in damp location.
      b. Spray directly by oil, or with oily gas location.
      c. Spray directly by salt water, or salty location.
      d. Storage in location with toxic gases, such as hydrogen sulfide, sulfurous acid, nitrous acid, chlorine or its compounds, and ammonium.
      e. Full with ammonium gas, alkaline toxic gas location.
      f. With acidic and alkaline solvent location.
      g. Directly sunlight, ozone, ultraviolet rays or radiation condition.
      h. Severe vibration or mechanical shock conditions beyond the limits prescribed in the catalogs or the product specification.

G. Disposal
   Please consult with a local industrial waste disposal specialist when disposing of aluminum. Electrolytic capacitors. If burning, please burn it with high temperature (more than 800°C). Low temperature burning, can generate halogen gas which can affect human healthy. Besides that, in order to reduce exploding, please make a hole at the vent or damage it before burning.

H. Catalogs
   The ESR value in the catalogs, measure area is the closet area to the capacitor body.
   Specifications in catalogs may be subject to change without notice. Catalog data are typical.
   This value does not guarantee the performance.
THE PROPER USAGE METHOD OF CONDUCTIVE POLYMER SOLID ALUMINUM ELECTROLYTIC CAPACITOR

I . Lifetime Estimation
Subject series : FR/FH/FG/FF/FS/FT/FP/VB/VP/VS

Conductive polymer aluminum solid capacitors are finite life electronic components like aluminum electrolytic capacitors. The lifetime is affected by ambient temperature, humidity, ripple current and surge voltage. The lifetime of aluminum electrolytic capacitors is affected mainly by the loss of electrolyte as the result of the liquid electrolyte evaporating through the rubber seal materials, resulting in capacitance drop and tanδ rise. On the other hand, the lifetime of conductive polymer aluminum solid capacitors is affected mainly by oxidation degradation of the conductive polymer caused by osmose of oxygen or the thermal degradation of the conductive polymer by ambient temperature or self-heating, resulting in ESR rise and tanδ rise. The infiltration rate of the oxygen is depend on the temperature as the liquid electrolyte evaporation and the relationship follows the Arrhenius’s Law, too. Similarly, thermal degradation of the conductive polymer by self-heating follows the Arrhenius’s Law, too. Therefore, the lifetime estimation has been using the theory of lifetime increasing by 10 times at every 20°C reducing of the ambient temperature.

1. Lifetime Estimation

Equation (1) can be used for estimating the lifetime of the conductive polymer aluminum solid capacitors based on the ambient temperature and the rise of internal temperature due to ripple current.

\[ L_x = L_0 \times 10^{\left(\frac{T_0 - T_x}{20}\right)} \]  

\( L_x \) : Estimation of actual lifetime (hour)
\( L_0 \) : Specified lifetime with the rated voltage at the upper limit of the category temperature (hour)
\( T_0 \) : Maximum category temperature (°C)
\( T_x \) : Actual ambient temperature of the capacitor (°C)

Longer lifetime is expected by lowering the ripple current and the ambient temperature. Please consult us about lifetime equations for the series of the category temperature 125°C.
Subject series : FT

An approximate value of ripple current-caused ΔT can be calculated using Equation (2)

\[ \Delta T = \Delta T_0 \times (I_x/I_o)^2 \]  

\( \Delta T_0 \) : Rise in internal temperature due to the rated ripple current (20°C) The product that the maximum category temperature is less than 105°C
\( I_x \) : Operating ripple current (Arms) actually flowing in the capacitor.
\( I_o \) : Rated ripple current (Arms), frequency compensated, at the upper limit of the category temperature range.

Please contact us about the product that the maximum category temperature is more than 125°C.

To determine more accurate values of ΔT, they can be actually measured using a thermocouple.

2. Rated Ripple Current Frequency Multipliers

Self-heat rise is generated by the ripple current even though the conductive polymer aluminum solid capacitors have low ESR compared to liquid based electrolyte aluminum electrolytic capacitor. Longer lifetime is expected by lowering the ripple current and the ambient temperature.

Table 1 shows Frequency Multipliers of Rated ripple current.

<table>
<thead>
<tr>
<th>Frequency [Hz]</th>
<th>120</th>
<th>1k</th>
<th>10k</th>
<th>50k</th>
<th>100k~500k</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMD type</td>
<td>0.05</td>
<td>0.3</td>
<td>0.55</td>
<td>0.7</td>
<td>1</td>
</tr>
<tr>
<td>Radial lead type</td>
<td>0.1</td>
<td>0.35</td>
<td>0.6</td>
<td>0.8</td>
<td>1</td>
</tr>
</tbody>
</table>

Conductive polymer aluminum solid capacitors have super low ESR characteristic in high-frequency range. On the whole, ESR in low-frequency range relatively rises. Therefore, they can use only 1 ripple current in low-frequency range.
3. Restriction of calculated lifetime
   (1) The result calculated by the estimated lifetime formula, it is not guaranteed lifetime by Nippon Chemi-Con Corporation.
   (2) When designer calculate the lifetime of apparatus, please include an ample margin in consideration to the estimated lifetime of a capacitor.
   (3) When calculated lifetime result are over 15 years by using the estimated lifetime formula, please consider 15 years to be a maximum in considering that the sealing rubber characteristics vary during the lifetime.
   (4) If 15 years or more may be required as an expected lifetime, please consult us.

II. About failure and shelf-life
   Failure rate(failure rate level) subject to 0.5%/1000 h of JIS C 5003 (Credibility level 60%)
   The main failure mode of polymer solid aluminum electrolytic capacitor of is shown below.

1. Random failure
   The main cause of failure mold is short-circuit due to heat stress, electrical stressing and mechanical stress in using environment or welding.
   (1) applied voltage more than rated voltage.
   (2) applied reverse voltage.
   (3) Excessive mechanical stress.
   (4) Applying fast charging and discharging that more than specifications and cause surge current.
   a. If the short circuit current flows through the solid capacitor will cause the following phenomenon.
      (1) When the electric current is less after short-circuit (φ10 : about below1 A, φ8 : about below 0.5 A, φ6.3 : about below 0.2 A) PC-CON body will have little heat but appearance is normal even continuous electricity.
      (2) When the short circuit current value exceeds the above numerical, internal temperature will increased, encapsulation adhesive pad summoned and the odorous gases to overflow.
   b. In order to ensure the safety in case of occurs short circuit, please take the following countermeasures.
      (1) Cut off the main power supply and stop using immediately if overflow the odorous gases.
      (2) Due to the different conditions, the odorous gases occurrence generally takes a few seconds to several minutes, When using protection circuits we recommend to start protect function in this period.
      (3) Cleaned immediately if the gas enters into eye, gargle immediately if inhalation into mouth.
      (4) Don’t lick the electrolyte if electrolyte contact with the skin please washing with soap immediately.
      (5) PC - CON including combustible material, current value greatly after the short circuit and short circuit parts will have a possibility of spark. In order to protect safety, please pay attention to the design structure and use protection circuit.

2. The wear failure (Shelf life)
   Electrical characteristics can make a big change when more than the guarantee time of durability and high temperature and high humidity test, electrolyte will insulation (degradation) formation of open mode eventually.
   Even used within the prescribed scope of electrical and mechanical properties, it may also reducing capacitance and increase ESR, so please take care when design.

III. Leak Current
   The leak current of conductive polymer solid aluminum electrolytic capacitor will increase due to the mechanical stress.
   In this case, if the solid capacitor apply voltage below the high using temperature, the repairing effect of leak current will reducing gradually.
If the solid capacitor applies rated voltage within the high using temperature, the repairing speed of leak current will faster.

Conductive polymer solid aluminum electrolytic capacitor
Reparing character of leak current
10μF/16 V.DC (apply 16 V.DC)

Conductive polymer solid aluminum electrolytic capacitor
Repiring character of leak current
33μF/10 V.DC (ambient temperature 65°C)
(Test voltage 10V.DC)

※ In order to show more clearly said repair of leakage current, we use the sample of apply stress to PC-CON that increased leak current on purp.

IV. The limited of faster charging and discharging
Faster charging and discharging will lead to large surge current and then result in short-circuit or increase leak current.
When the surge current value as below, we recommend to use protection circuit in order to maintain high reliability.
(1) more than 10 A.
(2) exceed rated ripple current 10times.

V. Correct mounting
1. About the soldering iron soldering
   (a) Avoiding applying stress on PC - CON body when it need to process lead due to unconformity between lead gap and circuit board gap of plug-in mounting.
   (b) Avoiding applying excessive stress on PC - CON body when soldering.
   (c) When need to take out PC-CON after soldering, please melt molten solder sufficient, implement under the condition of not put stress on the PC - CON body.
   (d) Don’t let the tip of the soldering iron to touch the PC - CON body.

2. Wave-soldering
   (a) Do not have wave soldering to SMD product.
   (b) Do not dip the PC-CON body into dissolved soldering flux.
   (c) Welding parts only limited between the circuit board and the opposite side of the PC - CON.
   (d) Don’t splash other place expectation rosin.
   (e) Avoiding other parts lie down and touching PC-CON when soldering.

3. Reflow soldering
   (a) Do not have reflow soldeering to plug-in mounting product.
   (b) Please consult us when use VPS for soldering.

4. Precaution after soldering
   Take care for not to apply the following excessive stress for polymer solid aluminum electrolytic capacitor.
   (a) Do not tilt down or distorted capacitor.
   (b) Mobile circuit board can not handle PC - CON.
   (c) Do not crash PC-CON.
   (d) Do not make the PC - CON touch PCB circuit boards and other components when stacked.
5. Recommended conditions for solder

Reflow soldering under the condition of the following reflow soldering up to 2 times

6. Solder iron temperature: less than 400°C±10°C; working hours: within 5s

Wave-soldering

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Time</th>
<th>Number of Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preheat 120°C below(ambient</td>
<td>less than120s</td>
<td>once</td>
</tr>
<tr>
<td>Temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Welding Condition</td>
<td>260°C+5°C below</td>
<td>less than 10+1s</td>
</tr>
</tbody>
</table>

*1: For 2 times, solder dipping time total of 10 + 1 seconds.

7. Recommend the bonding pad size

<table>
<thead>
<tr>
<th>Size Code</th>
<th>a</th>
<th>b</th>
<th>c</th>
</tr>
</thead>
<tbody>
<tr>
<td>φ5.0</td>
<td>1.4</td>
<td>7.4</td>
<td>1.6</td>
</tr>
<tr>
<td>φ6.3</td>
<td>2.1</td>
<td>9.1</td>
<td>1.6</td>
</tr>
<tr>
<td>φ8.0</td>
<td>2.8</td>
<td>11.1</td>
<td>1.9</td>
</tr>
<tr>
<td>φ10.0</td>
<td>4.3</td>
<td>13.1</td>
<td>1.9</td>
</tr>
</tbody>
</table>

Unit: mm
PRECAUTIONS FOR CONDUCTIVE POLYMER SOLID ALUMINUM ELECTROLYTIC CAPACITOR

1. Device circuits design considerations

1. **Prohibited to use circuit**
   Conductive Polymer Solid Aluminum Electrolytic Capacitor (The following is called capacitor) may cause the leak current occur changing due to the heat stress in welding. Please avoid to use in the below circuit.
   ① High resistance voltage holding circuit.
   ② Coupled circuits.
   ③ The other circuits that affected leakage current larger

2. **Circuit design**
   Please design circuit on the basis of confirming the following content.
   ① As the change of temperature and frequency, electric property of capacitor will changes. Please design circuit after confirming those changes.
   ② When more than 2 capacitors in parallel, please consider the balance of current when design circuit.
   ③ When more than 2 capacitors in series, as the difference of load voltage, it may load overvoltage, so please consulting us when using.
   ④ Please don’t install heating components around the capacitor and the back of the printed wiring board.

3. **Using capacitors for significantly safety-oriented applications**
   Consult us about capacitors for a device application affecting human safety (① Aviation and aerospace ② Nuclear ③ Medical) or for any device whose failure will make an impact on society.

4. **Polarity**
   Our company conductive polymer capacitor is the solid aluminum electrolytic capacitor with polarity. Never apply a reverse voltage or AC voltage.
   Connecting with wrong polarity will short-circuit in initial State. About polarity, please confirm product catalogue or the diagram in the product specifications.

5. **Operating voltage**
   Do not apply an over-voltage that exceeds rated voltage, Because even if to load the voltage that more than the rated voltage only for an instant, it can also lead to increased leakage current and short-circuit. The total peak value of the ripple voltage plus the DC voltage must not exceed the rated voltage of the capacitors. In the work, it doesn’t need to reduce the voltage. Although capacitors specify a surge voltage, in the temperature range, under the rated voltage, whatever is the environment temperature; it also has limited and does not assure long-term use.

6. **Ripple current**
   Do not apply an overcurrent that exceeds the rated ripple current specified for the capacitors. Excessive ripple current will increase heat production within the capacitors, shortening the life and short-circuit.

7. **Operating temperature**
   If use beyond working temperature range of environment, can lead to aging and failure performance, please use in working temperature range.

8. **Charging and discharging**
   Don not use capacitor in the circuit of rapid charge and discharge repeatedly. If capacitors are used in the circuits that repeat a charge and discharge, capacitance will decrease and/or the capacitors will be damaged by internal heat generation. When the peak of current value more that 20A, we recommend to use protect circuit in order to keep the reliability.

9. **Leakage current**
   Sometime the leakage current will increase, but if load voltage in working temperature, it will decrease gradually though self-healing effect. In addition, the more closely to the limit temperature, the faster of the reduce speed of leakage current. The reasons for leakage current increase as below :
   ① Welding
   ② High temperature without load, high temperature and high humidity, rapid temperature change test and so on.
10. Failure mode

① Reduce the failure rate by reducing the surrounding temperature, ripple current, and load voltage.

② Electrostatic capacity decreases caused by product temperature rise and opening mode wear caused by ESR rise which are the main failure mode.

Sometimes it will occur short-circuit mode due to the overvoltage and large current.

③ Lead to short-circuit due to load the voltage that more than rated voltage, when the current is larger, the shell will expansion or peeling off, give out bad smell due to the internal pressure rising.

④ The constitute material of products containing flammable materials, the short-circuit parts will fire may due to the spark. The install ways, location, graphic design of the product, please consider the following importance points of design to ensure the absolute safety.

* Setting up protection circuit and protection devices to ensure that equipment safety.
* Setting up long circuit etc., so that the devices will stabilization even of a single fault.

11. The insulation of the capacitor

The outer sleeve of a capacitor does not assure electrical insulation Please have electrical insulation between the capacitor sleeve and cathode terminal and anode terminal and circuit board.

12. Operating conditions

Do not use/expose capacitors to the following conditions:

① Direct contact with water, salt water or oil, or high condensation environment.

② Direct sunlight.

③ Toxic gases such as hydrogen sulfide, sulfurous acid, nitrous acid, chlorine and its compounds, bromine and its compounds and ammonium.

④ Ozone, ultraviolet rays or radiation.

⑤ Extreme vibration or mechanical shock that exceeds limits in the catalogs or product specifications.

13. Capacitor Mounting

① SMD product (mould SMD, SMD) solder graphics of the Capacitor printed wiring board, Please refer to the provisions of the catalogue or specifications for graphic design.

② For radial lead type capacitors, please make sure the terminal spacing of a capacitor equals the holes spacing on the PC board.

③ Do not print any copper trace under the seal (terminal) side of a capacitor. Copper traces should be 1 mm (preferably 2mm or more) spaced apart from the side of the capacitor body.

④ In designing a double-sided PC board, do not locate any through-hole via or unnecessary hole underneath a capacitor.

⑤ In designing a double-sided PC board, do not print any circuit pattern underneath a capacitor.

II. Installation

1. Assembling

① Do not try to reuse the capacitors once assembled and electrified.

② Capacitors may have been spontaneously recharged with time by a recovery voltage phenomenon. In this case, discharge the capacitors through a resistor of approximately 1kΩ, before use.

③ If non-solid aluminum electrolytic capacitors have been stored at any conditions more than 35°C and 75%RH for long storage periods of time more than the limits specified in the catalogs or product specifications, they may have high leakage current. In this case, discharge by apply-ing the rated voltage through a resistor of approximately 1kΩ.

④ Confirm the rated capacitance and voltage of capacitors before installation.

⑤ Confirm the polarity of capacitors before installation.

⑥ Do not try to use the capacitors that were dropped to the floor and so forth.

⑦ Do not deform the can case of a capacitor.

⑧ Make sure that the terminal spacing of a capacitor equals the holes spacing on the PC board before installing the capacitor.

⑨ Do not apply excessive mechanical force to capacitors more than the limits prescribed in the catalogs or product
Usage conditions specifications. If apply excessive force, the terminal will break off or deformation and affect install, even cause short-circuit, break line, increase LC and damage package. Avoid excessive mechanical force while the capacitors are in the process of vacuum-picking, placing and positioning by automatic mounting machines or cutting the lead wires by automatic insertion machines.

2. Soldering and heat resistance

Ensure that the soldering conditions meet the specifications recommended by Nippon Chemi-Con. Note that the leakage current may increase or capacitance may decrease due to thermal stresses that occur during soldering, etc. Furthermore, the leakage current which rose gradually decreases, when voltage is applied at below the category upper limit temperature. Additionally, the self-repairing action is faster when voltage near the rated voltage rather than at a higher voltage is applied at below the category’s upper temperature limit.

1) Verify the following before using a soldering iron:
   ① That the soldering conditions (temperature and time) are within the ranges specified in the catalog or product specifications.
   ② That the tip of the soldering iron does not come into contact with the capacitor itself.

2) Verify the following when flow soldering:
   ① Do not dip the body of a capacitor into the solder bath only dip the terminals in. The soldering must be done on the reverse side of PC board.
   ② Soldering conditions should be within the limits prescribed in the catalog or the product specifications.
   ③ Do not apply flux to any part of capacitors other than their terminals.
   ④ Make sure the capacitors do not come into contact with any other components while soldering. Please note the SMD product (SMD type) non-corresponding wave-soldering.

3) Verify the following when reflow soldering:
   ① Soldering conditions (preheat, solder temperature and soldering time) should be within the limits prescribed in the catalogs or the product specification.
   ② The heat level should be appropriate. (Note that the thermal stress on the capacitor varies depending on the type and position of the heater in the reflow oven and the color and material of the capacitor)
   Exception for the surface mount type, reflow soldering must not be used for the other capacitors.
   ④ Do not reuse a capacitor that has already been soldered to PC board and then removed. When using a new capacitor in the same location, remove the flux, etc. first, and then use a soldering iron to solder on the new capacitor in accordance with the specifications.

3. Handling After Soldering

Do not apply any mechanical stress to the capacitor after soldering onto the PC board.
   ① Do not lean or twist the body of the capacitor after soldering the capacitors onto the PC board.
   ② Do not use the capacitors for lifting or carrying the assemblyboard.
   ③ Do not hit or poke the capacitor after soldering to PC board. When stacking the assembly board, be careful that other components do not touch the aluminum electrolytic capacitors.
   ④ Do not drop the assembled board.

4. Cleaning PC boards

1) Do not wash capacitors by using the following cleaning agents. Solvent resistant capacitors are only suitable for washing using the cleaning conditions prescribed in the catalog or the product specification. In particular, ultrasonic cleaning will accelerate damage to capacitors.
   ① Halogenated solvents →cause capacitors to fail due to corrosion.
   ② Alkali system solvents →corrode (dissolve) an aluminum case.
   ③ Petroleum system solvents →cause the rubber seal material to deteriorate.
   ④ Xylene →causes the rubber seal material to deteriorate.
   ⑤ Acetone →erases the markings
   CFC alternatives or the other cleaners above; please consult with us.

2) Verify the following points when washing capacitors:
   ① Monitor conductivity, pH, specific gravity and the water content of cleaning agents. Contamination adversely affects
these characteristics.

2. Be sure not to expose the capacitors under solvent rich conditions or keep capacitors inside a closed container. In addition, dry the solvent sufficiently on the PCB board and the capacitor with an air knife (temperature should be less than the maximum rated category temperature of the capacitor) for 10 minutes. Aluminum electrolytic capacitors can be characteristically and catastrophically damaged by halogen ions, particularly by chlorine ions, though the degree of the damage mainly depends upon the characteristics of the electrolyte and rubber seal material. When halogen ions come into contact with the capacitor, the foil corrodes when a voltage is applied. This corrosion causes an extremely high leakage current which results in venting and an open circuit.

3. Verify the following when reflow soldering:
   ① Higher alcohol cleaning agents. Using these cleaning agents, capacitors are capable of withstanding immersion or ultrasonic cleaning for 10 minutes at a maximum liquid temperature of 60°C. Find optimum condition for washing, rinsing, and drying. Be sure not to rub the marking off the capacitor which can be caused by contact with other components or the PCB board. Note that shower cleaning adversely affects the markings on the sleeve.
   ② Non-Halogenated Solvent Cleaning. Immersion, ultrasonic or vapor cleaning for 5 minutes. However, from an environmental point of view, these types of solvent will be banned in near future. We would recommend not using them if at all possible.
   ③ Isopropyl Alcohol (IPA). IPA (Isopropyl Alcohol) is one of the most acceptable cleaning agents; it is necessary to maintain a flux content in the cleaning liquid at a maximum limit of 2 Wt. %.

5. Precautions for using adhesives and coating materials
   1. Do not use any adhesive and coating materials containing.
   2. Verify the following before using adhesive and coating material.
      ① Remove flux and dust left over between the rubber seal and the PCB board before applying adhesive or coating materials to the capacitor.
      ② Dry and remove any residual cleaning agents before applying adhesive and coating materials to the capacitors. Do not cover over the whole surface of the rubber seal with the adhesive or coating materials.
      ③ For permissible heat conditions for curing adhesives or coating materials, please consult with us.
      ④ Covering over the whole surface of the capacitor rubber seal with resin may result in a hazardous condition because the inside pressure cannot be completely released. Also, a large amount of halogen ions in resins will cause the capacitors to fail because the halogen ions penetrate into the rubber seal and the inside of the capacitor.
      ⑤ Some coating materials cannot be implemented to the capacitor.

6. Fumigation
   In many cases when exporting or importing electronic devices, such as capacitors, wooden packaging is used. In order to control insects it may become necessary to fumigate the shipment. Precautions during “Fumigation” using halogenated chemical such as Methyl Bromide must be taken. Halogen gas can penetrate packaging materials such as cardboard boxes and vinyl bags. Penetration of the halogenated gas can cause corrosion of Electrolytic capacitors. Nippon Chemi-Con gives consideration to the packaging materials not to require the Fumigation. Verify whether the assembled PCB board, products and capacitors themselves are subjected to Fumigation during their transportation or not.

III. The Operation of Devices
   1. Do not touch the capacitor terminals directly.
   2. Do not short-circuit the terminal of a capacitor by letting it come into contact with any conductive object.
      Also, do not spill electric-conductive liquid such as acid or alkaline solution over the capacitor.
   3. Please make sure the assembly of the complete circuit of capacitor installation environment.
      Do not use capacitors in circumstances where they would be subject to exposure to the following materials
      ① Oil, water, salty water or damp location.
      ② Direct sunlight.
      ③ Ozone, ultraviolet rays or radiation.
      ④ Toxic gases such as hydrogen sulfide, sulfurous acid, nitrous acid, chlorine or its compounds, and ammonium.
      ⑤ Severe vibration or mechanical shock conditions beyond the limits prescribed in the catalog or product specification.
IV. Maintenance Inspection

1. Make periodic inspections of capacitors that have been used in industrial applications.
   Before inspection, turn off the power supply and carefully discharge the electricity in the capacitors. Verify the polarity when measuring the capacitors with a voltmeter. Do not apply any mechanical stress to the terminals of the capacitors.

2. The following items should be checked during the periodic inspections.
   ① Significant damage in appearance.
   ② Electrical characteristics: leakage current, capacitance, tanδ and other characteristics prescribed in the catalog or product specification.
   We recommend replacing the capacitors if the parts are out of specification.

V. Contingencies

1) If gas has vented from the capacitor during use, there is a short circuit and burning, or the capacitor discharges an odor or smoke, turn off the main power supply to the equipment or unplug the power cord.
2) If there is a problem with the capacitor or a fire breaks out, the capacitor may produce a burning gas or reactive gas from the outer resin, etc. If this happens, keep your hands and face away from the gas. If vented gas is inhaled or comes into contact with your eyes, flush your eyes immediately with water and/or gargle. If vented gas comes into contact with the skin wash the affected area thoroughly with soap and water.

VI. Storage

We recommend the following conditions for storage.
1) Store capacitors in a cool, dry place. Store at a temperature between 5 and 35°C, with a humidity of 75% or less.
   (table-1 Maximum storage term)
   The duration, please refer to the table below.

<table>
<thead>
<tr>
<th>Type</th>
<th>Before the bag is opened</th>
<th>After the bag is opened</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMD (Resin-Molded chip type)</td>
<td>within six months after delivery</td>
<td>Within 30 days after the bag is opened</td>
</tr>
<tr>
<td>Radial lead type</td>
<td>within one year after delivery</td>
<td>Within 7 days after the bag is opened</td>
</tr>
</tbody>
</table>

① SMD products are sealed in a PE plastic bag. Use all capacitors in desposit period once the bag is opened.
② If the bag have open and need to storage, please return unused capacitors to the bag, and seal it with a zipper.
③ Be sure to follow our recommendations for reflow soldering.
2) Store the capacitors in a location free from direct contact with water, salt water, and oil.
3) Store in a location where the capacitor is not exposed to toxic gas, such as hydrogen sulfide, sulfuric acid, nitrous acid, chlorine or chlorine compounds, bromine or other halogen gases, methyl bromide or other halogen compounds, ammonia, or similar.
4) Store in a location where the capacitor is not exposed to ozone, ultraviolet radiation, or other radiation.
5) It is recommended to store capacitors in their original packaging wherever possible.

VII. Disposal

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

VIII. Regarding compliance for EU REACH Regulation

1) According to the content of REACH handbook (Guidance on requirements for substances in articles which is published in May 2008), our electronic components are “articles without any intended release”. Therefore they are not applicable for "Registration" for EU REACH Regulation Article 7 (1). Reference: Electrolytic Condenser Investigation Society:"Study of REACH Regulation in EU about Electrolytic Capacitor" (publicized on 13 March 2008)
2) Jamicon develops the products without substance of very high concern (SVHC).

IX. Catalogs

Specifications in the catalogs are subject to change without notice. Test data shown in the catalogs are not assured as the whole performance values, but typical values.