

Conductive Polymer Hybrid Aluminum Electrolytic Capacitors (Hereinafter called capacitor) that uses highly conductive polymer electrolytic materials and electrolyte. Please read the following in order to get the most out of your capacitor. The circuits described as examples in this catalog and the "delivery specifications" are featured in order to show the operations and usage of our products, however, this fact does not guarantee that the circuits are available to function in your equipment systems.

We are not in any case responsible for any failures or damage caused by the use of information contained herein. You should examine our products, of which the characteristics are described in the "delivery specifications" and other documents, and determine whether or not our products suit your requirements according to the specifications of your equipment systems. Therefore, you bear final responsibility regarding the use of our products.

Please make sure that you take appropriate safety measures such as use of redundant design and malfunction prevention measures in order to prevent fatal accidents and/or fires in the event any of our products malfunction.

For Conductive Polymer Aluminum Solid Capacitors, see Precautions and Guidelines (Conductive Polymer).

For Aluminum Electrolytic Capacitors, see Precautions and Guidelines (Aluminum Electrolytic Capacitors).

1) Device circuits design considerations

1) Confirm installation and operating requirements for the capacitors, then use them within the performance limits prescribed in this catalog or product specifications.

2) Polarity

Capacitors are polarized. Never apply a reverse voltage or AC voltage. Connecting with wrong polarity will short-circuit or damage the capacitor with the pressure relief vent opening early on. To identify the polarity of a capacitor, see the relevant diagram in the catalogs or product specifications, or the polarity marking on the body of the capacitors.

3) Operating voltage

Do not apply an over-voltage that exceeds a rated voltage specified for the capacitors. The total peak value of the ripple voltage plus the DC voltage must not exceed the rated voltage of the capacitors. Capacitors do not require voltage derating within the category temperature. Although capacitors specify a surge voltage that exceeds the full rated voltage, it does not assure long-term use but limited use under specific conditions.

4) Ripple current

Do not apply an over current that exceeds the rated ripple current specified for the capacitors. Excessive ripple current will increase heat production within the capacitors, causing the capacitors to be damaged as follows:

- Shorten lifetime
- Open pressure relief vent
- Short circuit

At the time of low DC bias voltage, reverse voltage may be applied if uses with less than rated ripple current. Please use it as far as the reverse voltage is not applied. The rated ripple current is specified along with a specific ripple frequency. Where using the capacitors at any ripple frequency other than the specified frequency, calculate the allowable ripple current by multiplying the rated ripple current by a frequency compensation factor (Frequency Multiplier) specified for each product series.

5) Operating temperature (Category temperature)

Do not apply high temperatures that exceed the upper limit of the category temperature range specified for the capacitors. Using the capacitors at temperatures higher than the upper limit will considerably shorten the lifetime of the capacitors and make the pressure relief vent open. The temperature, please confirm the temperature of the capacitors which included the ambient temperature of the device, not only the temperature in the device but also radiant heat of the heating element (power transistor, resistance) in the apparatus, self heating caused by the ripple current. Additionally, please do not place heating ele-

ment on the back side of the capacitors. In addition, please use the capacitors within category temperature range because the life of the capacitors are affected by the operating temperature. In other words, lowering ambient temperatures will extend the expected lifetime of the capacitors.

6) Lifetime

Select the capacitors to meet the service life requirements of device.

7) Charging and discharging

Do not use capacitors in circuits intended for rapid charge and discharge cycle operations. If capacitors are used in the circuits that repeat a charge and discharge with a large voltage drop or a rapid charge and discharge at short interval cycle, capacitance will decrease and/or the capacitors will be damaged by internal heat generation. Please consult us the capacitors to use for the circuit where rapid charge and discharge is repeated. Please be careful about rush currents. Recommend to install protective circuit.

8) Leakage current

The leakage current may increase due to thermal stress such as reflow soldering. After that, however, the leakage current will gradually decrease by self-healing action of the dielectric oxide layer when the capacitors are applied with a voltage less than the rated voltage within the Category Temperature range. As the voltage is closer to the rated voltage and the temperature is closer to the upper limit of Category Temperature range, the leakage current decreases faster.

The leakage current will increase by the following factors,

- ① Soldering
- ② Testing of high temperature exposure with no voltage applied, high temperature/humidity storage, temperature cycles, etc.

9) Failure mode of capacitors

Non-solid aluminum electrolytic capacitors have a limited lifetime which ends in an open circuit failure mode, in general. Depending on the product type and operating conditions, the failure mode may involve in opening of the pressure relief vent. But it may lead to shot circuit mode failure when capacitor is used in the overload more than the guarantee ranges including over voltage and the over current.

10) Capacitor insulation

The can case of capacitor does not assure electrical insulation. The outer coating on can case is aimed for indication and does not assure function of the electrical insulation. Electrically isolate the outer can case of a capacitor from the negative terminal, the positive terminal and circuit patterns.

11) 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.
The standard vibration condition is applicable to JIS C 5101-4.

12) Mounting

Capacitors contain paper separators and electric-conductive electrolyte that contains organic solvent as main solvent material, both of which are flammable. If the electrolyte leaks onto a printed circuit board, it can erode the device circuit pattern, may short-circuit the copper traces, smoke and burn. Make sure of designing a PC board as follows:

- ① Provide clearance space (2mm minimum) over the pressure relief vent of a capacitor to avoid blocking the correct opening of the pressure relief vent for 10mm case diameter of capacitor.
- ② Do not locate any wire or circuit pattern over the pressure relief vent of a capacitor.
- ③ Avoid locating any heat source components near capacitors or on the opposite side of the PC board under capacitors.
- ④ Design the solder land on the PC board in accordance with the catalog or the product specification.
- ⑤ For radial capacitors, design the terminal holes on the PC board to fit the terminal dimension of the capacitor.
- ⑥ Do not print any copper trace under the seal (terminal) side of a capacitor. When the electrolyte leaks out, it may occur circuit pattern short-circuit, and tracking or migration. Copper traces should be 1 mm (preferably 2mm or more) spaced apart from the side of the capacitor body.
- ⑦ In designing a double-sided PC board, do not locate any through-hole via or unnecessary hole underneath a capacitor.
- ⑧ In designing a double-sided PC board, do not print any circuit pattern underneath a capacitor.

13) Using capacitors for significantly safety-oriented applications

Consult with us in advance of usage of our products in the following listed applications. ① Aerospace equipment ② Power generation equipment such as thermal power, nuclear power etc. ③ Medical equipment ④ Transport equipment (automobiles, trains, ships, etc.) ⑤ Transportation control equipment ⑥ Disaster prevention / crime prevention equipment ⑦ Highly publicized information processing equipment ⑧ Submarine equipment ⑨ Other applications that are not considered general-purpose applications.

14) Others

Design device circuits taking into consideration the following conditions:

- ① Electrical characteristics of a capacitor depend on the temperature and frequency. In designing the device circuits, consider the change in the characteristics.
- ② If using more than one capacitor connected in parallel, design the device circuits to balance the current flow in individual capacitors.
- ③ If using more than one capacitor connected in series, connect shunting resistors in parallel with the individual capacitors to balance the voltage.

2) 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.
Capacitors may produce recovery voltage higher than aluminum electrolytic capacitors and conductive polymer aluminum solid capacitors. In this case, discharge electricity through approximately 1kΩ before use.
- ③ If 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, make pre-conditioning by applying 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 Verify that the lead spacing of the capacitor fits the hole spacing in the PC board before installing the capacitors.
- ⑨ Do not apply excessive mechanical force to capacitors more than the limits prescribed in the catalogs or product specifications. 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

- ① For soldering using a soldering iron, consider the following conditions:
Soldering conditions (temperature and time) should be (380 ± 10°C, 3 ± 0.5second).
Do not touch the body of a capacitor with the hot tip of the soldering iron.
- ② Verify the following when flow soldering:
 - 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.
 - Soldering conditions (preheat, solder temperature and dipping time) should be within the limits prescribed in the catalog 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.
- ③ For reflow soldering, consider the following conditions:
Soldering conditions (preheat, reflow temperature and time) should be within the limits prescribed in the catalogs or product specifications.
 - When using the infrared heater and setting its temperatures, adjust the heating levels taking into consideration that the color and materials of a capacitor vary in their infrared absorbance.
 - The allowable number of reflow passes is specified in the catalogs or product specifications.
 - Please consult us about vapor phase soldering (VPS).
- ④ Do not try to reuse the capacitors once assembled.
- ⑤ Only use radial lead type capacitors for flow soldering. The other type capacitors are not designed for the flow soldering.
- ⑥ Only use chip type capacitors for reflow soldering. The other type capacitors are not designed for the reflow soldering.

3) Handling after soldering

After soldering the PC board, do not apply the following mechanical stress to the capacitor:

- ① Do not tilt, push down or twist the body of the capacitor.
- ② Do not grab the body of the capacitor to carry the assembly board.

- ③ Do not hit anything against the capacitor. When stacking the assembled boards, do not put any of the PC boards or other components against the capacitor.
- ④ Do not drop the assembled board.

4) Cleaning assembly boards

- ① Do not clean capacitors with the following cleaning agents:
 - Halogenated solvents: cause capacitor failures due to corrosion.
 - Alkali system solvents: corrode (dissolve) the aluminum can case.
 - Terpene and petroleum system solvents: deteriorate the rubber seal materials.
 - Xylene: deteriorates the rubber seal materials as well.
 - Acetone: erases the markings printed on a capacitor.

Where cleaning is necessary, use only solvent resistant type capacitors that have been assured for the cleaning within the specific cleaning conditions prescriber in the catalogs or product specifications. In particular, carefully set up the conditions for ultrasonic cleaning system. Consult us regarding alternative CFCs or other cleaners before use.

- ② Where cleaning the capacitors, confirm the following conditions:
 - Control the contamination (the conductivity, pH, specific gravity, water content, etc.) of the cleaning agents.
 - After the cleaning, do not leave the capacitors (assembly boards) in an environment of cleaning agent-rich or in a closed container. Sufficiently evaporate the residual cleaning agent from the assembly boards and the capacitors by forced hot air at temperatures less than the upper limit of category temperature range for more than 10 minutes.

In general, aluminum electrolytic capacitors are sensitive to contamination of halogen ions (particularly to chlorine ions). Depending on the properties of the electrolyte and rubber seal materials used in a capacitor, the halogen ions lead up to catastrophic failures on the capacitor. Where the inside of a capacitor has been contaminated with more than a certain amount of halogen ions and the capacitor is in use, the corrosion reaction of aluminum occurs. The corrosion causes the capacitor to have a significant increase in leakage current with heat produced, open the pressure relief vent and become open circuit mode failure.

Due to global environmental issues (greenhouse effects and other environmental destruction by depletion of the ozone layer), the conventional cleaning solvents of CFC 113, Trichloroethylene and 1,1,1-trichloroethylene were replaced by substitutes. The following are some substitute cleaning agents and allowable cleaning conditions:

- a) Fatty-alcohol cleaning agents
 - Pine Alpha ST-100S (Arakawa Chemical)
 - Clean Through 750H, 750K, 750L and 710M (Kao)
 - Technocare FRW-14, 15, 16 and 17 (Momentive Performance Materials)

[Cleaning conditions]

Either of immersion or ultrasonic cleaning, for a maximum of 10 minutes and at a maximum liquid temperature of 60°C is acceptable. Make sure that the markings on the capacitor are not rubbed against any other component or the PC board during cleaning. Note that shower cleaning affects the markings on the capacitor.

- b) Alternative CFCs
 - AK225AES (Asahi Glass)

[Cleaning conditions]

Solvent resistant type capacitors, which were originally developed to intend to resist Freon TE or Freon TES, are also capable of withstanding any one of immersion, ultrasonic or vapor cleaning, for a maximum of 5 minutes.

However, this type of cleaning agent is not recommended to use, as the cleaning materials may be banned in near future in view of global environmental issues

- c) IPA (Isopropyl Alcohol)
 - Immersion cleaning with a maximum flux concentration of 2 wt% is acceptable.

5) Adhesives and coating materials

- ① Do not use any adhesive or coating materials containing halogenated solvents.
- ② Make sure of the following conditions before applying adhesive or coating materials to a capacitor,
 - No flux residue nor stain is left between the rubber seal of a capacitor and PC board.
 - Dry the capacitor to remove residual cleaning agents before applying adhesive and coating materials. Do not cover up the entire surface of the rubber seal of the capacitor with adhesives or coating materials.
 - Consult us Heating and curing conditions for adhesives and coating materials.
 - Covering up the entire surface of the rubber seal with resin mold materials will obstruct the normal diffusion of internal hydrogen gas from a capacitor and result in serious failures. Also, where the adhesive and coating materials contain a large amount of halogen ions, the halogen ions will contaminate the inside of the capacitor through the rubber seal materials, causing the capacitor to become a failure.
 - Depending on solvent materials that the adhesive or coating materials contains, note that the surface of a capacitor may change in appearance.

6) Fumigation

In exporting or importing electronic devices, they may be exposed to fumigation with halide such as methyl bromide.

Where the capacitors are exposed to halide such as methyl bromide, the capacitors will be damaged with the corrosion reaction with halogen ions in the same way as cleaning agents. For the export and import, Nippon Chemi-Con considers using some packaging method and so forth so that fumigation is not required. For customers to export or import electronic devices, semi-assembly products or capacitor components, confirm if they will be exposed to fumigation and also consider final condition of packaging. (Note that either cardboard or vinyl package has a risk of fumigation gas penetration.)

3) Precautions during operation of devices

- (1) Never touch the terminals of a capacitor directly with bare hands.
- (2) Do not short-circuit between the capacitor terminals with anything conductive. Also, do not spill any conductive liquid such as acid or alkaline solution over a capacitor.
- (3) Confirm environmental conditions where the device will be placed. Do not use the device in the following environmental conditions:
 - ① Water or oil spatters, or high condensation environment.
 - ② Direct sunlight.
 - ③ Ozone, ultraviolet rays or radiation.
 - ④ Toxic gases such as hydrogen sulfide, sulfuric acid, nitrous acid, chlorine and its compounds, bromine and its compounds and ammonium.
 - ⑤ Severe vibration or mechanical shock conditions beyond the limits prescribed in the catalog or product specification. The standard vibration condition is applicable to JIS C 5101-4.

4) Maintenance inspections

- (1) For industrial use capacitors, make periodic inspections of the capacitors. Before the inspections, turn off the power supply of the device and discharge the electricity of the capacitors. Where checking it by a volt-ohm meter, confirm the polarity beforehand. Do not apply mechanical stress to the terminals of the capacitors during inspection.

(2) Characteristics to be inspected

- ① Significant damage in appearance: vent opening, electrolyte leakage, etc.
- ② Electrical characteristics: Leakage current, capacitance, $\tan \delta$ and other characteristics prescribed in the catalogs or product specifications. If finding anything abnormal on the characteristics above, check the specifications of the capacitor and take appropriate actions such as replacement.

5 Contingencies

- 1) A capacitor with more than a certain case size has the pressure relief vent functioning to escape abnormal gas pressure increase. If gas expels from a venting capacitor, disconnect the power supply of the device or unplug the power supply cord. If not disconnecting the power supply, the device circuit may be damaged due to the short circuit failure of the capacitor or short-circuited with the liquid that the gas was condensed to. It may cause secondary damages such as device burnout in the worst case scenario. The gas that comes out of the open vent is vaporized electrolyte not smoke.
- 2) The gas expelled from a venting capacitor is more than 100°C. Never expose your face to the capacitor. If your eyes are exposed to the gas or you inhale it, immediately flush your eyes and/or gargle with water. If the electrolyte comes in contact with the skin, wash with soap and water.

6 Storage

- 1) Do not store capacitors at high temperature or high humidity. Store the capacitors indoors at temperatures of 5 to 35°C and humidities of less than 75%RH. In principle, aluminum electrolytic capacitors should be used within 2 years after production.
- 2) Keep capacitors packed in the original packaging material wherever possible.
- 3) Avoid the following storage environmental conditions:
 - ① Water spattering, high temperatures, high humidity or condensation environment.
 - ② Oil spattering or oil mist filled.
 - ③ Salt water spattering or salt filled.
 - ④ Acidic toxic gases such as hydrogen sulfide, sulfuric acid, nitrous acid, chlorine, bromine and methyl bromide filled.
 - ⑤ Alkaline toxic gases such as ammonium filled.
 - ⑥ Acid or alkaline solutions spattering.
 - ⑦ Direct sunlight, ozone, ultraviolet rays or radiation.
 - ⑧ Extreme vibration or shock loading.
- 4) JEDEC J-STD-020 is not applicable.

7 Capacitor disposal

Please consult with a local organization for the proper disposal of industrial waste. For incinerating capacitors, apply a high temperature incineration (over 800°C). Incinerating them at temperatures lower than that may produce toxic gases such as chlorine. To prevent capacitors from explosion, punch holes in or sufficiently crush the can cases of the capacitors, then incinerate.

8 About AEC-Q200

The Automotive Electronics Council (AEC) was originally established by major American automotive related manufactures. Today, the committees are composed of representatives from the sustaining Members of manufacturing companies in automotive electrical components. It has standardized the criteria for "stress test qualification" and "reliability tests" for electronic components.

AEC-Q200 is the reliability test standard for approval of passive components in Automotive applications. It specifies the test type, parameters and quantity, etc. for each component. The

criteria of the reliability tests such as for our main products, "Aluminum Electrolytic Capacitors" are described in this standard.

Pursuant to the customer's specific testing requirements, Chemi-Con submits the test results according to AEC-Q200 for Aluminum Electrolytic Capacitors used in automotive applications on request.

An electronic component manufacturer cannot simply claim that their product is "AEC-Q200 Qualified". It can be claimed "Compliant", "Capable", "Available", etc., however each component must be tested per each users "Qualification Test Plan" in order to claim AEC-Q200 status.

Please contact us for more information.

9 Response to the Substances of Concern

- 1) Nippon Chemi-Con aims for developing products that meet laws and regulations concerning substances of concern. (Some products may contain regulated substances for exempted application) Please contact us for more information about law-compliance status.
- 2) According to the content of REACH handbook (Guidance on requirements for substances in articles which is published on 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)

10 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. For more details, refer to JEITA RCR-2367C (March 2006) with the title of "Safety Application Guide for fixed aluminum electrolytic capacitors for use in electronic equipment".