



6. Application Guidelines

6-1-1. Circuit Design

(1) Please make sure the application and mounting conditions to which the capacitor will be exposed are within the conditions specified in the catalog or alternate product specification (Referred as to specification here after).

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

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

Do not apply excessive 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 that no reverse voltage or AC voltage is applied to the capacitors. Please use bi-polar capacitors for a circuit that can possibly see reversed polarity.

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

(5) For a circuit that repeats rapid charging/discharging of electricity, an appropriate capacitor that is capable of enduring such a condition must be used. Welding machines and photoflash 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.

For appropriate choice of capacitors for circuit that repeat rapid charging/discharging, please consult us.

(6) For conductive polymer solid capacitors, the leakage current may become greater even if the soldering conditions adhere to the specification requirements. Therefore, do not use such capacitors in the following circuits because trouble or failure may occur.

- a) High impedance circuits
- b) Coupling circuits
- c) Time constant circuits
- d) Do not use the capacitors in circuits except those above if changes in the leakage current affects circuit operations.

(7) It is said that to restrain output ripple current, the output smoothing capacitor of the switching power supply is suitable to use the smaller ESR capacitor. However when the low ESR capacitor is used, the phenomenon sometimes occurs that is called the abnormal oscillation of output voltage.

30 degrees to 40 degrees or more of Phase margin is thought as a necessity to inhibit the oscillation of output voltage with a general negative feed-back circuit. The Phase margin is numerical value how much the minimum value of the Phase is distant from -180 degrees. The smaller the Phase margin gets, the higher the possibility to oscillate by the characteristic dispersion and temperature change of the component will be.

By doing Phase compensation with the feed-back circuit of the error amplifier the oscillation of output voltage can be inhibited.

6. 铝电解电容器应用指南:

6-1-1. 电路设计

(1) 首先, 请确定电容器的使用和安装条件是否(必须)符合样本所供选择的产品规格中所规定的条件;

(2) 工作温度和施加的纹波电流必须符合规范中的要求。

- ① 电容器使用时的环境温度不能超过产品规格中规定的工作温度
- ② 施加的纹波电流不得超过允许值

(3) 在设计电路时, 必须选择符合其使用寿命要求的合适的电容器

(4) 铝电解电容器是有极性的, 因此要确保不对电容器施加反向电压或交流电压, 在可能会出现反向电压的场合, 建议使用双极性电容器。

注意: 即使是双极性电容器, 也不能应用在使用交流电压的场合。

(5) 对于需要反复充放电的电路而言, 那就必须使用能承受这种工作环境的合适电容器。像焊接机、闪光灯等设备当中就有这样的电路。此外, 在诸如伺服电机等控制电路中, 会出现反复的快速充放电, 电路中的电压波动很大。因此如要选择反复快速充放电电路中用合适电容器, 请与我们联系。

(6) 导电性高分子型固体铝电解电容器在电路使用中由于焊接等原因会导致漏电流增大, 因此不推荐应用于以下电路。

- a) 高阻抗电路
- b) 耦合电路
- c) 时间常数电路
- d) 受漏电流影响较大的电路

(7) 选用开关电源的输出平滑电容器时, 为了抑制输出纹波电压, 所选用电容器的等效串联电阻(ESR)越小越好, 然而使用ESR小的电容器有可能发生输出电压的异常振荡。

为防止输出电压发生振荡, 在一般负反馈线路上, 相位需要留有30~40度以上的余量。相位的余量是指相位的下限值至-180度的数值, 相位的余量越小, 构件的性能差及温度变化引起振荡的可能性越大。

通过利用误差放大器反馈线路的相位修正, 可以防止输出电压的振荡。



(8) Make sure that no excess voltage (that is, higher than the rated voltage) is applied to the capacitor. Please pay attention so that the peak voltage, which is DC voltage overlapped by ripple current, will not exceed the rated voltage.

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

(9) 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 us for details.

(10) 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 gases (such as hydrogen sulfide, sulfuric acid, nitrous acid, chlorine, bromine, methyl bromide, ammonia, etc.)
 - (e) Being exposed to direct sunlight, ozone, ultraviolet ray, or radication
 - (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.

(11) 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
Φ6.3~16mm	2mm or more
Φ18~35mm	3mm or more
Φ40mm 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 upper position.

(12) The main chemical solution of the electrolyte and the separator paper used in the capacitors are combustible. The electrolyte is conductive. When it comes in contact with the P.C. board, there is a possibility of pattern corrosion or short circuit between the circuit pattern which could result in smoking or catching fire.

Do not locate any circuit pattern beneath the capacitor end seal.

(8) 确保电容器不能在过压状态下工作（即高于额定电压）

- ① 请注意峰值电压，即由直流电压叠加纹波电流的电压，不能超过额定电压；
- ② 在要串联使用2个以上电容器的场合，施加的电压要低于额定电压，并用一个均衡电阻与电容器并联，使电压平均地施加到每个电容器上。

(9) 电容器外面的套管不能保证做绝缘之用，所以在需要将其作为电绝缘的应用场合，这些电容器不能使用一般标准的套管。假如你的应用场合需要特殊绝缘的话，请与我们联系了解详细情况。

(10) 在下列条件下使用的电容器很可能会导致失效

- ① 环境条件
 - (a) 接触水，高温高湿度气候，或易产生冷凝水的地方；
 - (b) 接触油，或充满油气的地方；
 - (c) 接触盐水，或充满盐尘的地方；
 - (d) 含有有毒气体的场合（如盐酸、硫酸、硝酸、氯、溴、甲基溴、氨等）；
 - (e) 直接暴露在有阳光、臭氧、紫外线或辐射的环境中；
 - (f) 接触酸碱溶液。
- ② 在震动或机械冲击超过指标规定范围的那些恶劣环境下

(11) 当在设计印刷电路板时，请注意下列事项：

- ① 电路板上的开孔间距必须与电容器引线的间距相匹配；
- ② 在电容器的防爆阀上方，不应有任何电路走线图形或导线；
- ③ 除非另有规定，否则防爆上方应留出下列间隙：

外壳直径	须留间隙
Φ6.3~16mm	≥2mm
Φ18~35mm	≥3mm
Φ40或40mm以上	≥5mm

④ 如果防爆阀是朝着印刷电路板方向的（例如防爆阀在盖板上的电容器），则要在电路板上相应的开一个孔，可使阀打开后的气体排出。这个孔必须对准电容器防爆的位置

⑤ 安装螺丝终端电容器时，必须将装盖板的面朝上。当水平方向安装螺丝终端电容器时，必须将正极终端放在上面。

(12) 电解液中使用的化学溶液和电容器中的电解纸都是易燃品，而且电解液是导电的，一旦它与电路板接触，就有可能造成电路板上的走线图形腐蚀，或走线图形之间的短路，最终导致冒烟或起火。



(13) 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).

(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 in specifications.

(17) When you install more than 2 capacitors in parallel, consider the balance of current flowing through the capacitors. Especially, When a solid conductive polymer aluminum electrolytic capacitor and a standard aluminum electrolytic capacitor 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.

6-1-2. Mounting

(1) Once a capacitor has been assembled in the set and power applied, Even if a capacitor is discharged, an electric potential(recovery 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 1 k resistor.

(3) Leakage current of the parts that have been stored for more than 1 year may increase. If leakage current has increased, please perform a voltage treatment using 1 k 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 type capacitor 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 too strong when capacitors are placed and fixed by an automatic insertion machine.

(13) 在设计线路板时，在其正反两面上均不要让电容器靠近发热元件；

(14) 电性能的改变与温度和频率有关，所以在设计电路时要考虑这些变化因素；

(15) 当在双面线路板上安装电容器时，要让开线路图形和还未使用的插孔；

(16) 终端螺丝或支架螺丝的力矩应符合规格书上规定的值；

(17) 当你并联安装2个以上电容器时，要考虑流经电容器的电流的平衡，特别是当并联固体聚合物铝电解电容器和标准的铝电解电容器时，要给予这方面特别的考虑；

(18) 如果串联使用2个以上的电容器时，要确保施加的电压小于额定电压，并要采用一个与每个电容器并联的均衡电阻使该电压均匀地施加到每个电容器上。

6-1-2. 安装

(1) 一旦电容器装上机器，并接通电源，即使电容器已放过电，但是在两个终端之间仍存在一个电位差（再生电压）；

(2) 正极和负极之间的电位差也可能是由返回的电动势所造成的，所以一定要用一只1K电阻实施放电；

(3) 存放1年以后的电容器漏电流可能会增加，如果漏电流增大了，请用一只1K电阻进行电压处理；

(4) 在把电容器装上电路板之前，请首先确认一下其额定值；

(5) 在把电容器装上电路板前，请对极性进行确认；

(6) 不要让电容器掉落到地板上，也不能使用掉到地板上的电容器；

(7) 安装时千万不能损坏电容器；

(8) 安装之前确认一下电容器引线间距是否与线路板的孔距相匹配；

(9) 焊片式电容器要紧靠线路板安装（电容器的底部和线路板之间不留间隙）；

(10) 当用自动插件机安装和固定电容器时，请注意夹持力不能太大；



(11) Please pay attention to that the mechanical shock to the capacitor by suction nozzle of the automatic insertion machine or automatic moulder, 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 specification.
Solder temperature: $260 \pm 5^{\circ}\text{C}$, Immersing lead time: 10 ± 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 specification.
Pre-heating : Less than 150°C , 90 seconds max. Max. temperature at capacitor top during reflow : 230°C
The duration for over 200°C temperature at capacitor top: 20 seconds max.
The duration from the pre-heat temperature to peak temperature of reflow varies due to changes of the peak temperature.
- 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.
- ③ The number of reflow time for SMT aluminum electrolytic capacitors shall be one time. If this type of capacitor has to be inevitably subjected to the reflow twice, enough cooling time between the first and second reflow (at least more than 30 minutes) shall be taken to avoid consecutive reflow. Please contact us if you have questions.

(15) Soldering 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 does not contain non-ionic halides.

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

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

(18) 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.

(11) 请注意由自动插件机或产品检查仪或中心定位机所产生的振动对电容器的影响;

(12) 手工焊接

- ① 焊接条件必须符合规范的要求;
- ② 如果由于引线间距和线路板上的孔距不匹配需要引线成型的话, 则必须在焊接前弯好引线, 而不能对电容器施加太多的应力;
- ③ 如需要拆下焊好的电容器, 则要让焊锡充分熔化, 使引线不受任何应力;
- ④ 请注意不能让烙铁接触电容器本体;

(13) 波峰焊

- ① 电容器本体不能浸入锡缸, 铝电解电容器必须装在线路板的上面, 只允许线路板的反面与焊锡接触;
- ② 焊接条件必须符合规格书规定的指标值:
焊锡温度小于 $260 \pm 5^{\circ}\text{C}$, 引线浸没时间小于 10 ± 1 秒, 线路板厚度不小于 1.6mm
- ③ 除了终端外, 其他部分均不能沾上助焊剂
- ④ 要防止电容器与其他元器件接触

(14) 回流焊

- ① 焊接条件必须符合规格书规定的指标值:
预热: 小于 150°C , 最多 90 秒; 回流焊过程中电容器顶部的最高温度为 230°C , 在电容器顶部超过 200°C 的时间最多为 20 秒; 从预热温度到回流焊峰值温度的时间随峰值温度的改变而变化。
- ② 使用红外加热器时, 应注意加热的程度, 因为电容器本体的颜色, 套管材料和电容器大小等方面的差异会使红外线的吸收率产生变化;
- ③ 表面贴装用铝电解电容器能承受的回流焊次数是一次, 如果这种电容器一定要进行第二次回流焊的话, 那么在第一次和第二次回流焊之间要有足够的冷却时间 (至少 30 分钟以上), 不能连续进行回流。如有问题请与我们联系。

(15) 焊锡、助焊剂

有不含有离子卤化物而含有许多非离子卤化物的非卤型助焊剂, 当这些非离子卤化物渗入电容器之后会引起一种化学反应, 其结果就会象使用了清洁剂一样对电容器造成损害, 所以要采用不含非离子卤化物的助焊剂。

(16) 电容器焊到线路板上之后, 不要将电容器倾倒或扭曲。

(17) 拿线路板时, 不要抓住焊好的电容器。

(18) 不要让焊好的电容器碰到其他任何东西。如果要线路板堆放储存的话, 要确保线路板或其他元件不要碰到电容器。电容器不能受焊好的线路板或其他焊好的元器件的热辐射影响。



6-1-3. 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 will be free from spilling water or oil, direct sunlight, ultraviolet rays, radiation, poisonous gases, vibration or mechanical shock.

6-1-4. Maintenance Inspection

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.

6-1-5. 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.

6-1-6. 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) Confirm that the environment does not have any of the following conditions:
 - ① Where capacitors are exposed to water, high temperature & high humidity atmosphere, or condensation of moisture.
 - ② Where capacitors are exposed to oil or an atmosphere that is filled with particles of oil.
 - ③ Where capacitors are exposed to salty water, high temperature & high humidity atmosphere, or condensation of moisture.
 - ④ The atmosphere is filled with toxic acid gasses (e.g. hydrogen sulfide, sulfurous acid, nitrous acid, chlorine, bromine, methy bromide, etc.)
 - ⑤ The atmosphere is filled with toxic alkaline gasses (e.g. ammonia)

Where capacitors are exposed to acidic or alkaline solutions.

6-1-7. Disposal

Take either of the following methods in disposing of capacitors.
Make a hole in the capacitor body or crush capacitors and incinerate them.
If incineration is not applicable, hand them over to a waste disposal agent and have them buried in a landfill.

6-1-3. 设备中

- (1) 不要用手直接接触电容器的终端
- (2) 不要用导体在两个终端之间进行短路，也不能把诸如酸碱溶液等导电液体泼近或泼到电容器上。
- (3) 要确保安装设备的环境条件要远离水、油、阳光的直接照射，紫外线、辐射、有毒气体、振动或机械冲击。

6-1-4. 保养检查

请定期检查安装在工业设备中的铝电解电容器必须检查下列内容

- ① 外观：是否有明显的异常，如防爆阀打开，漏液等；
- ② 电性能：容量，tgδ、漏电流和规范中规定的项目

6-1-5. 在紧急情况下

- (1) 如果你看到防爆阀打开后冒出的烟雾，请立即关掉电源，将插头从插座上拔下。
- (2) 当防爆阀打开时，不要将脸凑近电容器，因为从里面散发出来的气体温度可达100°C以上，如果气体冲进你眼睛的话，请立即用纯水冲洗眼睛。
如果吸入这种气体的话，请马上用水清洗眼睛和喉咙。请不要咽下电解液，如果皮肤接触到了电解液，请用水和肥皂将它洗净。

6-1-6. 储存

- (1) 建议将电容器储存在5°C~35°C 和相对湿度小于75%的环境中。
- (2) 确认储存环境中不会出现下列情况：
 - ① 有水，高温高湿或有水凝结
 - ② 接触油，或充满油污气
 - ③ 有盐水，高温高湿，或有水凝结
 - ④ 空气中含有毒酸气（如硫化氢、硫酸、亚硝酸、氯、溴、甲基溴等）
 - ⑤ 空气中含有毒碱气（如氨）
 - ⑥ 电容器置于酸碱溶液中。

6-1-7. 废弃处理

电容器的废弃处理可采用下列任何一种方法进行：
在电容器壳体上打个孔或将其敲碎后焚烧掉，如果焚烧不可行的话，请将这些电容器交给废品处理代理商找地方埋掉。