



Application Guidelines (應用指引)

1. Circuit Design

- 1.1 Please make sure the environment and mounting conditions to which the capacitor will be exposed are within the conditions specified in this catalog (or alternate SAMXON'S specifications, such as series drawings).
- 1.2 Operating temperature and applied ripple current must be within SAMXON'S specification.
 - The capacitor must not be used in an ambient temperature which exceeds the operating temperature specified in this catalog.
 - Do not apply excessive current which exceeds the allowable ripple current.
- 1.3 Appropriate capacitors which comply with the life requirement of the products should be selected when designing the circuit.
- 1.4 Aluminum electrolytic capacitors are polarized. Do not apply reverse voltage or AC voltage. Please use non-polar capacitors for a circuit that can possibly see reversed polarity. Note: Even non-polar capacitors cannot be used for AC voltage application.
- 1.5 Do not use aluminum electrolytic capacitors in a circuit that requires rapid and very frequent charge/discharge. In this type of circuit, it is necessary to use a special design capacitor with extended life characteristics.
- 1.6 Do not apply excess voltage.
 - 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 will be applied to each capacitor equally using a balancing resistor in parallel with the capacitor.
- 1.7 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.
 - Do not connect the blank terminal (reinforcing terminal) of a multi-terminal (three- or four-terminal) product of the snap-in type to another circuit it may cause a short circuit.
- 1.8 Capacitors must not be used under the following conditions:
 - Capacitors must not be exposed to water (including condensation), brine or oil.
 - Ambient conditions that include toxic gases such as hydrogen sulfide, sulfurous acid, nitrous acid, chlorine, ammonium, etc.
 - Ambient conditions that expose the capacitor to ozone, ultraviolet ray and radiation.
 - Severe vibration and physical shock conditions that exceed SAMXON'S specifications.
- 1.9 When designing a circuit board, please pay attention to following:
 - Make the hole spacing on the P.C. board match the lead spacing of the capacitor.
 - There should not be any circuit pattern or circuit wire above the capacitor safety vent.
 - Unless otherwise specified, following clearance should be mad above the safely vent.

Case Diameter	Gap Required
Φ6.3~16	2mm or more
Φ18~35	3mm or more
Φ40 or more	5mm or more

- 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.
- Do not install screw terminal capacitor with end seal side down. When you install a screw terminal capacitor in a horizontal mount, the positive terminal must be in the upper position.

- 1.10 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 in result of smoking or catching fire. Do not locate any circuit pattern beneath the capacitor end seal.
- 1.11 Do not design a circuit board so that heat generating components such as resistor and transistors are placed near an aluminum capacitor or reverse side of P.C. board (under the capacitor).
- 1.12 Electrical characteristics may vary depending on changes in temperature and frequency. Please consider this variation when you design circuits.
- 1.13 When you are designing capacitors for use on double-sided P.C. boards, do not place capacitors on circuit patterns or over the unused holes.
- 1.14 The torque for terminal screw or brackets screws must be within the specified value on SAMXON's drawings.
- 1.15 When you install more than 2 capacitors in parallel, consider the balance of current flowing into the capacitors.

2. Mounting

- 2.1 Once a capacitor has been assembled in the set and power applied, do not attempt to reuse the capacitor in other circuits or application.
- 2.2 Electric potential between positive and negative terminal may exist as a result or returned electromotive force, so please discharge the capacitor using a 1kΩ resistor.
- 2.3 Leakage current of the parts that have been stored for more than 6 months may increase. When leakage current has increased, please perform a voltage treatment using 1kΩ resistor.
- 2.4 Please confirm ratings before installing capacitors on the P.C. board.
- 2.5 Please confirm polarity before installing capacitors on the P.C. board.
- 2.6 Do not drop capacitors on the floor, nor use a capacitor that was dropped.
- 2.7 Be careful not to deform the capacitor during installation.
- 2.8 Please confirm that the lead spacing of the capacitor matches the hole spacing of the P.C. board prior to installation.
- 2.9 Snap-in can type capacitor such as JIS configuration 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).
- 2.10 Please pay attention that the clinch force is not too strong when capacitors are placed and fixed by an automatic insertion machine.



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- 2.11 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.
- 2.12 Soldering condition must be confirmed to be within SAMXON'S specification.
- Pb/Sn Type
Flow Soldering: $235 \pm 5^{\circ}\text{C}$ ≤ 10 sec.
Hand Soldering (Soldering iron tip): $350 \pm 10^{\circ}\text{C}$ ≤ 3 sec.
 - Pb-free Type
Flow Soldering: $260 \pm 5^{\circ}\text{C}$ ≤ 10 sec.
Hand Soldering (Soldering iron tip): $400 \pm 10^{\circ}\text{C}$ ≤ 3 sec.
- 2.13 Do not tilt lay down or twist the capacitor body after the capacitor are soldered to the P.C. board.
- 2.14 Do not carry the P.C. board by grasping the soldered capacitor.
- 2.15 Please do not allow anything to touch the capacitor after soldering. If P.C. board are stored in 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.
- 2.16 Do not clean capacitors with halogenated cleaning agent.
- 2.17 Precautions on fixing materials and coating materials.
- Do not use any ingredients which contain halogen.
 - Please pay attention to remove flux and any contamination which remains in the gap between the end seal and P.C. board and dry that portion well before coating.
 - Please do not apply any material all around the capacitor body but apply it partially.
 - Please contact our sales office to make sure whether the curing condition of coating material would cause any problems.
- 2.18 Do not install screw terminal capacitor with end seal side down. When you install a screw terminal capacitor in a horizontal position, the positive terminal must be in the upper position.

3. Storage

- 3.1 The characteristics of aluminum electrolytic capacitors degrade when stored in a static condition for long period of time. The rate of deterioration depends upon temperature and humidity.
- 3.2 Capacitors should be stored at the temperature of 5°C to 35°C , the humidity of less than 75% RH and out of direct sunlight.
- 3.3 Capacitors that have been stored for long periods normally over one year should be subjected to a "voltage aging" treatment before use. This will reform and repair the oxide dielectric.
- 3.4 Suggested aging procedure is gradually applying the rated voltage to the capacitor(s) for 30 to 60 minutes. If the capacitance still exceeds the specified leakage current value, please do not use it.

4. Disposal

- 4.1 Dispose of capacitors as industrial waste.
- 4.2 Consignment to the waste disposal specialists to handle it professionally.

The above mentioned material according to EIAJ RCR-2367B (issued in March, 2002), titled "Guideline of notabilia for aluminum electrolytic capacitors for use in electronic equipment". Please refer to the book for details.

5. Printed Circuit Board Cleaning

5.1 Foreword

It had been generally accepted that halogen type organic solvents were hazardous to aluminum electrolytic capacitors. This is because an organic solvent can permeate the capacitor through the end seal. Then, the solvent dissolves and free chlorine ion (Cl⁻ion), which can corrode the aluminum electrodes. The following measures were previously the only way to avoid this phenomenon.

- Use of cleaning agents, not hazardous to capacitors such as water or alcohol.
- Mount capacitors on PC boards cleaned with a halogen type solvent beforehand.
- Use of epoxy end seals

These measures have disadvantages with respect to working efficiency, cleaning capability, cost etc. Therefore, aluminum electrolytic capacitors which can withstand halogen type cleaning agents are desirable.

5.2 Types of Cleaning Agents

Generally there are three types of cleaning agents.

- Water type
- Alcohol type
- Halogen type

Of these, water and alcohol will have little effect even if they permeate the capacitor. However, halogens can cause corrosion of aluminum foil and tab. Common types of halogen cleaning agents are listed in Table below:

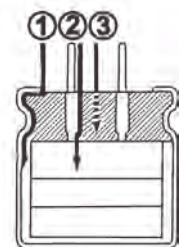
Chemical Name	Structural Formula	Representative Brand Name
Trichlorotrifluoroethane	C ₂ Cl ₃ F ₃	Freon TF, Daiflon S-3
Fluorotrichloromethane	CCl ₃ F	Freon-11, Daiflon S-1
Trichloroethane	C ₂ H ₃ Cl ₃	Chloroethene
Trichloroethylene	C ₂ HCl ₃	Trichlene
Methyl Chloride	CH ₃ Cl	MC

The last four solvents listed above are particularly corrosive to aluminum and are not recommended to use as cleaning solvents.

5.3 Penetration Channel of Solvent and Corrosion Mechanism

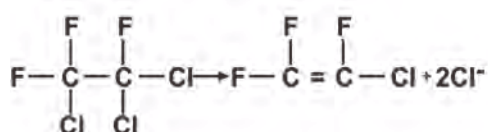
The three channels by which solvents can penetrate into the capacitor are illustrated:

- ① Penetration through a clearance between the rubber and the aluminum case (curled section)
- ② Penetration through a clearance between the rubber and the lead wires
- ③ Permeation through the rubber end seal

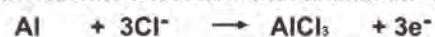


To reduce the possibility of solvents entering a capacitor, tight sealing is required to eliminate clearances between the rubber and the aluminum case/lead wires. A solvent resistant rubber material is also a necessity.

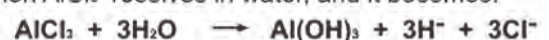
When a solvent, for example, trichlorotrifluoroethane gets inside a non anti-solvent capacitor, the chlorine ion is free as shown by the following reaction formula.



This chlorine ion reacts with aluminum as follows:



Then AlCl₃ resolves in water, and it becomes:



Thus, the Cl⁻ion is free again and repeats the corrosion of aluminum. The degree of this reaction depends on the volume of solvent, the ambient temperature of the capacitor in service, the applied voltage and time etc.

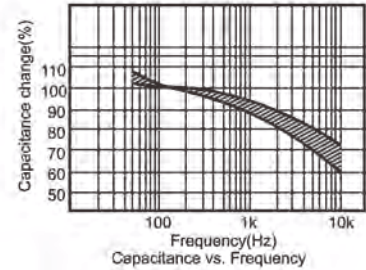


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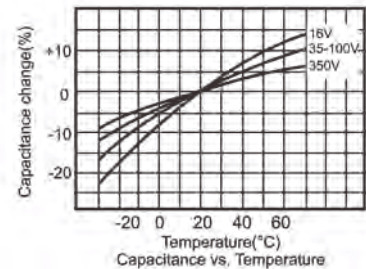
6. Basic Electrical Characteristics Capacitance:

The capacitance of capacitor is determined as AC capacitance by measuring its impedance. As the AC capacitance depends on frequency, voltage and other measuring methods, JIS C 5102 prescribes that the series capacitive component of an equivalent series circuit (○—R—L—C—○) shall be considered as the capacitance by measuring it at a frequency of 120Hz and a maximum AC voltage of 0.5Vrms with a DC bias voltage of 1.5 to 2.0V applied for aluminum electrolytic capacitors.

The capacitance of an aluminum electrolytic capacitor shows smaller values as a measuring frequency increases. See the typical behavior shown as right chart.



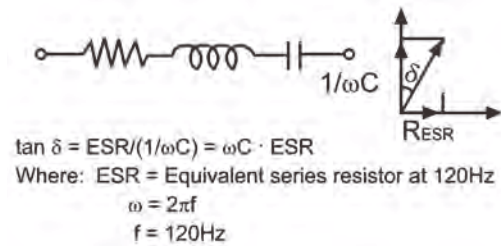
Measuring temperature as well as frequency effects the capacitance. As the measuring temperature decreases, the capacitance shows smaller values. See the typical behavior shown as right chart.



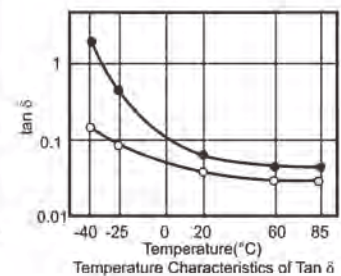
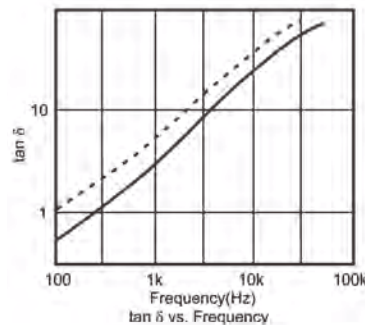
On one hand, DC capacitance, which can be determined by measuring the charge when a DC voltage is applied, shows a slightly larger value than the AC capacitance at a normal temperature and has the flatter characteristic over the temperature range.

Tan δ (tangent of loss angle or dissipation factor):

The tan δ is the ratio of the resistive component (ESR) to the capacitive reactance (1/ωC) in the equivalent series circuit, and its measuring conditions are the same as the capacitance.



The tan δ show higher values as a measuring frequency increases and a measuring temperature decreases, as follows:



Equivalent Series Resistance (ESR)

The ESR is comprised of the resistance due to aluminum oxide layer and electrolyte/separator combination and other resistance effected with foil length, foil surface area, etc.

The ESR value depends on the temperature. Decreasing the temperature makes the resistivity of the electrolyte increase with the result of the ESR increasing.

As the measuring frequency increases, the ESR decreases and reaches an almost constant value that is mainly the frequency-independent resistance due to electrolyte/separator combination.

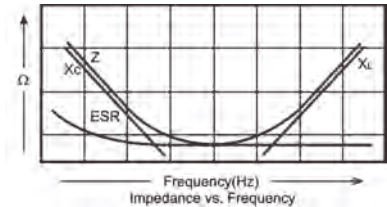
Impedance (Z):

The impedance is the resistance which oppose the flow of alternating current at a specific frequency. It is related to capacitance (C) and inductance (L) in terms of capacitive and inductive reactance, and also related to the ESR. It is expressed as follows:

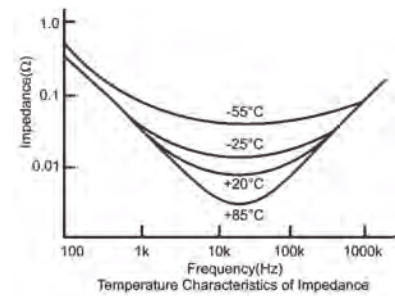
$$Z = \sqrt{ESR^2 + (X_L - X_C)^2}$$

Where: $X_C = 1/\omega C = 1/2\pi fC$
 $X_L = \omega L = 2\pi fL$

As shown as right chart, the capacitive reactance (Xc) predominates at the range of low frequencies, and the impedance decreases with increasing frequency until it reaches the ESR in the middle frequency range. At the range of the higher frequencies the inductive reactance (Xl) comes to predominate, so that the impedance increases with increasing the measuring frequency.

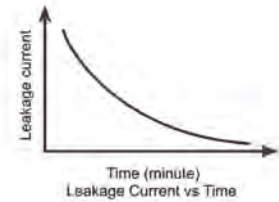


As shown as right chart, the impedance value varies with temperature, because the resistance of the electrolyte strongly changes with temperature.

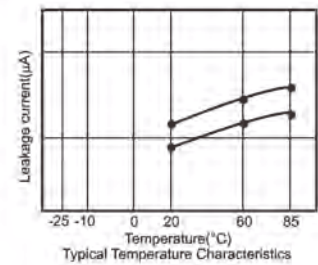


Leakage Current:

The dielectric of a capacitor has a very high resistance which prevents the flow of DC current. However, due to the characteristics of the aluminum oxide layer that functions as a dielectric in contact with electrolyte, a small amount of current, called leakage current, will flow to reform and repair the oxide layer while a voltage is being applied. As shown below, a high leakage current flows in the first minutes as a voltage is applied to the capacitor, and then the leakage current will decrease and reach an almost steady-state value with time.

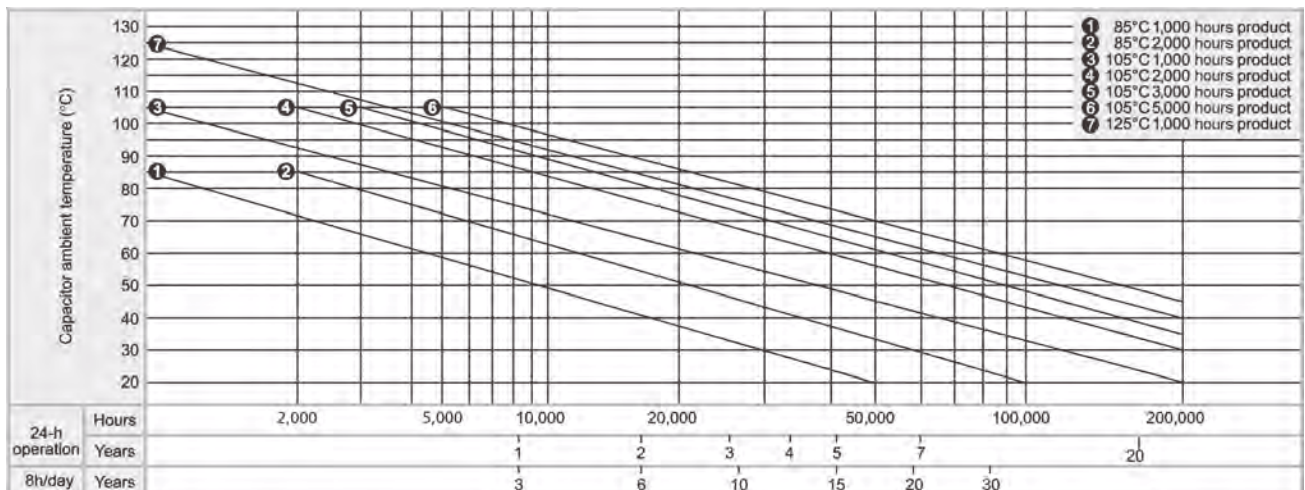


Measuring temperature and voltage effect the leakage current. The leakage current shows higher values as the temperature and voltage increase.



In general, the leakage current is measured at 20°C by applying the rated voltage, which is applied through a resistor of 1,000Ω connected in series with the capacitor, and several minutes after the capacitor reached the rated voltage. The catalog prescribes the measuring temperature and time.

LIFE ESTIMATION CHART





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7. Quality Policy

7.1 General

Our basic corporate goals and commitment to total quality are set down in our quality policy. The quality of our products and services is an essential part of our corporate strategy, whose paramount aim is total customer satisfaction. Consistent application of quality management system results in flawless products and a high level of user benefit from our components. Our quality management system always reflects the most stringent international standards.

Our corporate goals is to play a leading role among the world's most competitive companies in electronic components. All quality management measures are geared to optimum customer benefit.

They include:

- Mastery of processes
- Continuous improvement programs to narrow process tolerances, and to increase quality and yield.
- Enhanced productivity
- Continuous optimization of material, capital and human resources.
- Promotion of innovation
- Putting customer benefit first in every product we design. Determining customer needs in partnership with customers, and rapid implementation of agreements.

The SAMXON quality management system, which is documented in the new edition of the company-wide SAMXON Quality Management Handbook, is designed to support this strategy.

7.2 Quality assurance

The required measures and regulations for quality assurance are documented in instructions on operations and procedures; the effectiveness and adequacy of the QA system are regularly checked in internal audits.

7.3 Quality programs

Project-oriented improvement programs pursuing the strategic objective of zero defects are set up and conducted by specialist teams.

7.4 Process assurance

Assurance of production processes starts as early as the planning and development phase. Quality tools like FMEA and SVP help detect and avoid potential errors, and safeguard process capability and product quality. Documentation of all production and testing steps as well as training of personnel are essential to flawless production. Statistical process control (SPC) is used wherever applicable. Permanent availability of plant is ensured by preventive maintenance.

7.5 Incoming inspection

Raw materials, parts and consumable undergo incoming inspection appropriate to their significance in the end product, unless this responsibility has been transferred to the supplier under a quality assurance agreement or similar.

7.6 In-process inspection

Wherever possible, in-process inspection is conducted to certify the conformity not only of intermediate products, but also of process supervision and control (e.g. SPC). It is generally integrated into the process steps and designed to be as preventive as possible, i.e. to avoid errors.

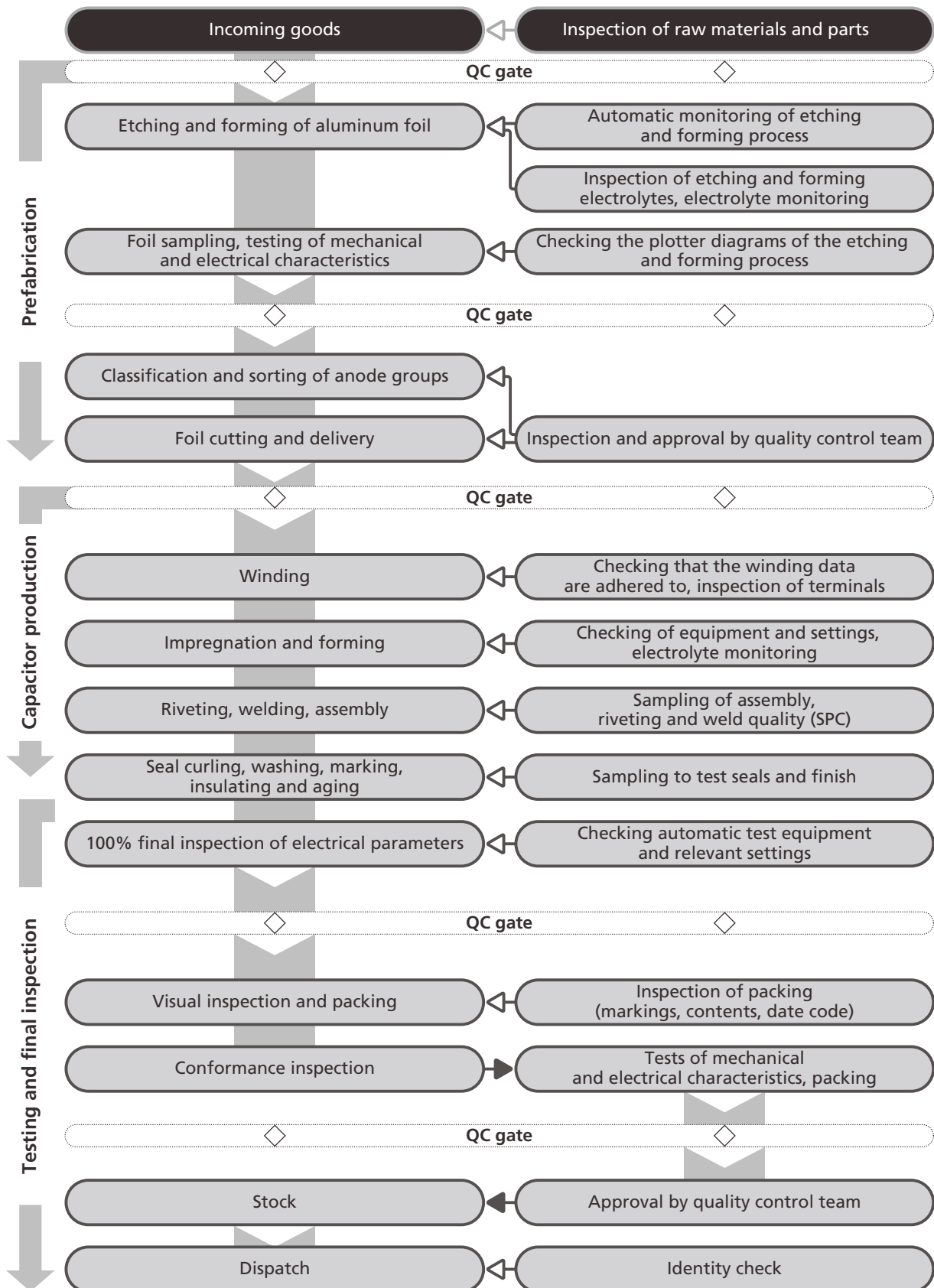
7.7 Final inspection/approval for shipment

Final inspection verifies the major properties of the end products batch by batch, usually by means of fully automated selection tests.

Approval for shipment helps certify that products shipped comply with specifications. It includes:

- Testing of principal parameter,
- Identification check and visual assessment,
- Examination of papers accompanying the batch.

8. Manufacturing and quality assurance procedures for Al electrolytic capacitors





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9. Environmental

Environmental policy

Our fundamental commitment to protection of the environment is laid down in SAMXON environmental policy:

- We work continuously to lighten the burden on the environment and to reduce consumption of energy and resources beyond statutory requirements.
- We take all precautions to avoid environmental hazards and to prevent damage to the environment.
- Potential impact on the environment is assessed and flows into product and process planning at the earliest possible stage.
- Our environmental management system ensures that our environmental policy is effectively implemented. The technical and organizational procedures required are regularly monitored and constantly upgraded.
- Every employee is required to act in an environmentally conscious manner. It is a permanent task of management to promote awareness of responsibility for the environment at all levels.
- We seek to influence our business associates to follow environmental guidelines similar to ours. We supply our customers with information on environmentally friendly use of our products. We work in a spirit of cooperation with the authorities.
- We inform the public of the environmental impact of our activities and the environmental achievements of our company.

10. Compliance with RoHS Directive

The company is committed to compliance with the European Union Restriction of Hazardous Substance (RoHS) Directive. We hereby guarantee that our products do not contain following materials exceeding the RoHS Directive (2011/65/EU).

- | | |
|---|----------|
| ■ Lead (Pb) and its compounds | ≤1000ppm |
| ■ Mercury (Hg) and its compounds | ≤1000ppm |
| ■ Cadmium (Cd) and its compounds | ≤100ppm |
| ■ Hexavalent chromium, Cr ⁶⁺ , Cr VI | ≤1000ppm |
| ■ Polybrominated biphenyls, PBBs | ≤1000ppm |
| ■ Polybrominated diphenyls, PBDEs | ≤1000ppm |

11. Halogen Free Compliant

The products identified in the catalogue, and their homogeneous subcomponents, do not contain any of the following substances in concentrations greater than the listed maximum limits.

Substance	Maximum Limit (ppm)
Bromine (Br)	900 ppm (0.09%)
Chlorine (Cl)	900 ppm (0.09%)
Total concentration of Chlorine (Cl) + Bromine (Br)	1500 ppm (0.15%)