



Aluminum Electrolytic Capacitors

Quality and environment

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EPCOS AG is a TDK Group Company.

Corporate goals

Our aim is to play a leading role among the world's most competitive companies in the sector of electronic components. This aim is shared by the EPCOS quality and environment management system:

1 EPCOS quality system

1.1 Extract from the EPCOS quality policy

- The quality of our products and services represents a key constituent of our corporate strategy, whose principal aim is customer satisfaction.
- Our quality management system is continuously oriented to the international standards that stipulate the highest requirements.

1.2 Quality management system

The quality management system to ISO/TS 16949 is applied throughout the company and is used to implement the EPCOS quality policy. The implications include

- as a rule, product and process developments follow the rules of APQP¹⁾,
- quality tools such as FMEA²⁾, DoE³⁾ and SPC⁴⁾ to minimize risks and ensure continuous improvements in conjunction with regular internal audits and QM reviews.

1.3 Certification

The EPCOS quality management system forms the basis for the company's certification to ISO 9001 and ISO/TS 16949 which comprises the EPCOS plants and sales organizations. The company certificates are posted on the EPCOS Internet (www.epcos.com/quality).

1.4 Production sequence and quality assurance

The business groups implement the corporate specifications for quality management in procedural and work instructions referred to products and processes.

The following example shows quality assurance applied to the production sequence of aluminum electrolytic capacitors.

1) APQP= Advanced Product Quality Planning

2) FMEA= Failure Mode and Effects Analysis

3) DoE= Design of Experiments

4) SPC= Statistical Process Control

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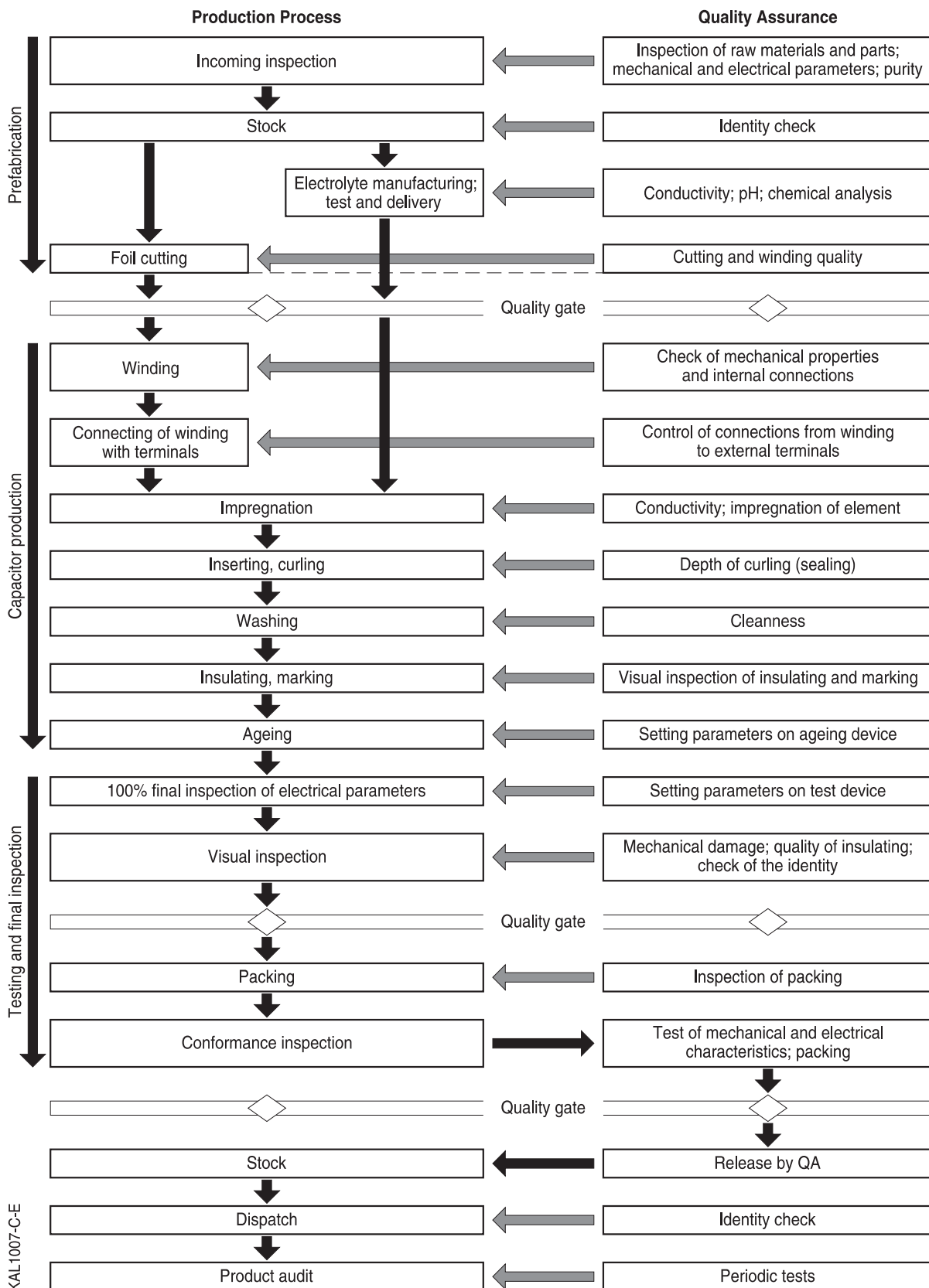


Figure 1
Quality assurance in the production process

1.5 Delivery quality

"Delivery quality" means compliance with the agreed data at the time of delivery.

1.6 Failure criteria

A component is defective if one of its features does not correspond to the specification of the data sheet or to an agreed delivery specification.

1.7 Incoming goods inspection at the customer's premises

For the incoming goods inspection we recommend the use of a random sampling plan according to ISO 2859-1 (contents compliant with MIL STD 105 D or IEC 60410).

The test methods used and the AQL must be agreed between the customer and the supplier.

1.8 Final inspection/approval for shipment

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

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

- testing of principal parameters,
- identification check and visual assessment,
- examination of papers accompanying the batch.

1.9 Duration of use

The duration of use in terms of reliability is the time period during which random failures occur, i.e. the range in the product operating life in which the failure rate remains largely constant (early failures and end of operating life excepted). Its value depends strongly on the conditions of use.

1.10 Failure rate (long-term failure rate)

The failure rate is defined as the failure percentage divided by a specified operating period. The failure rate is expressed in fit (failures in 10^9 component hours) or as percentage of failures in 1000 hours.

1 fit = $1 \cdot 10^{-9}$ /h (fit = failure in time)

Example of a failure rate λ_{test} determined by a useful life test:

- | | |
|--------------------------------|-----------------|
| 1. Number of components tested | N = 8000 |
| 2. Operating hours | $t_b = 25000$ h |
| 3. Number of failures | n = 2 |

$$\lambda_{\text{test}} = \frac{n}{N} \cdot \frac{1}{t_b} = \frac{2}{8000} \cdot \frac{1}{25000 \text{ h}} = 10 \text{ fit} = 0.001 \% / 1000 \text{ h}$$

Failure rate specifications must include failure criteria, operating conditions and ambient conditions.

When plotted against time, the failure rate of components usually shows a characteristic curve with the following three periods:

I: early failure period, II: useful period, III: wear-out failure period

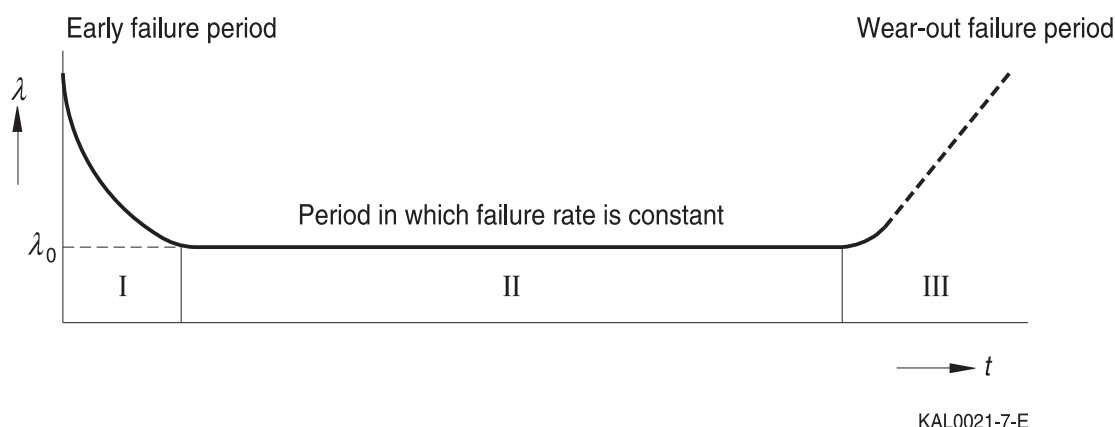


Figure 2
Failure rates

Unless otherwise specified, the failure rate refers to the useful period (II). During this period, an approximately constant failure rate λ_0 can be assumed.

1.11 Conversion factors for failure rates

The conversion factors for different load conditions can be derived from EN 61709.

1.12 Traceability

At all stages of production, components are identified by papers accompanying each batch. The completion of manufacturing and testing steps is confirmed and documented. This enables the batch to be traced back through the production process.

For further information refer to chapter "General technical information, 14.1 Bar code label".

1.13 Electrical and mechanical properties

The measuring conditions can be found in the chapter "General technical information". The product data and relevant tolerance limits are defined in the respective data sheets.

1.14 Dimensions

The dimensional drawings in the individual data sheets are definitive for the dimensions.

1.15 Finish

The finish of aluminum electrolytic capacitors is assessed in compliance with EPCOS finish specifications. These are based on IEC 60384-4.

1.16 Reliability

A variety of endurance tests and environmental tests are conducted to assure the reliability of aluminum electrolytic capacitors. These tests are derived from the extremes of expected application conditions. The test conditions are intensified to obtain valid results within a reasonable period. For details refer to the table "Specifications and characteristics in brief" for each series.

The reliability testing programs run by EPCOS are based on the test plans of the relevant international standards and customer requirements.

EPCOS performs reliability tests to qualify new component families and for periodic requalification.

1.17 AQL values

The AQL (AQL = acceptable quality level) figures are based on a random sampling plan to DIN ISO 2859-1 (contents compliant with MIL STD 105D or IEC 60410).

The sampling instructions of this standard are such that a delivered lot will be accepted with a probability of $\geq 90\%$ if the percentage of non-conformancies does not exceed the stated AQL figure. As a rule, the percentage of non-conformancies in deliveries from EPCOS is significantly below the AQL figure. The acceptance value we apply to inoperatives, i.e. unusable components is $c = 0$.

1.17.1 Classification of inoperatives / non-conformancies

A non-conformancy exists if a component characteristic fails to meet the data sheet specifications or an agreed delivery specification. Inoperatives are totally unusable components (in line with CECC detail specifications).

Inoperatives

- Incorrect or missing marking (when specified, and provided they may lead to misapplication)
- Missing or useless terminals
- Broken or missing encapsulation (if encapsulation is specified)
- Short or open circuits
- Capacitance exceeding three times the applicable tolerance
- Marking: polarity, if missing
- Leakage current more than 10 times the limiting value or $\geq 100 \mu\text{A}$; whichever is greater
- Impedance exceeding three times the limit value
- Alternating orientation of taped components
- Mixing with other component types

Non-conformancies

- Non-conformancies in electrical characteristics
(electrical characteristics outside of specified limits)
- Non-conformancies in mechanical properties
(e.g. incorrect dimensions, damaged case, illegible marking, bent terminals)

1.17.2 AQL figures

The following AQL figures apply to the non-conformancies listed above:

■ Inoperatives (electrical and mechanical)	0.065
■ Sum of electrical non-conformancies	0.25
■ Sum of mechanical non-conformancies	0.25

1.18 Conditions of use

EPCOS products may only be used in line with the technical specifications and installation instructions and must comply with the state of the art. Non-observance of limits, operating conditions or handling guidelines can lead to disturbances in the circuit and other undesirable consequences such as a higher failure rate.

In this connection, please refer to the "Important notes" on page 2.

Should you have any application-referred questions, please contact our experts, who will be pleased to advise you.

1.19 Customer complaints

If a fault occurs in a product despite careful manufacture and testing, please contact your local sales organization. Your complaint will be registered and forwarded to the relevant technical departments for rapid handling.

EPCOS treats technical complaints according to the 8D⁵⁾ methodology; i.e. with the use of interdisciplinary teams who aim to implement rapid countermeasures and sustained corrective actions and answer all complaints with an 8D report.

In order to deal quickly and smoothly with complaints, the following data are helpful:

- Number of components subject to complaint or returned
- Fault description (with photos if applicable)
- How and when was the fault detected?
- Logistics data (delivery note no., batch no., date code)
- Operating conditions
- Operating duration up to occurrence of the fault
- Measurement parameters in the case of divergent technical data

In the event of transport damage, we would ask you to describe this in more detail and if required to mark it so that it can be distinguished from any further damage sustained during the return shipment. The original package should also be checked and any damage should be described. In order to avoid further damage, the original packaging should also be used for the return shipment.

If you receive a damaged shipment, please document this damage together with a signature of the forwarding company on the delivery papers.

5) 8D = 8 disciplines

2 Environmental management

2.1 Environmental policy

Our fundamental commitment to environmental protection is laid down in the EPCOS environmental policy.

EPCOS defines the following environmental protection principles:

1. We work continuously toward reducing the burden on the environment, toward minimizing associated risks and toward lowering the use of energy and resources, above and beyond the legal requirements.
2. We take appropriate precautions to avoid environmental hazards and to prevent damage to the environment.
3. Potential impacts on the environment are assessed and incorporated in our process and product planning at the earliest possible stage.
4. By applying appropriate management, we ensure that our environmental policy is implemented effectively. The technical and organizational procedures required to do this are regularly monitored and constantly further developed.
5. Each employee is required to act in an environmentally conscious manner. It is the constant duty of management to increase and encourage awareness of responsibility at all levels.
6. We work with our business partners to promote compliance with similar objectives. We provide our customers with information on ways to minimize any potentially adverse environmental impacts of our products.
7. We work in a spirit of cooperation with the relevant authorities.
8. We inform the public of the impact on the environment caused by the company and our activities related to the environment.
9. Every employee is required to observe the rules relating work safety.
10. We take preventive measures to avoid work-related accidents.

2.2 Environmental management system

The EPCOS ISO 14001 based environmental management system is applied throughout the company in order to implement the EPCOS environmental policy. It is posted on the EPCOS Intranet and is thus accessible to all employees.

2.3 Certification

The EPCOS Group operates an environmental management system that conforms to the requirements of ISO 14001 and is mandatory for all plants. The company certificate is posted on the EPCOS Internet: www.epcos.com/environmental_management.

2.4 RoHS

The term "RoHS-compatible" shall mean the following: Components defined as "RoHS-compatible" are compatible with the requirements of Art. 4 of Directive 2011/65/EU ("RoHS II") of the European Parliament and of the Council on the restriction of the use of certain hazardous substances in electrical and electronic equipment of 8 June 2011 and with the requirements of the provisions which will result from transposition of RoHS II into national law to the extent that such provisions reflect this directive.

"RoHS-compatible" components do not contain any of the following substances in quantities exceeding the maximum concentration limits of 0.1% for lead, mercury, hexavalent chromium, PBB, PBDE, and 0.01% for cadmium at a homogeneous material level, unless the application is exempted by Annex III of "RoHS II".

2.5 REACH

According to Art. 33 we are obliged to inform our customers immediately, or on request of a consumer within 45 days, if it comes to our knowledge that a Substance of Very High Concern (SVHC) is contained in a product or its packaging with more than 0.1% w/w. This provision applies if this substance is found on the candidates list by the European Chemical Agency. Respective information is provided via www.epcos.com/reach (Link: REACH Candidates List and Information according REACH Art. 33, concerning EPCOS Products).

2.6 Banned and hazardous substances in components

As a manufacturer of passive components, we develop our products on the basis of sustainability. In order to establish a standardized procedure for EPCOS worldwide, material compliance management and a mandatory list of banned and declarable substances as well as substances of special interest (EPCOS BAD-SL) are part of our quality management system. Our planning and development instructions include regulations and guidelines that aim to identify environmental aspects and to optimize products and processes with respect to material use and environmental compliance, to design them with sparing use of resources and to substitute hazardous substances as far as possible.

Consideration of the environmental aspects is checked and recorded in the design reviews: the environmental officer provides support in the assessment of the environmental impacts of a development project.

2.7 Material data sheets for product classes

EPCOS posts material data sheets on the Internet (www.epcos.com/material) that show typical compositions of product classes by selected representatives. The materials are listed with their percentage weight distribution referred to the respective component.

As stipulated by IEC/PAS 61906 (IEC 62474), all materials are listed, whose percentage by weight exceeds 0.1% or at least a given legal limit. All specifications are typical data and may vary slightly within a product class or production lot.

The material data sheets do not represent guaranteed properties, but are merely given for purposes of information.

Please note in the connection the "Important notes" on page 2.

2.8 Disposal

Aluminum electrolytic capacitors can be disposed of, in principle reused or – partly – recycled, depending on their actual condition. However as disposal is regulated by national law, the respective national provisions must be observed.