



Aluminum Capacitors

TESTS AND REQUIREMENTS

This datasheet contains an abridged version of tests and requirements given in “IEC 60384-4” or “EN 130300” respectively. Correct sequence of measurement for electrical parameters in accordance with “IEC 60384-4”:

1. Leakage current
2. Capacitance
3. $\tan \delta$ or ESR
4. Impedance

Table 1

| NON-SOLID ALUMINUM TYPES | | | | |
|------------------------------|--|----------------------------|---|--|
| NAME OF TEST | IEC 60384-4/ EN 130300 SUBCLAUSE | IEC 60068-2 TEST METHOD | PROCEDURE (quick reference) | REQUIREMENTS |
| Robustness of terminations: | 4.4 | Ua | Leaded types: loading force 10 N for 10 s | No visible damage |
| Tensile strength | | | Power types: loading force 20 N for 10 s | |
| Bending | | | Leaded types: loading force 5 N Two consecutive bends | |
| Torsion | | | Leaded types, axial: two successive rotations of 180° in opposite direction; 5 s per rotation | |
| Torque on nut (stud) | | Ud | Power types / screw terminal: torque of 1.76 Nm gradually applied | No visible damage |
| Resistance to soldering heat | 4.5 | Tb (method 1A) | Solder bath: 260 °C; 10 s | No visible damage; marking legible $\Delta C/C: \pm 5 \%$ |
| Solderability | 4.6 | Ta | Solder bath: 235 °C; 2 s; immersed up to 2 mm from the body; non activated flux | No visible damage; marking legible $\geq 95 \%$ tinning |
| Rapid change of temperature | 4.7 | Na | For snap-in, DIN-PW and screw terminal capacitors: 5 cycles of 3 h at lower and upper category temperature For axial, radial, and SMD capacitors: 5 cycles of 30 min at lower and upper category temperature | No visible damage; no leakage of electrolyte |
| Vibration ⁽¹⁾ | 4.8 | Fc | 10 Hz to 500 Hz; 0.75 mm or 10 g (whichever is less); 3 directions; 2 h per direction Form MR or ST types: 10 Hz to 55 Hz; 0.75 mm or 10 g (whichever is less); 3 directions; 2 h per direction | No visible damage; No leakage of electrolyte; marking legible $\Delta C/C: \pm 5 \%$ with respect to initial measurements |
| Bump ⁽¹⁾ | 4.9 | Eb | 40 g; 2 directions; 4000 bumps total Form MR: 40 g; 2 directions; 1000 bumps total | No visible damage; no leakage of electrolyte $\Delta C/C: \pm 5 \%$ with respect to initial measurement |
| Climatic sequence: | 4.11 | | | |
| Dry heat | 4.11.1 | Ba | 16 h at upper category temperature; no voltage applied | No visible damage; no leakage of electrolyte |
| Damp heat, cyclic | 4.11.2 | Db | 1 cycle (55 °C → 25 °C) of 24 h; RH 95 % to 100 %; no voltage applied | |
| Cold | 4.11.3 | Aa | 2 h at lower category temperature; no voltage applied | No visible damage; no leakage of electrolyte |



| NON-SOLID ALUMINUM TYPES | | | | |
|--|--|----------------------------|---|---|
| NAME OF TEST | IEC 60384-4/ EN 130300 SUBCLAUSE | IEC 60068-2 TEST METHOD | PROCEDURE (quick reference) | REQUIREMENTS |
| Low air pressure | 4.11.4 | M | 5 min at 25 °C ± 10 °C; at atmospheric pressure of 8.5 kPa; U _R applied during last min | No visible damage; no evidence of breakdown or flashover |
| Damp heat, cyclic | 4.11.5 | Db | 5 cycles (55 °C → 25 °C) of 24 h each; RH 95 % to 100 %; no voltage applied | No continuous chain of bubbles No visible damage; no leakage of electrolyte; marking legible Leakage current ≤ stated limit tan δ ≤ 1.2 x stated limit ΔC/C: ± 10 % |
| Sealing | 4.11.6 | Qc | 1 min in water at 90 °C | |
| | 4.11.7 | | Final measurement after climatic sequence | |
| Insulation resistance | 4.3.5 | | Insulation sleeve: foil method | Insulation resistance ≥ 100 MΩ |
| Voltage proof | 4.3.6 | | Insulation sleeve: foil method; 1000 V for 1 min | No breakdown or flashover |
| Damp heat, steady state | 4.12 | Ca | 56 d at 40 °C; RH 90 % to 95 %; no voltage applied | No visible damage; no leakage of electrolyte; marking legible Leakage current ≤ stated limit tan δ ≤ 1.2 x stated limit Insulation resistance > 100 MΩ; no breakdown or flashover below 1000 V ΔC/C: ± 10 % |
| Endurance | 4.13 | | For test duration, refer to the relevant datasheet; at upper category temperature; U _R applied | No visible damage; no leakage of electrolyte; marking legible Leakage current ≤ stated limit Insulation resistance > 100 MΩ; no breakdown or flashover below 1000 V U _R ≤ 6.3 V; ΔC/C: + 15 %/- 30 %; 6.3 V < U _R < 200 V; ΔC/C: ± 15 %; U _R ≥ 200 V; ΔC/C: ± 10 % tan δ ≤ 1.3 x stated limit Impedance ≤ 2 x stated limit |
| Surge | 4.14 | | From source of 1.15 x U _R for U _R ≤ 315 V or 1.1 x U _R for U _R > 315 V RC = 0.1 s ± 0.05 s 1000 cycles of 30 s on, 330 s off, at upper category temperature | No visible damage; no leakage of electrolyte Leakage current ≤ stated limit tan δ ≤ stated limit ΔC/C: ± 15 % |
| Reverse voltage | 4.15 | | 1 V in reverse polarity followed by U _R in forward polarity, both for 125 h at upper category temperature | Leakage current ≤ stated limit tan δ ≤ stated limit ΔC/C: ± 10 % |
| Pressure relief (only for types with vent) | 4.16 | | DC voltage applied in reverse direction producing a current of 1 A to 10 A | Pressure relief opens prior to danger of explosion or fire |



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|--|---|------------------------------------|---|--|
| NAME OF TEST | IEC 60384-4/ EN 130300 SUBCLAUSE | IEC 60068-2 TEST METHOD | PROCEDURE (quick reference) | REQUIREMENTS |
| Storage at upper category temperature | 4.17 | Ba | Test duration 500 h at upper category temperature; for longer test duration (shelf life), refer to the relevant datasheet | No visible damage; no leakage of electrolyte Leakage current $\leq 2 \times$ stated limit $\tan \delta \leq 1.2 \times$ stated limit $\Delta C/C: \pm 10 \%$ |
| Storage at low temperature | 4.18 | Ab | 72 h at the lower category temperature | No visible damage; no leakage of electrolyte Leakage current \leq stated limit $\tan \delta \leq$ stated limit $\Delta C/C: \pm 10 \%$ |
| Characteristics at high and low temperatures | 4.19 | | Step 1: reference measurement of impedance at 20 °C and 100 Hz | |
| | | Aa | Step 2: measurement at lower category temperature | Impedance at 100 Hz: $\leq 10 \times$ value of step 1 for $U_R \leq 6.3$ V; $\leq 8 \times$ value of step 1 for $6.3 \text{ V} < U_R \leq 16 \text{ V}$; $\leq 6 \times$ value of step 1 for $16 \text{ V} < U_R \leq 160 \text{ V}$ $\leq 10 \times$ value of step 1 for $U_R > 160 \text{ V}$ |
| | | Ba | Step 3: measurement at upper category temperature | Leakage current: $\leq 15 \times$ stated limit at 150 °C; $\leq 10 \times$ stated limit at 125 °C; $\leq 8 \times$ stated limit at 105 °C; $\leq 5 \times$ stated limit at 85 °C; $\leq 3 \times$ stated limit at 70 °C |
| Charge and discharge | 4.20 | | For $U_R \leq 160 \text{ V}$: 10^6 cycles of 0.5 s charge to U_R (RC = 0.1 s) and 0.5 s discharge (RC = 0.1 s); For $U_R > 160 \text{ V}$: under consideration | No visible damage; no leakage of electrolyte $\Delta C/C: \pm 10 \%$ |
| Additional tests in accordance with IEC 60384-1 and EN 130000 | | | | |
| Solvent resistance | 4.31 | Xa | Immersion: 5 min \pm 0.5 min with or without ultrasonic at 55 °C \pm 0.5 °C Solvents: demineralized water and / or calgonite solution (20 g/l) | Visual appearance not affected |
| Passive flammability | 4.38 | IEC 60695-11-5 | Needle flame test | Category of flammability: B |

Note

- (1) For vibration and bump testing, the components shall be mounted by their terminations (with mounting accessories where applicable). The following capacitors shall also be clamped by their body:
- (a) Radial types: $\varnothing D_{nom} \geq 12.5 \text{ mm}$; $L_{nom} \geq 15 \text{ mm}$
 - (b) Axial types: $\varnothing D_{nom} \geq 12.5 \text{ mm}$; $L_{nom} \geq 30 \text{ mm}$