

Aluminum Capacitors Axial High Temperature, High Ripple Current



Fig. 1

| QUICK REFERENCE DATA | |
|--|--------------------------|
| DESCRIPTION | VALUE |
| Nominal case sizes (Ø D x L in mm) | 10 x 30 to 21 x 38 |
| Rated capacitance range, C _R | 47 µF to 6800 µF |
| Tolerance on C _R | ± 20 % |
| Rated voltage range, U _R | 16 V to 100 V |
| Category temperature range | - 40 °C to + 125 °C |
| Endurance test at 150 °C | 1000 h |
| Endurance test at 125 °C | 4000 h |
| Useful life at 125 °C | 8000 h |
| Useful life at 85 °C, 1.4 x I _R applied | 40 000 h |
| Shelf life at 0 V, 125 °C | 1000 h (100 V: 500 h) |
| Shelf life at 0 V, 150 °C | ≤ 63 V: 500 h |
| Based on sectional specification | IEC 60384-4/EN 130300 |
| Climatic category IEC 60068 | 40/125/56 |

FEATURES

- Extra long useful life: Up to 8000 h at 125 °C
- Extended temperature range: Usable up to 150 °C
- Lowest ESR levels providing very high ripple current capability
- Miniaturized, high CV-product per unit volume
- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Axial leads, cylindrical aluminum case, insulated with a blue sleeve
- Taped versions up to case Ø 15 mm x 30 mm available for automatic insertion
- Lead diameter Ø d = 1.0 mm, available on request
- Material categorization: For definitions of compliance please see www.vishay.com/doc?99912


**RoHS
COMPLIANT**

APPLICATIONS

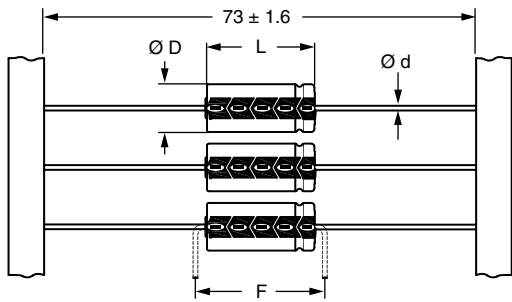
- Automotive, industrial and telecommunication
- Smoothing, filtering, buffering
- Low mounting height applications, vibration and shock resistant
- SMPS and standard power supplies

MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for ± 20 %)
- Rated voltage (in V)
- Upper category temperature (125 °C)
- Date code in accordance with IEC 60062
- Code for factory of origin
- Name of manufacturer
- Negative terminal identification
- Series number (120)

| SELECTION CHART FOR C _R , U _R , AND RELEVANT NOMINAL CASE SIZE (Ø D x L in mm) | | | | | |
|--|--------------------|-----------|-----------|-----------|-----------|
| C _R (µF) | U _R (V) | | | | |
| | 16 | 25 | 40 | 63 | 100 |
| 47 | - | - | - | - | 10 x 30 |
| 68 | - | - | - | - | 12.5 x 30 |
| 100 | - | - | - | 10 x 30 | 12.5 x 30 |
| 150 | - | - | - | 12.5 x 30 | 15 x 30 |
| 220 | - | - | 10 x 30 | 12.5 x 30 | 18 x 30 |
| 330 | - | - | 12.5 x 30 | 15 x 30 | 18 x 38 |
| 470 | - | 10 x 30 | 12.5 x 30 | 18 x 30 | 21 x 38 |
| 680 | 10 x 30 | 12.5 x 30 | 15 x 30 | 18 x 38 | - |
| 1000 | 12.5 x 30 | 12.5 x 30 | 18 x 30 | 21 x 38 | - |
| 1500 | 12.5 x 30 | 15 x 30 | 18 x 38 | - | - |
| 2200 | 15 x 30 | 18 x 30 | 21 x 38 | - | - |
| 3300 | 18 x 30 | 18 x 38 | - | - | - |
| 4700 | 18 x 38 | 21 x 38 | - | - | - |
| 6800 | 21 x 38 | - | - | - | - |

DIMENSIONS in millimeters AND AVAILABLE FORMS


Form BR: Taped on reel
Case $\varnothing D \times L = 6.5 \text{ mm} \times 18 \text{ mm}$ to $15 \text{ mm} \times 30 \text{ mm}$

Fig. 2 - Form BR



Form AA: Axial in box
Case $\varnothing D \times L = 10 \text{ mm} \times 30 \text{ mm}$ to $21 \text{ mm} \times 38 \text{ mm}$

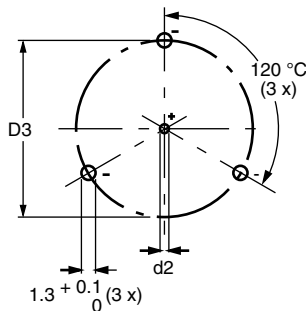
Fig. 3 - Form AA

Table 1

| AXIAL; DIMENSIONS in millimeters, MASS, AND PACKAGING QUANTITIES | | | | | | | | |
|---|-----------------------|------------|------------------------|------------|------------|----------------|----------------------|---------|
| NOMINAL CASE SIZE $\varnothing D \times L$ (mm) | AXIAL: FORM AA AND BR | | | | | MASS (g) | PACKAGING QUANTITIES | |
| | $\varnothing d$ (1) | l | $\varnothing D_{max.}$ | $L_{max.}$ | $F_{min.}$ | | FORM AA | FORM BR |
| 10 x 30 | 0.8 | 55 ± 1 | 10.5 | 30.5 | 35 | ≈ 4.8 | 340 | 500 |
| 12.5 x 30 | 0.8 | 55 ± 1 | 13.0 | 30.5 | 35 | ≈ 7.4 | 260 | 400 |
| 15 x 30 | 0.8 | 55 ± 1 | 15.5 | 30.5 | 35 | ≈ 11.7 | 200 | 250 |
| 18 x 30 | 0.8 | 55 ± 1 | 18.5 | 30.5 | 35 | ≈ 12.9 | 120 | - |
| 18 x 38 | 0.8 | 34 ± 1 | 18.5 | 39.5 | 44 | ≈ 19.0 | 125 | - |
| 21 x 38 | 0.8 | 34 ± 1 | 21.5 | 39.5 | 44 | ≈ 24.0 | 100 | - |

Notes

- (1) Lead diameter $\varnothing d = 1.0 \text{ mm}$, available on request.
- For detailed tape dimensions, please see www.vishay.com/doc?28361.



Mounting holes

Case $\varnothing D \times L = 15 \text{ mm} \times 30 \text{ mm}$ to $21 \text{ mm} \times 38 \text{ mm}$
Especially for applications with severe shocks and vibrations

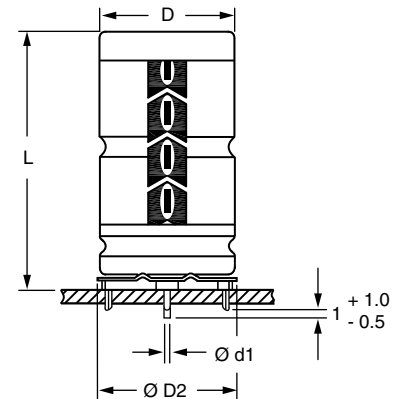
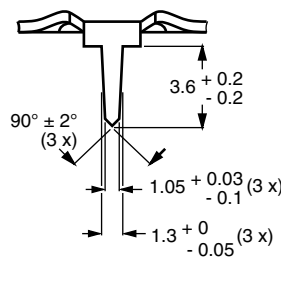

 Fig. 4 - Mounting hole diagram and outline; **form MR:** With mounting ring and pins

Table 2

| MOUNTING RING; DIMENSIONS in millimeters, MASS, AND PACKAGING QUANTITIES | | | | | | | | | |
|---|-----------|------------------------|------------------|------------------------|-------------------------|----------------|------------|----------------|----------------------|
| NOMINAL CASE SIZE $\varnothing D \times L$ | CASE CODE | MOUNTING RING: FORM MR | | | | | | MASS (g) | PACKAGING QUANTITIES |
| | | $\varnothing d1$ | $\varnothing d2$ | $\varnothing D_{max.}$ | $\varnothing D2_{max.}$ | D3 | $L_{max.}$ | | |
| 15 x 30 | 02 | 0.8 | $1.0 + 0.4$ | 15.5 | 17.5 | 16.5 ± 0.2 | 33 | ≈ 8.6 | 200 |
| 18 x 30 | 03 | 0.8 | $1.0 + 0.4$ | 18.5 | 19.5 | 18.5 ± 0.2 | 33 | ≈ 11.5 | 240 |
| 18 x 38 | 04 | 0.8 | $1.0 + 0.4$ | 18.5 | 19.5 | 18.5 ± 0.2 | 42 | ≈ 14.0 | 100 |
| 21 x 38 | 05 | 0.8 | $1.0 + 0.4$ | 21.5 | 22.5 | 21.5 ± 0.2 | 42 | ≈ 19.2 | 100 |



| ELECTRICAL DATA | |
|-----------------|--|
| SYMBOL | DESCRIPTION |
| C _R | Rated capacitance at 100 Hz, tolerance ± 20 % |
| I _R | Rated RMS ripple current at 10 kHz, 125 °C |
| I _{L1} | Max. leakage current after 1 min at U _R |
| I _{L5} | Max. leakage current after 5 min at U _R |
| ESR | Equivalent series resistance at 100 Hz (calculated from tan δ _{max.} and C _R) |
| Z | Max. impedance at 10 kHz |

ORDERING EXAMPLE

Electrolytic capacitor 120 series

1000 µF/16 V; ± 20 %

Nominal case size: Ø 12.5 mm x 30 mm; form BR

Ordering code: MAL212025102E3

Former 12NC: 2222 120 25102

Note

- Unless otherwise specified, all electrical values in Table 3 apply at T_{amb} = 20 °C, P = 86 kPa to 106 kPa, RH = 45 % to 75 %.

Table 3

| ELECTRICAL DATA AND ORDERING INFORMATION | | | | | | | | | | | | | |
|--|----------------------------------|---|--|----------------------------------|----------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-----------------------------|----------------------------|-----------------------------|-----------------------------|
| U _R (V) | C _R 100 Hz (µF) | NOMINAL CASE SIZE Ø D x L (mm) | I _R 10 kHz 125 °C (mA) | I _{L1} 1 min (µA) | I _{L5} 5 min (µA) | TYP. ESR 100 Hz (mΩ) | MAX. ESR 100 Hz (mΩ) | TYP. ESR 10 kHz (mΩ) | MAX. ESR 10 kHz (mΩ) | Z MAX. 10 kHz (mΩ) | ORDERING CODE MAL2120..... | | |
| | | | | | | | | | | | IN BOX FORM AA | TAPED ON REEL FORM BR | MOUNTING RING FORM MR |
| 16 | 680 | 10 x 30 | 2100 | 171 | 84 | 106 | 177 | 44 | 74 | 78 | 15681E3 | 25681E3 | - |
| | 1000 | 12.5 x 30 | 2550 | 232 | 104 | 77 | 128 | 35 | 58 | 61 | 15102E3 | 25102E3 | - |
| | 1500 | 12.5 x 30 | 2650 | 328 | 136 | 60 | 100 | 32 | 53 | 53 | 15152E3 | 25152E3 | - |
| | 2200 | 15 x 30 | 2940 | 462 | 181 | 48 | 79 | 28 | 46 | 46 | 15222E3 | 25222E3 | 45222E3 |
| | 3300 | 18 x 30 | 3430 | 674 | 251 | 41 | 68 | 26 | 43 | 43 | 15332E3 | - | 45332E3 |
| | 4700 | 18 x 38 | 4350 | 942 | 341 | 27 | 45 | 18 | 29 | 29 | 15472E3 | - | 45472E3 |
| | 6800 | 21 x 38 | 4590 | 1346 | 475 | 26 | 43 | 18 | 29 | 29 | 15682E3 | - | 45682E3 |
| 25 | 470 | 10 x 30 | 2100 | 181 | 87 | 112 | 187 | 45 | 74 | 84 | 16471E3 | 26471E3 | - |
| | 680 | 12.5 x 30 | 2550 | 244 | 108 | 81 | 136 | 35 | 59 | 64 | 16681E3 | 26681E3 | - |
| | 1000 | 12.5 x 30 | 2600 | 340 | 140 | 64 | 107 | 32 | 53 | 55 | 16102E3 | 26102E3 | - |
| | 1500 | 15 x 30 | 2890 | 490 | 190 | 49 | 82 | 28 | 46 | 46 | 16152E3 | 26152E3 | 46152E3 |
| | 2200 | 18 x 30 | 3310 | 700 | 260 | 43 | 71 | 27 | 44 | 44 | 16222E3 | - | 46222E3 |
| | 3300 | 18 x 38 | 4350 | 1030 | 370 | 28 | 47 | 18 | 29 | 29 | 16332E3 | - | 46332E3 |
| | 4700 | 21 x 38 | 4470 | 1450 | 510 | 27 | 44 | 18 | 29 | 29 | 16472E3 | - | 46472E3 |
| 40 | 220 | 10 x 30 | 1990 | 146 | 75 | 192 | 320 | 52 | 87 | 124 | 17221E3 | 27221E3 | - |
| | 330 | 12.5 x 30 | 2430 | 198 | 93 | 130 | 216 | 37 | 62 | 83 | 17331E3 | 27331E3 | - |
| | 470 | 12.5 x 30 | 2550 | 266 | 115 | 101 | 169 | 35 | 58 | 70 | 17471E3 | 27471E3 | - |
| | 680 | 15 x 30 | 2840 | 366 | 149 | 75 | 125 | 30 | 50 | 55 | 17681E3 | 27681E3 | 47681E3 |
| | 1000 | 18 x 30 | 3150 | 520 | 200 | 59 | 99 | 28 | 47 | 49 | 17102E3 | - | 47102E3 |
| | 1500 | 18 x 38 | 4130 | 760 | 280 | 39 | 65 | 19 | 31 | 32 | 17152E3 | - | 47152E3 |
| | 2200 | 21 x 38 | 4170 | 1096 | 392 | 34 | 56 | 19 | 31 | 31 | 17222E3 | - | 47222E3 |
| 63 | 100 | 10 x 30 | 1560 | 116 | 65 | 297 | 495 | 92 | 154 | 249 | 18101E3 | 28101E3 | - |
| | 150 | 12.5 x 30 | 2050 | 153 | 78 | 195 | 325 | 61 | 102 | 162 | 18151E3 | 28151E3 | - |
| | 220 | 12.5 x 30 | 2150 | 206 | 95 | 149 | 249 | 55 | 92 | 126 | 18221E3 | 28221E3 | - |
| | 330 | 15 x 30 | 2510 | 289 | 123 | 105 | 175 | 44 | 73 | 91 | 18331E3 | 28331E3 | 48331E3 |
| | 470 | 18 x 30 | 2860 | 395 | 158 | 81 | 135 | 38 | 64 | 74 | 18471E3 | - | 48471E3 |
| | 680 | 18 x 38 | 3720 | 554 | 211 | 55 | 92 | 26 | 43 | 49 | 18681E3 | - | 48681E3 |
| | 1000 | 21 x 38 | 3780 | 796 | 292 | 44 | 74 | 25 | 41 | 43 | 18102E3 | - | 48102E3 |
| 100 | 47 | 10 x 30 | 760 | 96 | 59 | 760 | 1269 | 349 | 581 | 720 | 19479E3 | 29479E3 | - |
| | 68 | 12.5 x 30 | 1030 | 122 | 67 | 531 | 885 | 246 | 410 | 503 | 19689E3 | 29689E3 | - |
| | 100 | 12.5 x 30 | 1140 | 160 | 80 | 389 | 648 | 196 | 327 | 381 | 19101E3 | 29101E3 | - |
| | 150 | 15 x 30 | 1480 | 220 | 100 | 266 | 443 | 137 | 229 | 262 | 19151E3 | 29151E3 | 49151E3 |
| | 220 | 18 x 30 | 1960 | 304 | 128 | 181 | 302 | 95 | 158 | 179 | 19221E3 | - | 49221E3 |
| | 330 | 18 x 38 | 2550 | 436 | 172 | 120 | 200 | 62 | 104 | 117 | 19331E3 | - | 49331E3 |
| | 470 | 21 x 38 | 2800 | 604 | 228 | 92 | 154 | 52 | 86 | 94 | 19471E3 | - | 49471E3 |



| ADDITIONAL ELECTRICAL DATA | | | |
|------------------------------------|-----------------------------------|---|---------------|
| PARAMETER | CONDITIONS | VALUE | |
| | | AXIAL | MOUNTING RING |
| Voltage | | | |
| Surge voltage | | $U_s \leq 1.15 \times U_R$ | |
| Reverse voltage | | $U_{rev} \leq 1 \text{ V}$ | |
| Current | | | |
| Leakage current | After 1 min at U_R | $I_{L1} \leq 0.012 C_R \times U_R + 40 \mu\text{A}$ | |
| | After 5 min at U_R | $I_{L5} \leq 0.004 C_R \times U_R + 40 \mu\text{A}$ | |
| Inductance | | | |
| Equivalent series inductance (ESL) | Case $\varnothing D \times L$ mm: | | |
| | 10 x 30 | Typ. 38 nH | |
| | 12.5 x 30 | Typ. 46 nH | |
| | 15 x 30 | Typ. 48 nH | Typ. 39 nH |
| | 18 x 30 | Typ. 50 nH | Typ. 39 nH |
| | 18 x 38 | Typ. 54 nH | Typ. 39 nH |
| | 21 x 38 | Typ. 59 nH | Typ. 39 nH |

CAPACITANCE (C)

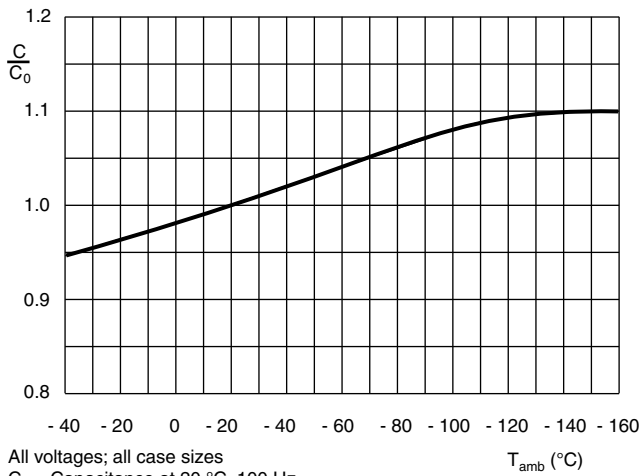


Fig. 5 - Typical multiplier of capacitance as a function of ambient temperature

EQUIVALENT SERIES RESISTANCE (ESR)

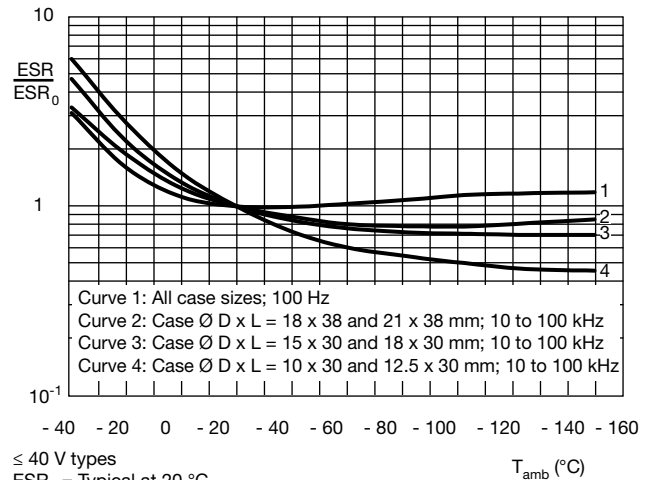


Fig. 6 - Typical multiplier of ESR as a function of ambient temperature at different frequencies

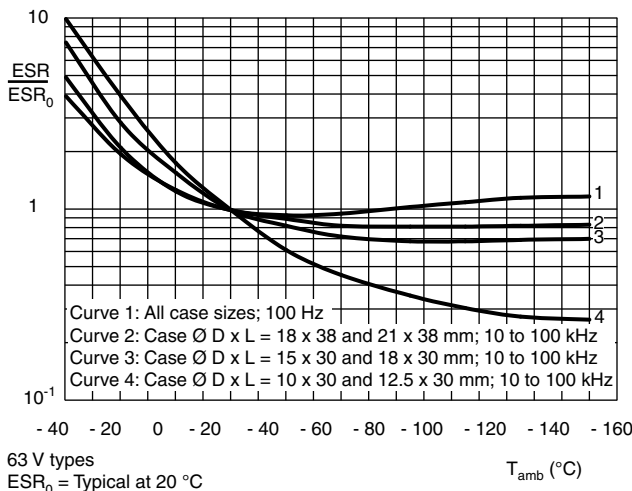


Fig. 7 - Typical multiplier of ESR as a function of ambient temperature at different frequencies

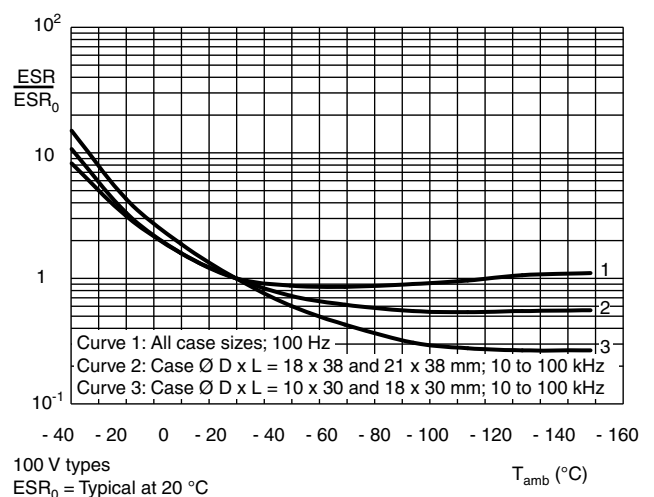


Fig. 8 - Typical multiplier of ESR as a function of ambient temperature at different frequencies

RIPPLE CURRENT AND USEFUL LIFE

JW64



I_A = Actual ripple current at 10 kHz
 I_R = Rated ripple current at 10 kHz, 125 °C
 (1) Useful life at 125 °C and I_R applied: 8000 h

Fig. 9 - Multiplier of useful life as a function of ambient temperature and ripple current load

Table 4

| MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY | | | | |
|---|---|---|---|---|
| FREQUENCY (Hz) | I_R MULTIPLIER | | | |
| | $U_R = 16\text{ V TO }40\text{ V}$ CASE SIZES (10 x 30 to 15 x 30) mm | $U_R = 16\text{ V TO }40\text{ V}$ CASE SIZES (18 x 30 to 21 x 38) mm | $U_R = 63\text{ V AND }100\text{ V}$ CASE SIZES (10 x 30 to 15 x 30) mm | $U_R = 63\text{ V AND }100\text{ V}$ CASE SIZES (18 x 30 to 21 x 38) mm |
| 50 | 0.37 | 0.54 | 0.23 | 0.44 |
| 100 | 0.48 | 0.63 | 0.32 | 0.56 |
| 300 | 0.69 | 0.75 | 0.53 | 0.76 |
| 1000 | 0.86 | 0.81 | 0.77 | 0.88 |
| 3000 | 0.96 | 0.87 | 0.93 | 0.94 |
| ≥ 10 000 | 1.00 | 1.00 | 1.00 | 1.00 |



Table 5

| TEST PROCEDURES AND REQUIREMENTS | | | |
|--|---|---|---|
| TEST | | PROCEDURE (quick reference) | REQUIREMENTS |
| NAME OF TEST | REFERENCE | | |
| Endurance | IEC 60384-4/ EN 130300 subclause 4.13 | $T_{amb} = 125\text{ }^{\circ}\text{C}$; U_R applied; 4000 h $T_{amb} = 150\text{ }^{\circ}\text{C}$; U_R applied; 1000 h | $\Delta C/C$: $\pm 15\%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ |
| Useful life | CECC 30301 subclause 1.8.1 | $T_{amb} = 125\text{ }^{\circ}\text{C}$; U_R and I_R applied; 8000 h | $\Delta C/C$: $\pm 45\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$ |
| Shelf life (storage at high temperature) | IEC 60384-4/ EN 130300 subclause 4.17 | $T_{amb} = 125\text{ }^{\circ}\text{C}$; no voltage applied; 1000 h (100 V: 500 h) $T_{amb} = 150\text{ }^{\circ}\text{C}$; no voltage applied; 500 h for voltages: $\leq 63\text{ V}$ After test: U_R to be applied for 30 min, 24 h to 48 h before measurement | $\Delta C/C$, $\tan \delta$, Z : For requirements see "Endurance test" above $I_{L5} \leq 2 \times \text{spec. limit}$ |
| Reverse voltage | IEC 60384-4/ EN 130300 subclause 4.15 | $T_{amb} = 125\text{ }^{\circ}\text{C}$: 125 h at $U = -1\text{ V}$ Followed by 125 h at U_R | $\Delta C/C$: $\pm 20\%$ $\tan \delta \leq \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ |



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JONHON

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