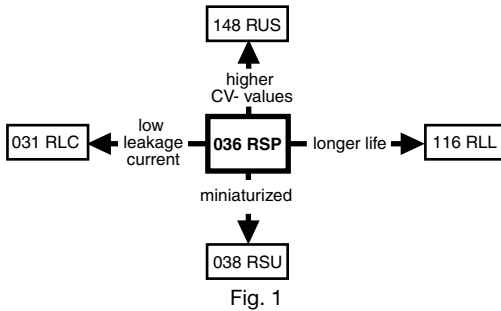
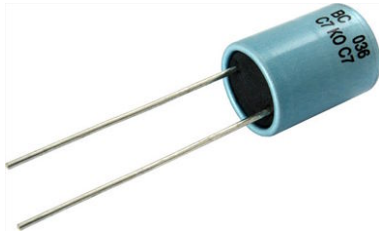


Aluminum Electrolytic Capacitors Radial Semi-Professional



FEATURES

- Useful life: 3000 h at +85 °C, 750 h at +105 °C
- Reduced leakage current
- Miniaturized, high CV-product per unit volume
- Natural pitch 2.5 mm and 5 mm
- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case, all-insulated (light blue)
- Charge and discharge proof
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912


**RoHS
COMPLIANT**

APPLICATIONS

- Automotive, telecommunication, industrial, EDP, and audio-video
- Coupling, decoupling, smoothing, filtering, buffering, timing
- Portable and mobile equipment (small size, low mass)

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 $\pm 20\%$)
- Rated voltage (in V)
- Date code in accordance with IEC 60062
- Code indicating factory of origin
- Name of manufacturer
- Minus-sign on top to identify the negative terminal
- Series number (036)

| QUICK REFERENCE DATA | |
|---|--|
| DESCRIPTION | VALUE |
| Nominal case sizes (\varnothing D x L in mm) | 5 x 11 and 8.2 x 11 |
| Rated capacitance range, C_R | 2.2 μF to 470 μF |
| Tolerance on C_R | $\pm 20\%$; $\pm 10\%$ on request |
| Rated voltage range, U_R | 6.3 V to 100 V |
| Category temperature range | -55 °C to +85 °C |
| Endurance test at 85 °C | 2000 h |
| Useful life at 105 °C | 750 h |
| Useful life at 85 °C | 3000 h |
| Useful life at 40 °C, 1.4 x I_R applied | 80 000 h |
| Shelf life at 0 V, 85 °C | 500 h |
| Based on sectional specification | IEC 60384-4 / EN130300 |
| Climatic category IEC 60068 | 55 / 085 / 56 |

| SELECTION CHART FOR C_R , U_R , AND RELEVANT NOMINAL CASE SIZES (\varnothing D x L in mm) | | | | | | | | | |
|--|-----------|----------|----------|----------|----------|----------|----------|----------|----------|
| C_R (μF) | U_R (V) | | | | | | | | |
| | 6.3 | 10 | 16 | 25 | 35 | 40 | 50 | 63 | 100 |
| 2.2 | - | - | - | - | - | - | - | 5 x 11 | - |
| 3.3 | - | - | - | - | - | - | - | 5 x 11 | - |
| 4.7 | - | - | - | - | - | - | - | 5 x 11 | - |
| 6.8 | - | - | - | - | - | - | - | 5 x 11 | - |
| 10 | - | - | - | - | - | - | 5 x 11 | 5 x 11 | 8.2 x 11 |
| | - | - | - | - | - | - | - | 8.2 x 11 | - |
| 15 | - | - | - | - | - | 5 x 11 | - | 5 x 11 | - |
| 22 | - | - | - | - | 5 x 11 | - | - | 5 x 11 | 8.2 x 11 |
| | - | - | - | - | - | - | - | 8.2 x 11 | - |
| 33 | - | - | 5 x 11 | - | - | - | 5 x 11 | 8.2 x 11 | - |
| 47 | - | 5 x 11 | - | - | 5 x 11 | - | 8.2 x 11 | 8.2 x 11 | - |
| 68 | - | - | - | 5 x 11 | - | 8.2 x 11 | - | 8.2 x 11 | - |
| 100 | 5 x 11 | - | 5 x 11 | 8.2 x 11 | - | - | 8.2 x 11 | - | - |
| 150 | - | 5 x 11 | 8.2 x 11 | - | 8.2 x 11 | - | - | - | - |
| 220 | - | 8.2 x 11 | 8.2 x 11 | 8.2 x 11 | - | - | - | - | - |
| 330 | 8.2 x 11 | - | 8.2 x 11 | - | - | - | - | - | - |
| 470 | - | 8.2 x 11 | - | - | - | - | - | - | - |

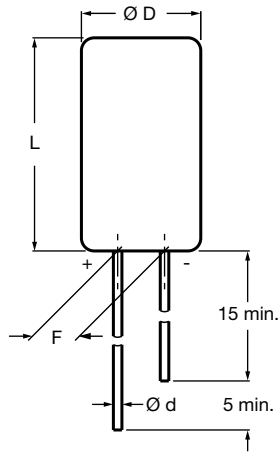
DIMENSIONS in millimeters AND AVAILABLE FORMS


Fig. 2 - Form CA: Long leads

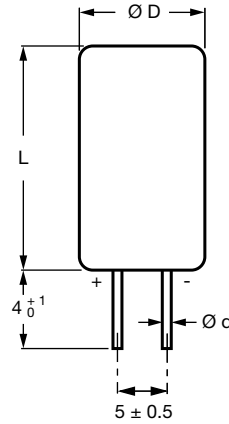

 Case $\varnothing D \times L = 8.2 \text{ mm} \times 11 \text{ mm}$ only

Fig. 3 - Form CB: Cut leads

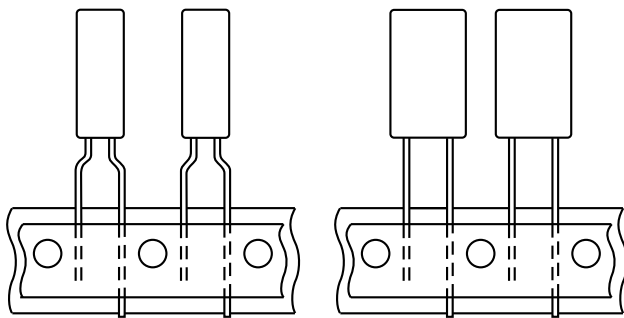

 Pitch $F = 5 \text{ mm}$
 Case $\varnothing D \times L = 5 \text{ mm} \times 11 \text{ mm}$ and $8.2 \text{ mm} \times 11 \text{ mm}$

Fig. 4 - Form TFA: Taped in box (ammopack)

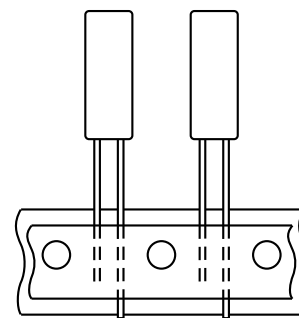

 Pitch $F = 2.5 \text{ mm}$
 Case $\varnothing D \times L = 5 \text{ mm} \times 11 \text{ mm}$ only

Fig. 5 - Form TNA: Taped in box (ammopack)

Table 1

| DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES | | | | | | | | |
|--|-----------|-----------------|-------------------------------|-------------------|---------------|---------------|----------------------|---------------|
| NOMINAL CASE SIZE $\varnothing D \times L$ | CASE CODE | $\varnothing d$ | $\varnothing D_{\text{max.}}$ | $L_{\text{max.}}$ | F | MASS (g) | PACKAGING QUANTITIES | |
| | | | | | | | FORM CA, CB | FORM TFA, TNA |
| 5 x 11 | 11 | 0.5 | 5.5 | 12 | 2.5 ± 0.5 | ≈ 0.4 | 1000 | 2000 |
| 8.2 x 11 | 13 | 0.6 | 8.7 | 12 | 5.0 ± 0.5 | ≈ 1.1 | 1000 | 1000 |

Note

- For tape dimensions, please see www.vishay.com/doc?28360.



| ELECTRICAL DATA | |
|-----------------|--|
| SYMBOL | DESCRIPTION |
| C _R | Rated capacitance at 100 Hz, tolerance ± 20 % |
| I _R | Rated RMS ripple current at 100 Hz, 85 °C |
| I _{L1} | Max. leakage current after 1 min at U _R |
| tan δ | Max. dissipation factor at 100 Hz |
| Z | Max. impedance at 10 kHz and 20 °C |

ORDERING EXAMPLE

Electrolytic capacitor 036 series
 100 µF / 16 V; ± 20 %
 Nominal case size: Ø 5 x 11 mm; Form TFA
 Ordering code: MAL203635101E3
 Former 12NC: 2222 036 35101

Note

- Unless otherwise specified, all electrical values in Table 2 apply at T_{amb} = 20 °C, P = 86 kPa to 106 kPa, RH = 45 % to 75 %

Table 2

| ELECTRICAL DATA AND ORDERING INFORMATION | | | | | | | | | | | | | | |
|--|----------------------------------|--|---|----------------------------------|-----------------|--------------------|----------------------------|-----------|------------|-----------|----------------|-----------|-------------|-----------|
| U _R (V) | C _R 100 Hz (µF) | NOMINAL CASE SIZE Ø D x L (mm) | I _R 100 Hz 85 °C (mA) | I _{L2} 2 min (µA) | tan δ 100 Hz | Z 10 kHz (Ω) | ORDERING CODE MAL2036..... | | | | | | | |
| | | | | | | | BULK PACKAGING | | | | TAPED AMMOPACK | | | |
| | | | | | | | LONG LEADS | | CUT LEADS | | FORM TFA | | FORM TNA | |
| | | | | | | | FORM CA | F (mm) | FORM CB | F (mm) | FORM TFA | F (mm) | FORM TNA | F (mm) |
| 6.3 | 100 | 5 x 11 | 130 | 7 | 0.20 | 1.7 | 53101E3 | 2.5 | - | - | 33101E3 | 5.0 | 73101E3 | 2.5 |
| | 330 | 8.2 x 11 | 300 | 16 | 0.20 | 0.52 | 53331E3 | 5.0 | 63331E3 | 5.0 | 33331E3 | 5.0 | - | - |
| 10 | 47 | 5 x 11 | 95 | 6 | 0.16 | 2.8 | 54479E3 | 2.5 | - | - | 34479E3 | 5.0 | 74479E3 | 2.5 |
| | 150 | 5 x 11 | 150 | 12 | 0.20 | 1.3 | 54151E3 | 2.5 | - | - | 34151E3 | 5.0 | 74151E3 | 2.5 |
| | 220 | 8.2 x 11 | 260 | 17 | 0.16 | 0.59 | 54221E3 | 5.0 | 64221E3 | 5.0 | 34221E3 | 5.0 | - | - |
| | 470 | 8.2 x 11 | 400 | 31 | 0.20 | 0.43 | 54471E3 | 5.0 | 64471E3 | 5.0 | 34471E3 | 5.0 | - | - |
| 16 | 33 | 5 x 11 | 90 | 7 | 0.14 | 2.7 | 55339E3 | 2.5 | - | - | 35339E3 | 5.0 | 75339E3 | 2.5 |
| | 100 | 5 x 11 | 160 | 13 | 0.16 | 1.6 | 55101E3 | 2.5 | - | - | 35101E3 | 5.0 | 75101E3 | 2.5 |
| | 150 | 8.2 x 11 | 230 | 18 | 0.14 | 0.6 | 55151E3 | 5.0 | 65151E3 | 5.0 | 35151E3 | 5.0 | - | - |
| | 220 | 8.2 x 11 | 280 | 24 | 0.16 | 0.55 | 55221E3 | 5.0 | 65221E3 | 5.0 | 35221E3 | 5.0 | - | - |
| 25 | 330 | 8.2 x 11 | 390 | 35 | 0.16 | 0.48 | 55331E3 | 5.0 | 65331E3 | 5.0 | 35331E3 | 5.0 | - | - |
| | 68 | 5 x 11 | 140 | 13 | 0.14 | 1.8 | 56689E3 | 2.5 | - | - | 36689E3 | 5.0 | 76689E3 | 2.5 |
| | 100 | 8.2 x 11 | 210 | 18 | 0.12 | 0.7 | 56101E3 | 5.0 | 66101E3 | 5.0 | 36101E3 | 5.0 | - | - |
| | 220 | 8.2 x 11 | 310 | 36 | 0.14 | 0.55 | 56221E3 | 5.0 | 66221E3 | 5.0 | 36221E3 | 5.0 | - | - |
| 35 | 22 | 5 x 11 | 87 | 8 | 0.10 | 2.7 | 90001E3 | 2.5 | - | - | 90027E3 | 5.0 | 90389E3 | 2.5 |
| | 47 | 5 x 11 | 130 | 13 | 0.12 | 1.9 | 90094E3 | 2.5 | - | - | 90098E3 | 5.0 | 90391E3 | 2.5 |
| | 150 | 8.2 x 11 | 270 | 35 | 0.12 | 0.6 | 90099E3 | 5.0 | 90101E3 | 5.0 | 90103E3 | 5.0 | - | - |
| 40 | 15 | 5 x 11 | 72 | 7 | 0.10 | 3.7 | 57159E3 | 2.5 | - | - | 37159E3 | 5.0 | 77159E3 | 2.5 |
| | 68 | 8.2 x 11 | 180 | 20 | 0.10 | 0.81 | 57689E3 | 5.0 | 67689E3 | 5.0 | 37689E3 | 5.0 | - | - |
| 50 | 10 | 5 x 11 | 60 | 6 | 0.08 | 4.5 | 90004E3 | 2.5 | - | - | 90028E3 | 5.0 | 90392E3 | 2.5 |
| | 33 | 5 x 11 | 110 | 13 | 0.10 | 2.1 | 90104E3 | 2.5 | - | - | 90108E3 | 5.0 | 90393E3 | 2.5 |
| | 47 | 8.2 x 11 | 160 | 18 | 0.08 | 0.96 | 90011E3 | 5.0 | 90012E3 | 5.0 | 90031E3 | 5.0 | - | - |
| | 100 | 8.2 x 11 | 250 | 33 | 0.10 | 0.7 | 90109E3 | 5.0 | 90111E3 | 5.0 | 90113E3 | 5.0 | - | - |
| 63 | 2.2 | 5 x 11 | 25 | 4 | 0.06 | 18 | 58228E3 | 2.5 | - | - | 38228E3 | 5.0 | 78228E3 | 2.5 |
| | 3.3 | 5 x 11 | 38 | 5 | 0.06 | 12 | 58338E3 | 2.5 | - | - | 38338E3 | 5.0 | 78338E3 | 2.5 |
| | 4.7 | 5 x 11 | 45 | 5 | 0.06 | 8.5 | 58478E3 | 2.5 | - | - | 38478E3 | 5.0 | 78478E3 | 2.5 |
| | 6.8 | 5 x 11 | 55 | 6 | 0.06 | 5.9 | 58688E3 | 2.5 | - | - | 38688E3 | 5.0 | 78688E3 | 2.5 |
| | 10 | 5 x 11 | 70 | 7 | 0.06 | 4.0 | 58109E3 | 2.5 | - | - | 38109E3 | 5.0 | 78109E3 | 2.5 |
| | 10 | 8.2 x 11 | 120 | 7 | 0.04 | 2.8 | 90036E3 | 5.0 | 90041E3 | 5.0 | 90181E3 | 5.0 | - | - |
| | 15 | 5 x 11 | 80 | 9 | 0.07 | 3.1 | 58159E3 | 2.5 | - | - | 38159E3 | 5.0 | 78159E3 | 2.5 |
| | 22 | 5 x 11 | 100 | 11 | 0.08 | 2.7 | 58229E3 | 2.5 | - | - | 38229E3 | 5.0 | 78229E3 | 2.5 |
| | 22 | 8.2 x 11 | 150 | 11 | 0.05 | 1.4 | 90117E3 | 5.0 | 90118E3 | 5.0 | 90139E3 | 5.0 | - | - |
| | 33 | 8.2 x 11 | 160 | 16 | 0.06 | 1.2 | 58339E3 | 5.0 | 68339E3 | 5.0 | 38339E3 | 5.0 | - | - |
| | 47 | 8.2 x 11 | 190 | 21 | 0.07 | 1.0 | 58479E3 | 5.0 | 68479E3 | 5.0 | 38479E3 | 5.0 | - | - |
| | 68 | 8.2 x 11 | 210 | 29 | 0.08 | 0.88 | 58689E3 | 5.0 | 68689E3 | 5.0 | 38689E3 | 5.0 | - | - |
| 100 | 10 | 8.2 x 11 | 80 | 9 | 0.06 | 3.5 | 59109E3 | 5.0 | 69109E3 | 5.0 | 39109E3 | 5.0 | - | - |
| | 22 | 8.2 x 11 | 110 | 16 | 0.06 | 1.8 | 59229E3 | 5.0 | 69229E3 | 5.0 | 39229E3 | 5.0 | - | - |



| ADDITIONAL ELECTRICAL DATA | | |
|------------------------------------|---|--|
| PARAMETER | CONDITIONS | VALUE |
| Voltage | | |
| Surge voltage | | $U_s \leq 1.15 U_R$ |
| Reverse voltage | | $U_{rev} \leq 1 V$ |
| Current | | |
| Leakage current | After 1 min $U_R = 6.3 V$ to $100 V$ | $I_{L1} \leq 0.006 C_R \times U_R + 3 \mu A$ |
| | After 5 min $U_R = 6.3 V$ to $100 V$ | $I_{L5} \leq 0.001 C_R \times U_R + 3 \mu A$ |
| Inductance | | |
| Equivalent series inductance (ESL) | Case $\varnothing D \times L = 5 mm \times 11 mm$ | Typ. 13 nH |
| | Case $\varnothing D \times L = 8.2 mm \times 11 mm$ | Typ. 16 nH |
| Resistance | | |
| Equivalent series resistance (ESR) | Calculated from $\tan \delta_{max}$ and C_R (see Table 2) | $ESR = \tan \delta / 2 \pi f C_R$ |

CAPACITANCE (C)

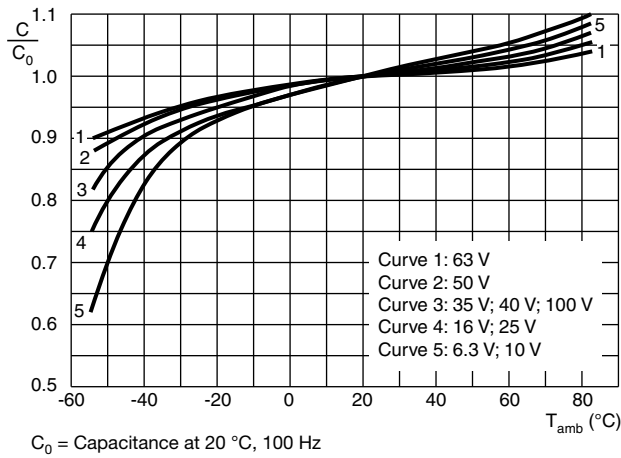


Fig. 6 - Typical multiplier of capacitance as a function of ambient temperature

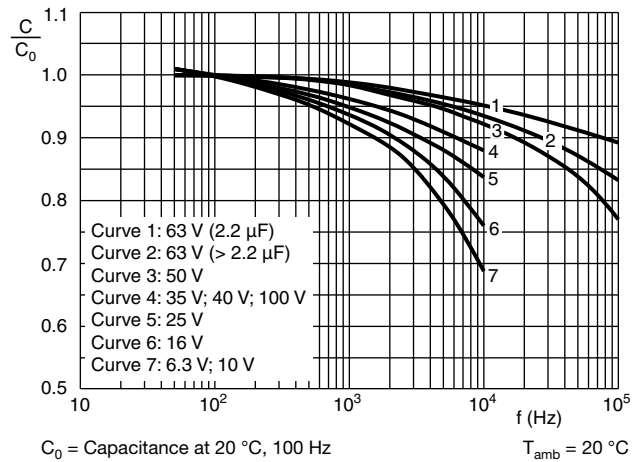


Fig. 7 - Typical multiplier of capacitance as a function of ambient temperature

IMPEDANCE (Z)

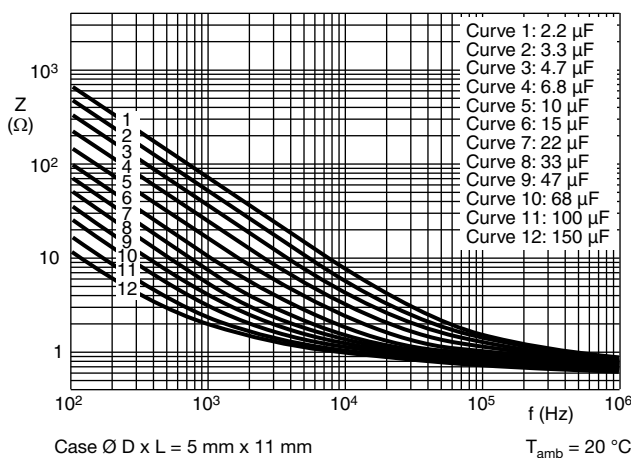


Fig. 8 - Typical impedance as a function of frequency

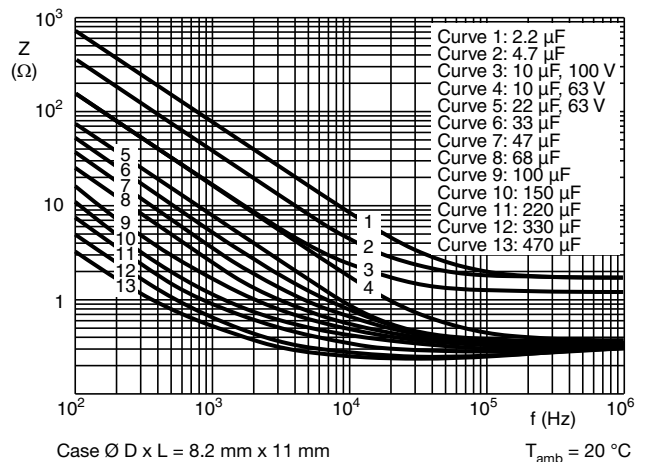


Fig. 9 - Typical impedance as a function of frequency

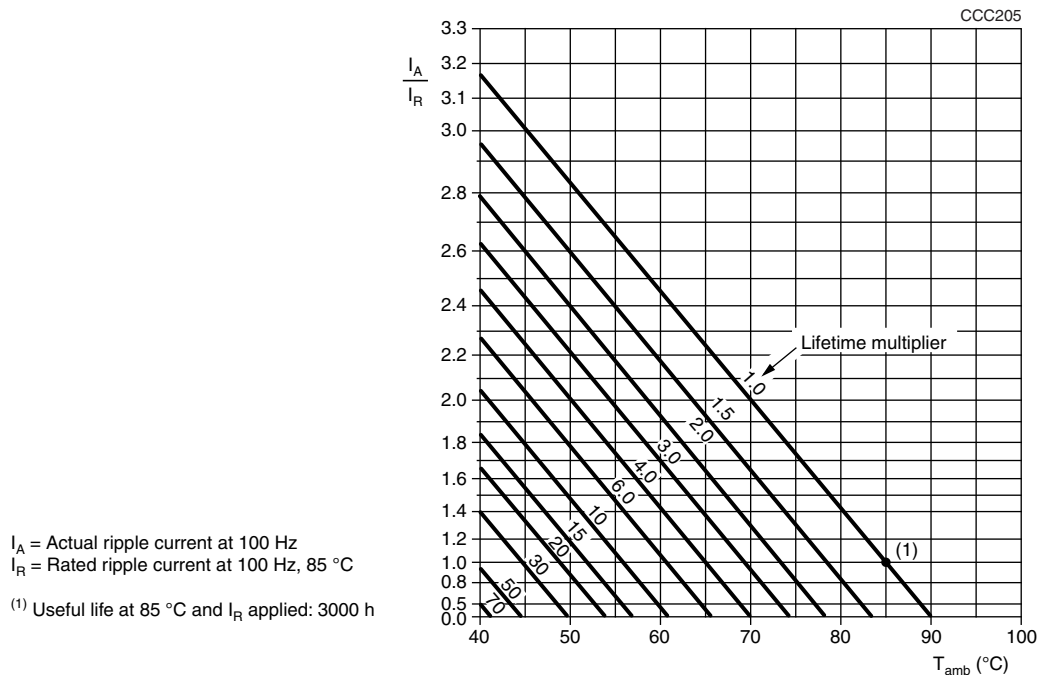
RIPPLE CURRENT AND USEFUL LIFE


Fig. 10 - Multiplier of useful life as a function of ambient temperature and ripple current load

Table 3

| MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY | | | |
|---|--|---------------------------------------|--|
| FREQUENCY (Hz) | I_R MULTIPLIER | | |
| | $U_R = 6.3 \text{ V TO } 10 \text{ V}$ | $U_R = 16 \text{ V TO } 35 \text{ V}$ | $U_R = 40 \text{ V TO } 100 \text{ V}$ |
| 50 | 0.90 | 0.85 | 0.80 |
| 100 | 1.00 | 1.00 | 1.00 |
| 300 | 1.12 | 1.20 | 1.25 |
| 1000 | 1.20 | 1.30 | 1.40 |
| 3000 | 1.25 | 1.35 | 1.50 |
| $\geq 10\ 000$ | 1.30 | 1.40 | 1.60 |

Table 4

| TEST PROCEDURES AND REQUIREMENTS | | | |
|---|---------------------------------------|--|--|
| TEST | | PROCEDURE (quick reference) | REQUIREMENTS |
| NAME OF TEST | REFERENCE | | |
| Endurance | IEC 60384-4 / EN130300 subclause 4.13 | $T_{amb} = 85 \text{ }^\circ\text{C}$; U_R applied; 2000 h | $U_R \leq 6.3 \text{ V}$; $\Delta C/C$: +15 % / -30 % $U_R > 6.3 \text{ V}$; $\Delta C/C$: $\pm 15 \%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ |
| Useful life | CECC 30301 subclause 1.8.1 | $T_{amb} = 85 \text{ }^\circ\text{C}$; U_R and I_R applied; 3000 h | $U_R \leq 6.3 \text{ V}$; $\Delta C/C$: +45 % / -50 % $U_R > 6.3 \text{ V}$; $\Delta C/C$: $\pm 45 \%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ No short or open circuit Total failure percentage: $\leq 1 \%$ |
| Shelf life (storage at high temperature) | IEC 60384-4 / EN130300 subclause 4.17 | $T_{amb} = 85 \text{ }^\circ\text{C}$; no voltage applied; 500 h 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 $I_{L5} \leq \text{spec. limit}$ |

Statements about product lifetime are based on calculations and internal testing. They should only be interpreted as estimations. Also due to external factors, the lifetime in the field application may deviate from the calculated lifetime. In general, nothing stated herein shall be construed as a guarantee of durability.



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