# Aluminum Capacitors
# Axial Miniature, Long-Life

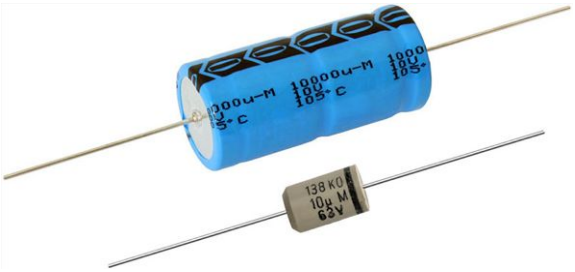

Fig. 1

| QUICK REFERENCE DATA | | |
|---|---|---|
| **DESCRIPTION** | **VALUE** | |
| Nominal case sizes (Ø D x L in mm) | 6.3 x 12.7 to 10 x 25 | 10 x 30 to 21 x 38 |
| Rated capacitance range, $C_R$ | 1.0 µF to 15 000 µF | |
| Tolerance on $C_R$ | ± 20 % | |
| Rated voltage range, $U_R$ | 6.3 V to 100 V | |
| Category temperature range | - 40 °C to + 105 °C | |
| Endurance test at 105 °C | 1000 h | 5000 h |
| Useful life at 105 °C | 2000 h | 10 000 h |
| Useful life at 40 °C, $I_R$ applied | 1.3 x $I_R$ applied: 200 000 h | 1.8 x $I_R$ applied: 500 000 h |
| Shelf life at 0 V, 105 °C | 500 h | |
| Based on sectional specification | IEC 60384-4/EN130 300 | |
| Climatic category IEC 60068 | 40/105/56 | |

## FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Axial leads, cylindrical aluminum case, insulated with a blue sleeve
  (case Ø 6.3 mm x 12.7 mm and 7.7 mm x 12.7 mm are molded with flame retardant plastic material)
- Mounting ring version not available in insulated form
- Taped versions up to case Ø 15 mm x 30 mm available for automatic insertion
- Charge and discharge proof
- Long useful life: 2000 h to 10 000 h at 105 °C, high reliability
- High ripple current capability
- Miniaturized, high CV-product per unit volume
- Material categorization: For definitions of compliance please see www.vishay.com/doc?99912

Pb-free

RoHS COMPLIANT

## APPLICATIONS

- Industrial, automotive, EDP and telecommunication
- Smoothing, filtering, buffering in SMPS; coupling, decoupling, timing
- Portable and mobile equipment (small size, low mass)
- Stand-by applications
- Low mounting height boards, vibration and shock resistant

## 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 (105 °C)
- Date code, in accordance with IEC 60062
- Code for factory of origin
- Name of manufacturer
- Negative terminal identification
- Series number (138)



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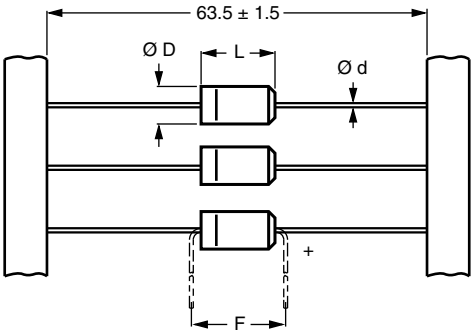
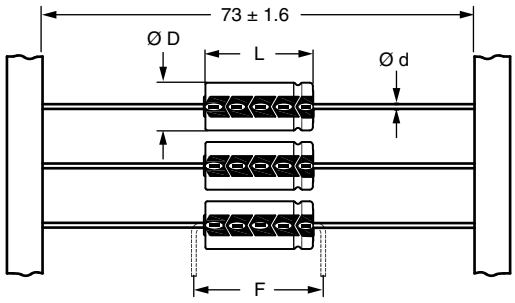
| SELECTION CHART FOR $C_R$, $U_R$, AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| $C_R$ (µF) | $U_R$ (V) | | | | | | | |
| | 6.3 | 10 | 16 | 25 | 40 | 50 | 63 | 100 |
| 1.0 | - | - | - | - | - | - | - | 6.3 x 12.7 |
| 2.2 | - | - | - | - | - | - | - | 6.3 x 12.7 |
| 4.7 | - | - | - | - | - | - | 6.3 x 12.7 | 7.7 x 12.7 |
| 10 | - | - | - | 6.3 x 12.7 | - | 6.3 x 12.7 | 7.7 x 12.7 | 6.5 x 18 |
| 22 | - | - | 6.3 x 12.7 | 6.3 x 12.7 | - | 7.7 x 12.7 | 6.5 x 18 | 8 x 18 |
| 33 | - | - | - | 6.3 x 12.7 | 7.7 x 12.7 | - | - | - |
| 47 | - | - | 6.3 x 12.7 | 7.7 x 12.7 | 6.5 x 18 | - | 8 x 18 | 10 x 25 |
| 68 | - | - | - | - | - | - | - | 10 x 30 |
| 100 | 6.3 x 12.7 | - | 7.7 x 12.7 | 6.5 x 18 | 8 x 18 | 10 x 18 | 10 x 25 | 12.5 x 30 |
| 150 | - | 7.7 x 12.7 | - | - | - | - | 10 x 30 | 15 x 30 |
| 220 | 7.7 x 12.7 | 6.5 x 18 | 8 x 18 | 10 x 18 | 10 x 25 | - | 12.5 x 30 | 15 x 30 |
| 330 | - | - | - | - | 10 x 30 | - | 12.5 x 30 | 18 x 30 |
| 470 | 6.5 x 18 | 8 x 18 | 10 x 18 | 10 x 25 | 12.5 x 30 | - | 15 x 30 | 18 x 38 |
| 680 | - | - | - | 10 x 30 | 12.5 x 30 | - | 18 x 30 | 21 x 38 |
| 1000 | 10 x 18 | 10 x 25 | 10 x 30 | 12.5 x 30 | 15 x 30 | - | 18 x 38 | - |
| 1500 | - | 10 x 30 | 12.5 x 30 | 15 x 30 | 18 x 30 | - | 21 x 38 | - |
| 2200 | 10 x 25 | 12.5 x 30 | 15 x 30 | 18 x 30 | 18 x 38 | - | - | - |
| 3300 | - | 15 x 30 | 18 x 30 | 18 x 38 | 21 x 38 | - | - | - |
| 4700 | - | 18 x 30 | 18 x 30 | 18 x 38 | - | - | - | - |
| 6800 | - | 18 x 38 | 18 x 38 | 21 x 38 | - | - | - | - |
| 10 000 | - | 18 x 38 | 21 x 38 | - | - | - | - | - |
| 15 000 | - | 21 x 38 | - | - | - | - | - | - |

## DIMENSIONS in millimeters AND AVAILABLE FORMS



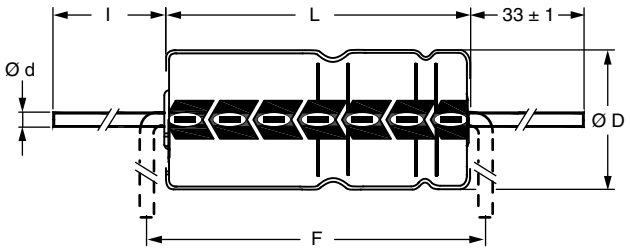

**Form BR:** Taped on reel
**Form BA:** Taped in box (ammopack)
Case Ø D x L = 6.3 mm x 12.7 mm to 7.7 mm x 12.7 mm

Fig. 2 - **Forms BA** and **BR**




**Form BR:** Taped on reel
Case Ø D x L = 6.5 mm x 18 mm to 15 mm x 30 mm
**Form BA:** Taped in box (ammopack)
Case Ø D x L = 6.5 mm x 18 mm to 10 mm x 25 mm

Fig. 3 - **Forms BA** and **BR**




**Form AA:** Axial in box
Case Ø D x L = 10 mm x 30 mm to 21 mm x 38 mm

Fig. 4 - **Form AA**



For technical questions, contact: aluminumcaps1@vishay.com

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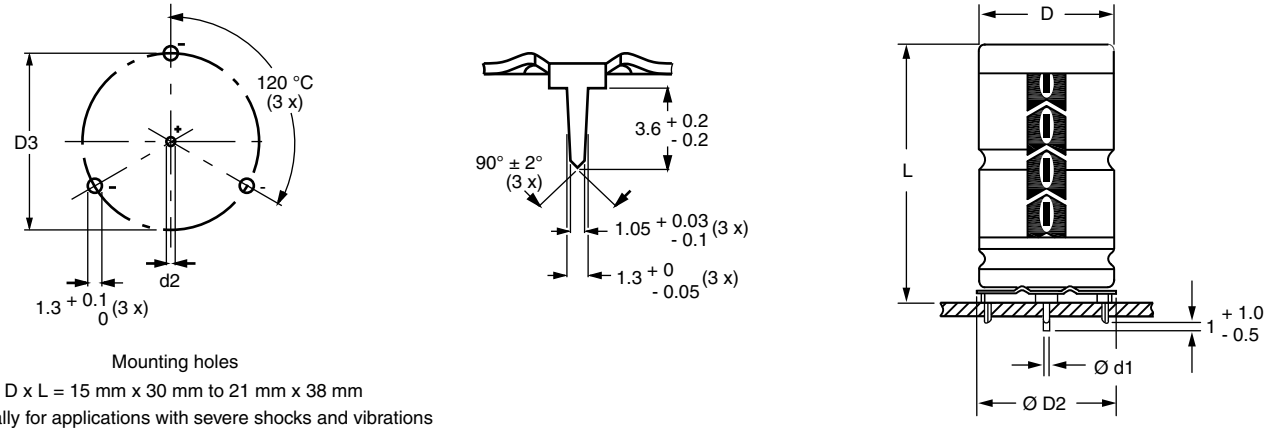
**Table 1**

| **AXIAL; DIMENSIONS** in millimeters, **MASS AND PACKAGING QUANTITIES** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **NOMINAL CASE SIZE Ø D x L (mm)** | **CASE CODE** | **AXIAL: FORM AA, BA, AND BR** | | | | | **MASS (g)** | **PACKAGING QUANTITIES** | | |
| | | **Ø d** | **l** | **Ø $D_{max.}$** | **$L_{max.}$** | **$F_{min.}$** | | **FORM AA** | **FORM BA** | **FORM BR** |
| 6.3 x 12.7 | (2) | 0.6 | - | 6.5 | 12.9 | 17.5 | ≈ 1.1 | - | 1000 | 1000 |
| 7.7 x 12.7 | (3) | 0.6 | - | 7.9 | 12.9 | 17.5 | ≈ 1.3 | - | 500 | 500 |
| 6.5 x 18 | 4 | 0.8 | - | 6.9 | 18.5 | 25 | ≈ 1.3 | - | 1000 | 1000 |
| 8 x 18 | 5 | 0.8 | - | 8.5 | 18.5 | 25 | ≈ 1.7 | - | 500 | 500 |
| 10 x 18 | 6 | 0.8 | - | 10.5 | 18.5 | 25 | ≈ 2.5 | - | 500 | 500 |
| 10 x 25 | 7 | 0.8 | - | 10.5 | 25.5 | 30 | ≈ 3.3 | - | 500 | 500 |
| 10 x 30 | 00 | 0.8 | 55 ± 1 | 10.5 | 30.5 | 35 | ≈ 4.8 | 340 | - | 500 |
| 12.5 x 30 | 01 | 0.8 | 55 ± 1 | 13.0 | 30.5 | 35 | ≈ 7.4 | 260 | - | 400 |
| 15 x 30 | 02 | 0.8 | 55 ± 1 | 15.5 | 30.5 | 35 | ≈ 11.7 | 200 | - | 250 |
| 18 x 30 | 03 | 0.8 | 55 ± 1 | 18.5 | 30.5 | 35 | ≈ 12.9 | 120 | - | - |
| 18 x 38 | 04 | 0.8 | 34 ± 1 | 18.5 | 39.5 | 44 | ≈ 19.0 | 125 | - | - |
| 21 x 38 | 05 | 0.8 | 34 ± 1 | 21.5 | 39.5 | 44 | ≈ 24.0 | 100 | - | - |

**Note**

- For detailed tape dimensions refer to packaging information: www.vishay.com/doc?28361




Mounting holes

Case Ø D x L = 15 mm x 30 mm to 21 mm x 38 mm

Especially for applications with severe shocks and vibrations

Fig. 5 - 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 Ø D x L** | **CASE CODE** | **MOUNTING RING: FORM MR** | | | | | | **MASS (g)** | **PACKAGING QUANTITIES** |
| | | **Ø d1** | **Ø d2** | **$D_{max.}$** | **Ø $D2_{max.}$** | **D3** | **$L_{max.}$** | | |
| 15 x 30 | 02 | 0.8 | 1.0 + 0.4 | 15.5 | 17.5 | 16.5 ± 0.2 | 33 | ≈ 11.7 | 200 |
| 18 x 30 | 03 | 0.8 | 1.0 + 0.4 | 18.5 | 19.5 | 18.5 ± 0.2 | 33 | ≈ 12.9 | 240 |
| 18 x 38 | 04 | 0.8 | 1.0 + 0.4 | 18.5 | 19.5 | 18.5 ± 0.2 | 42 | ≈ 19.0 | 100 |
| 21 x 38 | 05 | 0.8 | 1.0 + 0.4 | 21.5 | 22.5 | 21.5 ± 0.2 | 42 | ≈ 24.0 | 100 |



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| ELECTRICAL DATA | |
|---|---|
| SYMBOL | DESCRIPTION |
| $C_R$ | Rated capacitance at 100 Hz, tolerance ± 20 % |
| $I_R$ | Rated RMS ripple current at 100 Hz, 105 °C |
| $I_{L5}$ | Max. leakage current after 5 min at $U_R$ |
| tan δ | Max. dissipation factor at 100 Hz |
| ESR | Equivalent series resistance at 100 Hz (calculated from tan $\delta_{max.}$ and $C_R$) |
| Z | Max. impedance at 10 kHz or 100 kHz |

**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 %.

## ORDERING EXAMPLE

Electrolytic capacitor 138 series

470 µF/10 V; ± 20 %

Nominal case size: Ø 8 mm x 18 mm; Form BA

Ordering code: MAL213834471E3
Former 12 NC: 2222 138 34471

**Table 3**

| ELECTRICAL DATA AND ORDERING INFORMATION | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $U_R$ (V) | $C_R$ 100 Hz (µF) | NOMINAL CASE SIZE Ø D x L (mm) | $I_R$ 100 Hz 105 °C (mA) | $I_{L5}$ 5 min (µA) | tan δ 100 Hz | ESR 100 Hz (Ω) | Z 10 kHz (Ω) | Z 100 kHz (Ω) | ORDERING CODE MAL2138..... | | | |
| | | | | | | | | | IN BOX FORM AA | TAPED ON REEL FORM BR | TAPED IN BOX FORM BA | MOUNTING RING FORM MR |
| 6.3 | 100 | 6.3 x 12.7 | 99 | 5.3 | 0.24 | 3.800 | 3.000 | 1.800 | - | 23101E3 | 33101E3 | - |
| | 220 | 7.7 x 12.7 | 160 | 6.8 | 0.24 | 1.700 | 1.400 | 0.950 | - | 23221E3 | 33221E3 | - |
| | 470 | 6.5 x 18 | 250 | 9.9 | 0.24 | 0.810 | 0.640 | 0.500 | - | 23471E3 | 33471E3 | - |
| | 1000 | 10 x 18 | 430 | 17 | 0.24 | 0.380 | 0.300 | 0.240 | - | 23102E3 | 33102E3 | - |
| | 2200 | 10 x 25 | 640 | 32 | 0.29 | 0.210 | 0.180 | 0.150 | - | 23222E3 | 33222E3 | - |
| 10 | 150 | 7.7 x 12.7 | 140 | 7.0 | 0.2 | 2.100 | 1.300 | 0.950 | - | 24151E3 | 34151E3 | - |
| | 220 | 6.5 x 18 | 190 | 8.4 | 0.2 | 1.400 | 0.910 | 0.500 | - | 24221E3 | 34221E3 | - |
| | 470 | 8 x 18 | 300 | 13 | 0.2 | 0.680 | 0.430 | 0.350 | - | 24471E3 | 34471E3 | - |
| | 1000 | 10 x 25 | 520 | 24 | 0.2 | 0.320 | 0.200 | 0.160 | - | 24102E3 | 34102E3 | - |
| | 1500 | 10 x 30 | 670 | 34 | 0.28 | 0.320 | 0.260 | 0.260 | 14152E3 | 24152E3 | - | - |
| | 2200 | 12.5 x 30 | 890 | 48 | 0.29 | 0.220 | 0.190 | 0.190 | 14222E3 | 24222E3 | - | - |
| | 3300 | 15 x 30 | 1140 | 70 | 0.30 | 0.160 | 0.130 | 0.150 | 14332E3 | 24332E3 | - | 44332E3 |
| | 4700 | 18 x 30 | 1450 | 98 | 0.33 | 0.120 | 0.110 | 0.130 | 14472E3 | - | - | 44472E3 |
| | 6800 | 18 x 38 | 1880 | 140 | 0.34 | 0.085 | 0.074 | 0.110 | 14682E3 | - | - | 44682E3 |
| | 10 000 | 18 x 38 | 1980 | 200 | 0.41 | 0.070 | 0.062 | 0.100 | 14103E3 | - | - | 44103E3 |
| | 15 000 | 21 x 38 | 2200 | 300 | 0.55 | 0.063 | 0.058 | 0.099 | 14153E3 | - | - | 44153E3 |
| 16 | 22 | 6.3 x 12.7 | 58 | 4.7 | 0.12 | 8.700 | 7.300 | 2.700 | - | 25229E3 | 35229E3 | - |
| | 47 | 6.3 x 12.7 | 83 | 5.5 | 0.16 | 5.400 | 3.400 | 1.900 | - | 25479E3 | 35479E3 | - |
| | 100 | 7.7 x 12.7 | 130 | 7.2 | 0.16 | 2.500 | 1.600 | 1.000 | - | 25101E3 | 35101E3 | - |
| | 220 | 8 x 18 | 230 | 11 | 0.16 | 1.200 | 0.730 | 0.350 | - | 25221E3 | 35221E3 | - |
| | 470 | 10 x 18 | 360 | 19 | 0.16 | 0.540 | 0.340 | 0.250 | - | 25471E3 | 35471E3 | - |
| | 1000 | 10 x 30 | 630 | 36 | 0.20 | 0.340 | 0.270 | 0.260 | 15102E3 | 25102E3 | - | - |
| | 1500 | 12.5 x 30 | 860 | 52 | 0.20 | 0.230 | 0.190 | 0.190 | 15152E3 | 25152E3 | - | - |
| | 2200 | 15 x 30 | 1090 | 74 | 0.21 | 0.170 | 0.140 | 0.150 | 15222E3 | 25222E3 | - | 45222E3 |
| | 3300 | 18 x 30 | 1420 | 110 | 0.24 | 0.120 | 0.100 | 0.130 | 15332E3 | - | - | 45332E3 |
| | 4700 | 18 x 30 | 1480 | 150 | 0.28 | 0.100 | 0.090 | 0.120 | 15472E3 | - | - | 45472E3 |
| | 6800 | 18 x 38 | 1930 | 220 | 0.28 | 0.072 | 0.062 | 0.100 | 15682E3 | - | - | 45682E3 |
| | 10 000 | 21 x 38 | 2100 | 320 | 0.38 | 0.065 | 0.057 | 0.098 | 15103E3 | - | - | 45103E3 |
| 25 | 10 | 6.3 x 12.7 | 46 | 4.5 | 0.09 | 14.000 | 12.000 | 2.800 | - | 26109E3 | 36109E3 | - |
| | 22 | 6.3 x 12.7 | 61 | 5.1 | 0.14 | 10.000 | 5.500 | 2.500 | - | 26229E3 | 36229E3 | - |
| | 33 | 6.3 x 12.7 | 74 | 5.7 | 0.14 | 6.800 | 3.600 | 1.900 | - | 26339E3 | 36339E3 | - |
| | 47 | 7.7 x 12.7 | 96 | 6.4 | 0.14 | 4.700 | 2.600 | 1.000 | - | 26479E3 | 36479E3 | - |



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## 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 105 °C (mA) | $I_{L5}$ 5 min (µA) | tan δ 100 Hz | ESR 100 Hz (Ω) | Z 10 kHz (Ω) | Z 100 kHz (Ω) | ORDERING CODE MAL2138..... | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | IN BOX FORM AA | TAPED ON REEL FORM BR | TAPED IN BOX FORM BA | MOUNTING RING FORM MR |
| 25 | 100 | 6.5 x 18 | 160 | 9.0 | 0.13 | 2.100 | 1.200 | 0.550 | - | 26101E3 | 36101E3 | - |
| | 220 | 10 x 18 | 270 | 15 | 0.13 | 0.940 | 0.550 | 0.270 | - | 26221E3 | 36221E3 | - |
| | 470 | 10 x 25 | 440 | 28 | 0.13 | 0.440 | 0.260 | 0.170 | - | 26471E3 | 36471E3 | - |
| | 680 | 10 x 30 | 580 | 38 | 0.14 | 0.360 | 0.260 | 0.250 | 16681E3 | 26681E3 | - | - |
| | 1000 | 12.5 x 30 | 790 | 54 | 0.15 | 0.250 | 0.180 | 0.190 | 16102E3 | 26102E3 | - | - |
| | 1500 | 15 x 30 | 1020 | 79 | 0.15 | 0.170 | 0.130 | 0.150 | 16152E3 | 26152E3 | - | 46152E3 |
| | 2200 | 18 x 30 | 1320 | 110 | 0.17 | 0.130 | 0.100 | 0.130 | 16222E3 | - | - | 46222E3 |
| | 3300 | 18 x 38 | 1720 | 170 | 0.17 | 0.090 | 0.071 | 0.110 | 16332E3 | - | - | 46332E3 |
| | 4700 | 18 x 38 | 1840 | 240 | 0.21 | 0.076 | 0.063 | 0.100 | 16472E3 | - | - | 46472E3 |
| | 6800 | 21 x 38 | 2100 | 340 | 0.27 | 0.068 | 0.058 | 0.099 | 16682E3 | - | - | 46682E3 |
| 40 | 33 | 7.7 x 12.7 | 91 | 6.6 | 0.11 | 5.300 | 2.700 | 1.000 | - | 27339E3 | 37339E3 | - |
| | 47 | 6.5 x 18 | 120 | 7.8 | 0.10 | 3.400 | 1.900 | 0.650 | - | 27479E3 | 37479E3 | - |
| | 100 | 8 x 18 | 180 | 12 | 0.10 | 1.600 | 0.900 | 0.400 | - | 27101E3 | 37101E3 | - |
| | 220 | 10 x 25 | 350 | 22 | 0.10 | 0.720 | 0.410 | 0.200 | - | 27221E3 | 37221E3 | - |
| | 330 | 10 x 30 | 490 | 30 | 0.09 | 0.470 | 0.320 | 0.300 | 17331E3 | 27331E3 | - | - |
| | 470 | 12.5 x 30 | 650 | 42 | 0.09 | 0.340 | 0.230 | 0.220 | 17471E3 | 27471E3 | - | - |
| | 680 | 12.5 x 30 | 750 | 58 | 0.10 | 0.250 | 0.180 | 0.180 | 17681E3 | 27681E3 | - | - |
| | 1000 | 15 x 30 | 970 | 84 | 0.10 | 0.170 | 0.120 | 0.140 | 17102E3 | 27102E3 | - | 47102E3 |
| | 1500 | 18 x 30 | 1250 | 120 | 0.12 | 0.130 | 0.098 | 0.120 | 17152E3 | - | - | 47152E3 |
| | 2200 | 18 x 38 | 1640 | 180 | 0.12 | 0.093 | 0.069 | 0.100 | 17222E3 | - | - | 47222E3 |
| | 3300 | 21 x 38 | 1810 | 270 | 0.15 | 0.079 | 0.061 | 0.100 | 17332E3 | - | - | 47332E3 |
| 50 | 10 | 6.3 x 12.7 | 51 | 5.0 | 0.09 | 14.00 | 7.000 | 2.700 | - | 21109E3 | 31109E3 | - |
| | 22 | 7.7 x 12.7 | 82 | 6.2 | 0.09 | 6.500 | 3.002 | 1.100 | - | 21229E3 | 31229E3 | - |
| | 100 | 10 x 18 | 230 | 14 | 0.08 | 1.300 | 0.700 | 0.300 | - | 21101E3 | 31101E3 | - |
| 63 | 4.7 | 6.3 x 12.7 | 35 | 4.6 | 0.09 | 30.00 | 17.000 | 5.000 | - | 28478E3 | 38478E3 | - |
| | 10 | 7.7 x 12.7 | 59 | 5.3 | 0.08 | 13.00 | 8.000 | 1.800 | - | 28109E3 | 38109E3 | - |
| | 22 | 6.5 x 18 | 100 | 6.8 | 0.07 | 5.100 | 3.600 | 0.850 | - | 28229E3 | 38229E3 | - |
| | 47 | 8 x 18 | 150 | 9.9 | 0.07 | 2.400 | 1.700 | 0.500 | - | 28479E3 | 38479E3 | - |
| | 100 | 10 x 25 | 280 | 17 | 0.07 | 1.100 | 0.800 | 0.270 | - | 28101E3 | 38101E3 | - |
| | 150 | 10 x 30 | 410 | 23 | 0.11 | 0.730 | 0.440 | 0.400 | 18151E3 | 28151E3 | - | - |
| | 220 | 12.5 x 30 | 560 | 32 | 0.11 | 0.500 | 0.310 | 0.290 | 18221E3 | 28221E3 | - | - |
| | 330 | 12.5 x 30 | 660 | 46 | 0.12 | 0.370 | 0.230 | 0.220 | 18331E3 | 28331E3 | - | - |
| | 470 | 15 x 30 | 860 | 63 | 0.12 | 0.260 | 0.160 | 0.160 | 18471E3 | 28471E3 | - | 48471E3 |
| | 680 | 18 x 30 | 1130 | 90 | 0.12 | 0.190 | 0.120 | 0.140 | 18681E3 | - | - | 48681E3 |
| | 1000 | 18 x 38 | 1460 | 130 | 0.12 | 0.130 | 0.086 | 0.110 | 18102E3 | - | - | 48102E3 |
| | 1500 | 21 x 38 | 1680 | 190 | 0.13 | 0.100 | 0.072 | 0.110 | 18152E3 | - | - | 48152E3 |
| 100 | 1.0 | 6.3 x 12.7 | 16 | 4.2 | 0.09 | 140.0 | 55.000 | 10.00 | - | 29108E3 | 39108E3 | - |
| | 2.2 | 6.3 x 12.7 | 24 | 4.4 | 0.09 | 65.00 | 25.000 | 8.000 | - | 29228E3 | 39228E3 | - |
| | 4.7 | 7.7 x 12.7 | 40 | 4.9 | 0.08 | 27.00 | 17.000 | 5.000 | - | 29478E3 | 39478E3 | - |
| | 10 | 6.5 x 18 | 67 | 6.0 | 0.07 | 11.00 | 8.000 | 2.400 | - | 29109E3 | 39109E3 | - |
| | 22 | 8 x 18 | 100 | 8.4 | 0.07 | 5.100 | 3.600 | 1.400 | - | 29229E3 | 39229E3 | - |
| | 47 | 10 x 25 | 190 | 13 | 0.07 | 2.400 | 1.700 | 0.670 | - | 29479E3 | 39479E3 | - |
| | 68 | 10 x 30 | 300 | 18 | 0.07 | 1.700 | 1.100 | 0.970 | 19689E3 | 29689E3 | - | - |
| | 100 | 12.5 x 30 | 410 | 24 | 0.07 | 1.100 | 0.770 | 0.670 | 19101E3 | 29101E3 | - | - |
| | 150 | 15 x 30 | 550 | 34 | 0.07 | 0.780 | 0.520 | 0.460 | 19151E3 | 29151E3 | - | 49151E3 |
| | 220 | 15 x 30 | 650 | 48 | 0.07 | 0.540 | 0.370 | 0.330 | 19221E3 | 29221E3 | - | 49221E3 |
| | 330 | 18 x 30 | 880 | 70 | 0.08 | 0.380 | 0.270 | 0.240 | 19331E3 | - | - | 49331E3 |
| | 470 | 18 x 38 | 1130 | 98 | 0.08 | 0.270 | 0.190 | 0.170 | 19471E3 | - | - | 49471E3 |
| | 680 | 21 x 38 | 1330 | 140 | 0.09 | 0.210 | 0.140 | 0.140 | 19681E3 | - | - | 49681E3 |


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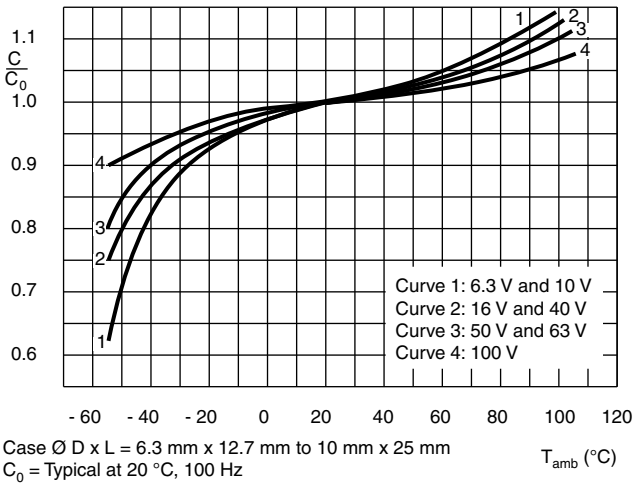
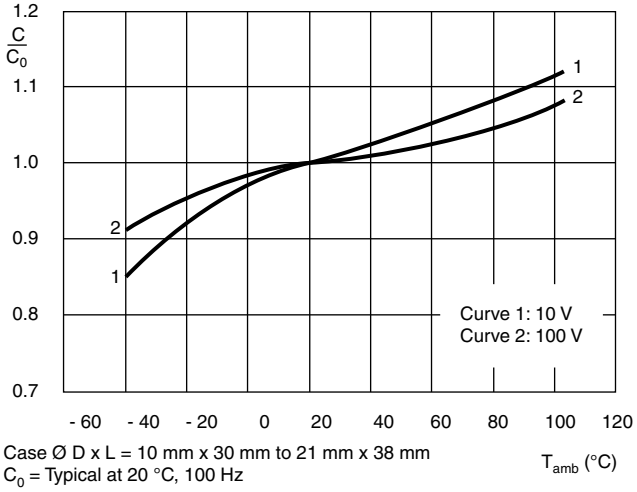
| ADDITIONAL ELECTRICAL DATA | | | |
|---|---|---|---|
| PARAMETER | CONDITIONS | VALUE | |
| | | AXIAL | MOUNTING RING |
| **Voltage** | | | |
| Surge voltage | | $U_s \leq 1.15 \times U_R$ | |
| Reverse voltage | | $U_{rev} \leq 1$ V | |
| **Current** | | | |
| Leakage current | After 1 min at $U_R$:<br>Case Ø D x L = 6.3 mm x 12.7 mm and 7.7 mm x 12.7 mm<br>Case Ø D x L = 6.5 mm x 18 mm to 21 mm x 38 mm | $I_{L1} \leq 0.02\ C_R \times U_R + 3$ µA<br>$I_{L1} \leq 0.006\ C_R \times U_R + 4$ µA | |
| | After 5 min at $U_R$ | $I_{L5} \leq 0.002\ C_R \times U_R + 4$ µA | |
| **Inductance** | | | |
| Equivalent series inductance (ESL) | Case Ø D x L mm: | | |
| | 6.3 x 12.7 | Typ. 20 nH | - |
| | 7.7 x 12.7 | Typ. 30 nH | - |
| | 6.5 x 18 | Typ. 15 nH | - |
| | 8 x 18 | Typ. 35 nH | - |
| | 10 x 18 | Typ. 69 nH | - |
| | 10 x 25 | Typ. 38 nH | - |
| | 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)




Case Ø D x L = 6.3 mm x 12.7 mm to 10 mm x 25 mm
$C_0$ = Typical at 20 °C, 100 Hz

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




Case Ø D x L = 10 mm x 30 mm to 21 mm x 38 mm
$C_0$ = Typical at 20 °C, 100 Hz

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



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## EQUIVALENT SERIES RESISTANCE (ESR)

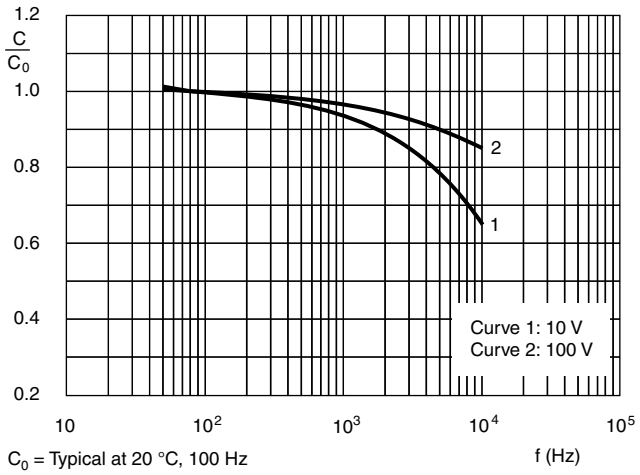


Fig. 8 - Typical multiplier of capacitance as a function of frequency

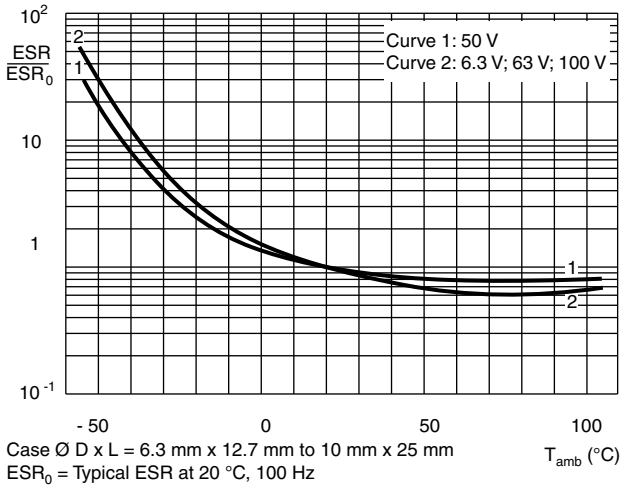


Fig. 9 - Typical multiplier of ESR as a function of ambient temperature

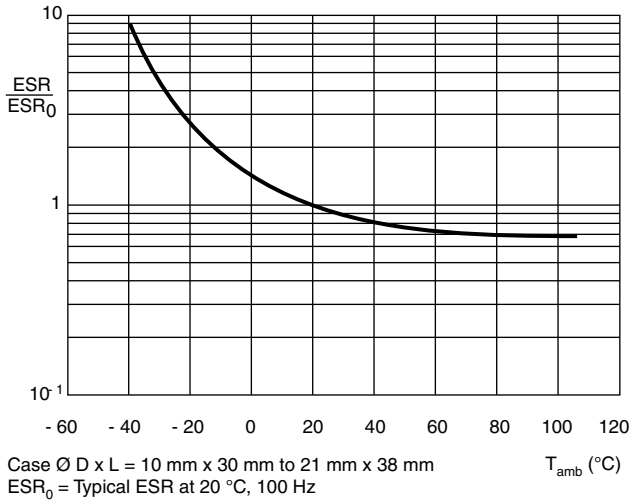


Fig. 10 - Typical multiplier of ESR as a function of ambient temperature

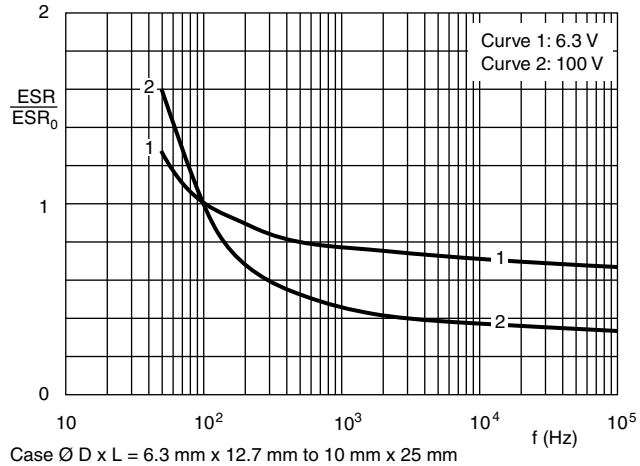


Fig. 11 - Typical multiplier ESR as a function of frequency


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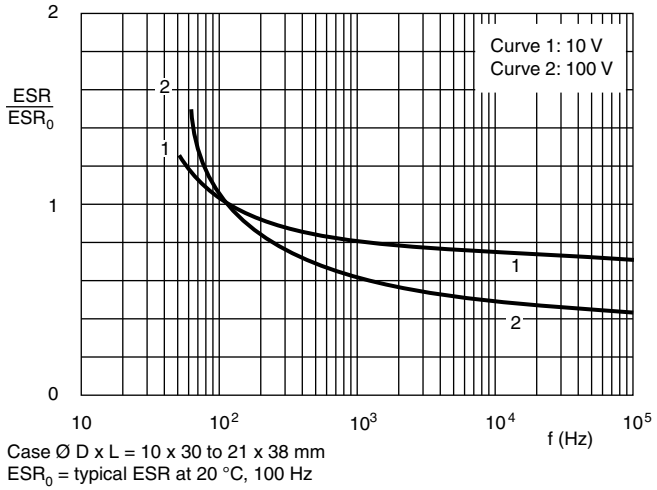
## EQUIVALENT SERIES RESISTANCE (ESR)



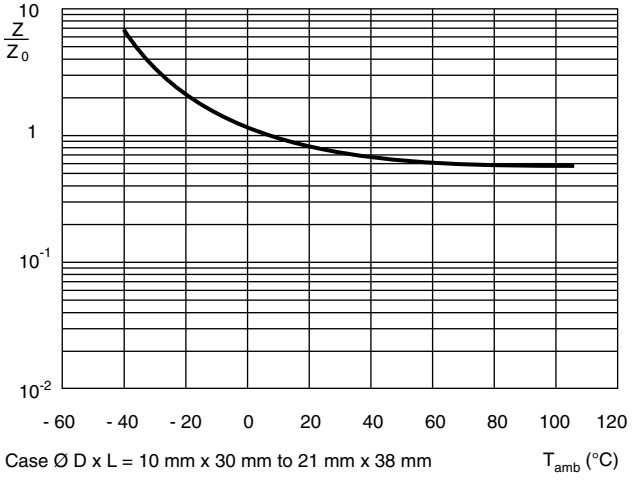

Case Ø D x L = 10 x 30 to 21 x 38 mm
$ESR_0$ = typical ESR at 20 °C, 100 Hz

Fig. 12 - Typical multiplier ESR as a function of frequency

## IMPEDANCE (Z)

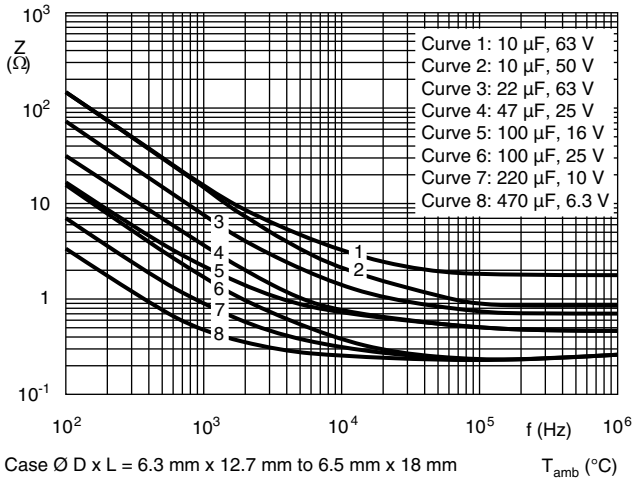
**Table 4**

| **IMPEDANCE VS. CAPACITANCE VALUES** (Case Ø D x L = 6.3 mm x 12.7 mm to 10 mm x 25 mm) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| $T_{amb}$ | **Z x $C_R$ (Ω x µF) AT 10 kHz** | | | | | | | |
| | **6.3 V** | **10 V** | **16 V** | **25 V** | **40 V** | **50 V** | **63 V** | **100 V** |
| + 20 °C | ≤ 300 | ≤ 200 | ≤ 160 | ≤ 120 | ≤ 90 | ≤ 70 | ≤ 80 | ≤ 80 |
| - 25 °C | ≤ 2000 | ≤ 1200 | ≤ 750 | ≤ 560 | ≤ 450 | ≤ 300 | ≤ 550 | ≤ 550 |
| - 40 °C | ≤ 5500 | ≤ 3200 | ≤ 2000 | ≤ 1500 | ≤ 1200 | ≤ 900 | ≤ 1500 | ≤ 1500 |




Case Ø D x L = 10 mm x 30 mm to 21 mm x 38 mm

Fig. 13 - Typical multiplier of ESR as a function of ambient temperature at 10 kHz




Case Ø D x L = 6.3 mm x 12.7 mm to 6.5 mm x 18 mm

Fig. 14 - Typical impedance as a function of frequency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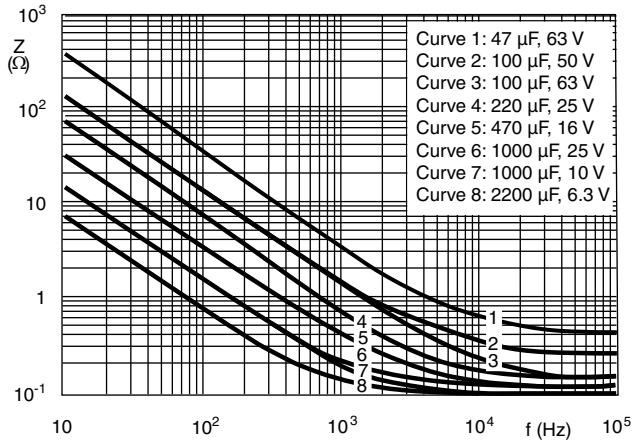


Fig. 15 - Typical impedance as a function of frequency

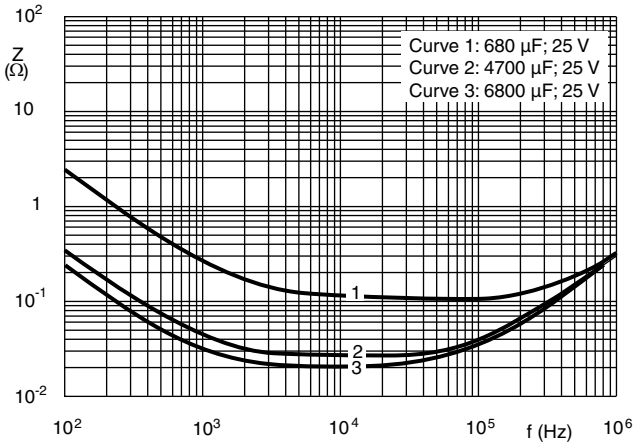


Fig. 16 - Typical impedance as a function of frequency

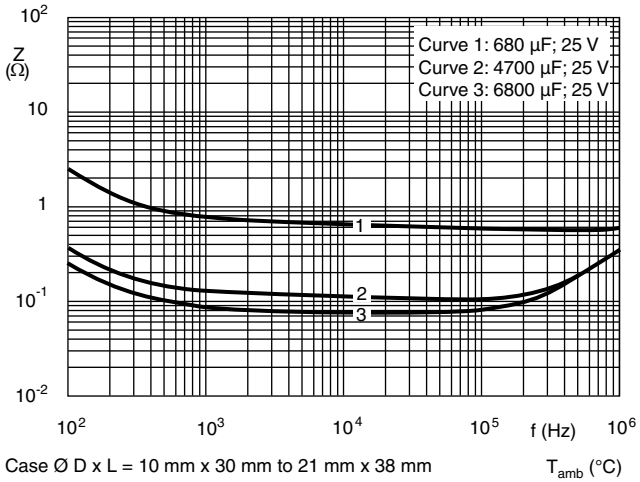


Fig. 17 - Typical impedance as a function of frequency

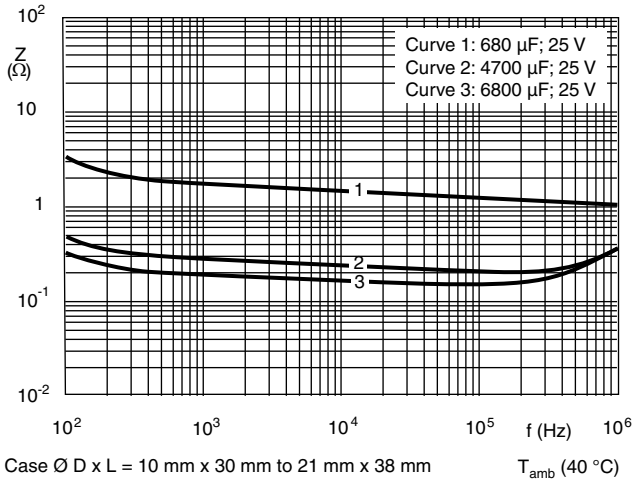


Fig. 18 - Typical impedance as a function of frequency


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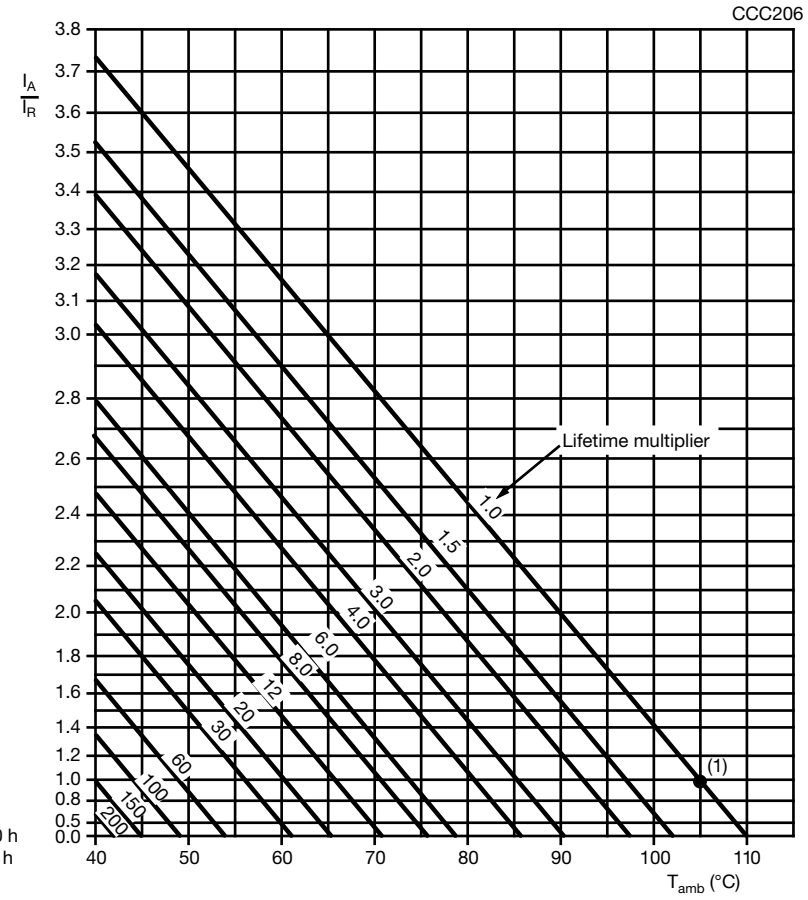
## RIPPLE CURRENT AND USEFUL LIFE




$I_A$ = Actual ripple current at 100 Hz
$I_R$ = Rated ripple current at 100 Hz, 105 °C

(1) Useful life at 105 °C and $I_R$ applied:
Case Ø D x L = 6.3 mm x 12.7 mm to 10 mm x 25 mm: 2000 h
Case Ø D x L = 10 mm x 30 mm to 21 mm x 38 mm: 10 000 h

Fig. 19 - Multiplier of useful life as a function of ambient temperature and ripple current load

**Table 5**

| MULTIPLIER OF RIPPLE CURRENT ($I_R$) AS A FUNCTION OF FREQUENCY | | | |
|---|---|---|---|
| FREQUENCY (Hz) | $I_R$ MULTIPLIER | | |
| | $U_R$ = 6.3 V TO 10 V | $U_R$ = 16 V TO 25 V | $U_R$ = 40 V TO 100 V |
| 50 | 0.95 | 0.90 | 0.85 |
| 100 | 1.00 | 1.00 | 1.00 |
| 300 | 1.07 | 1.12 | 1.20 |
| 1000 | 1.12 | 1.20 | 1.30 |
| 3000 | 1.15 | 1.25 | 1.35 |
| ≥ 10 000 | 1.20 | 1.30 | 1.40 |


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**Table 6**

| TEST PROCEDURES AND REQUIREMENTS | | | |
|---|---|---|---|
| TEST | | PROCEDURE (quick reference) | REQUIREMENTS |
| NAME OF TEST | REFERENCE | | |
| Endurance | IEC 60384-4/ EN130300 subclause 4.13 | $T_{amb}$ = 105 °C; $U_R$ applied;<br>Case Ø D x L:<br>6.3 mm x 12.7 mm to 10 mm x 25 mm: 1000 h;<br>10 mm x 30 mm to 21 mm x 38 mm: 5000 h | $U_R \leq$ 6.3 V; ΔC/C: + 15 %/- 30 %<br>$U_R >$ 6.3 V; ΔC/C: ± 15 %<br>tan δ ≤ 1.3 x spec. limit<br>Z ≤ 2 x spec. limit<br>$I_{L5} \leq$ spec. limit |
| Useful life | CECC 30301 subclause 1.8.1 | $T_{amb}$ = 105 °C; $U_R$ and $I_R$ applied;<br>Case Ø D x L:<br>6.3 mm x 12.7 mm to 10 mm x 25 mm: 2000 h;<br>10 mm x 30 mm to 21 mm x 38 mm: 10 000 h | $U_R \leq$ 6.3 V; ΔC/C: + 45 %/- 50 %<br>$U_R >$ 6.3 V; ΔC/C: ± 45 %<br>tan δ ≤ 3 x spec. limit<br>Z ≤ 3 x spec. limit<br>$I_{L5} \leq$ spec. limit<br>no short open circuit<br>total failure percentage: ≤ 1 % |
| Shelf life (storage at high temperature) | IEC 60384-4/ EN130300, subclause 4.17 | $T_{amb}$ = 105 °C; no voltage applied;<br>500 h<br>After test: $U_R$ to be applied for 30 min,<br>24 h to 48 h before measurement | ΔC/C, tan δ, Z:<br>For requirements<br>see “Endurance test” above<br>$I_{L5} \leq$ 2 x spec. limit |


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