

Aluminum Electrolytic Capacitors Radial Standard Ultra Miniature

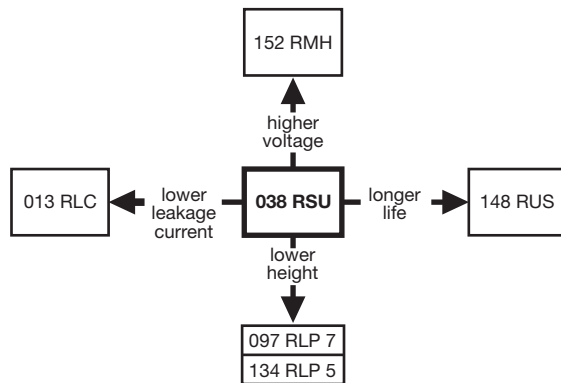
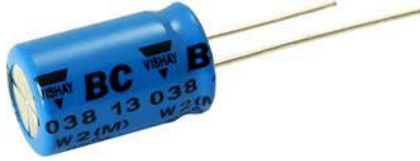


Fig. 1

| QUICK REFERENCE DATA | |
|---|------------------------|
| DESCRIPTION | VALUE |
| Nominal case sizes (Ø D x L in mm) | 5 x 11 to 18 x 40 |
| Rated capacitance range, C _R | 2.2 µF to 22 000 µF |
| Tolerance on C _R | ± 20 % |
| Rated voltage range, U _R | 6.3 V to 100 V |
| Category temperature range | -40 °C to +85 °C |
| Endurance test at 85 °C: | |
| Case size Ø D ≤ 8 mm | 2000 h |
| Case size Ø D ≥ 10 mm | 3000 h |
| Useful life at 85 °C: | |
| Case size Ø D ≤ 8 mm | 2500 h |
| Case size Ø D ≥ 10 mm | 3500 h |
| Useful life at 40 °C, 1.4 x I _R applied: | |
| Case size Ø D ≤ 8 mm | 60 000 h |
| Case size Ø D ≥ 10 mm | 90 000 h |
| Shelf life at 0 V, 85 °C | 1000 h |
| Based on sectional specification | IEC 60384-4 / EN130300 |
| Climatic category IEC 60068 | 40 / 085 / 56 |

FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case, insulated with a blue sleeve
- Pressure relief for case Ø D ≥ 6.3 mm
- Charge and discharge proof
- Miniaturized, high CV-product per unit volume
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912


**RoHS
COMPLIANT**

APPLICATIONS

- General purpose, industrial, automotive, consumer, and audio-video
- Coupling, decoupling, timing, smoothing, filtering, buffering in SMPS
- 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 ± 20 %)
- Rated voltage (in V)
- Date code, in accordance with IEC 60062
- Code indicating factory of origin
- Name of manufacturer
- Negative terminal identification
- Series number (038)

| SELECTION CHART FOR C_R , U_R , AND RELEVANT NOMINAL CASE SIZES ($\varnothing D \times L$ in mm) | | | | | | | | |
|---|-----------|----------|----------|----------|----------|----------|----------|----------|
| C_R (μF) | U_R (V) | | | | | | | |
| | 6.3 | 10 | 16 | 25 | 35 | 50 | 63 | 100 |
| 2.2 | – | – | – | – | – | – | 5 x 11 | 5 x 11 |
| 3.3 | – | – | – | – | – | – | 5 x 11 | 5 x 11 |
| 4.7 | – | – | – | – | – | – | 5 x 11 | 5 x 11 |
| 10 | – | – | – | – | – | – | 5 x 11 | 6.3 x 11 |
| 22 | – | – | – | – | – | 5 x 11 | 5 x 11 | 6.3 x 11 |
| 33 | – | – | – | – | – | 5 x 11 | 6.3 x 11 | 8 x 11.5 |
| 47 | – | – | – | – | 5 x 11 | 6.3 x 11 | 6.3 x 11 | 10 x 12 |
| 100 | – | 5 x 11 | 5 x 11 | 6.3 x 11 | 6.3 x 11 | 8 x 11.5 | 10 x 12 | 10 x 20 |
| 220 | 5 x 11 | 5 x 11 | 6.3 x 11 | 8 x 11.5 | 8 x 11.5 | 10 x 12 | 10 x 16 | 13 x 25 |
| 330 | 6.3 x 11 | 6.3 x 11 | 8 x 11.5 | 8 x 11.5 | 10 x 12 | 10 x 16 | 10 x 20 | 13 x 25 |
| 470 | 6.3 x 11 | 6.3 x 11 | 8 x 11.5 | 10 x 12 | 10 x 16 | 10 x 20 | 13 x 20 | 16 x 25 |
| 1000 | 8 x 11.5 | 10 x 12 | 10 x 16 | 10 x 20 | 13 x 20 | 13 x 25 | 16 x 25 | 18 x 40 |
| 2200 | 10 x 16 | 10 x 20 | 13 x 20 | 13 x 25 | 6 x 25 | 16 x 31 | 18 x 35 | – |
| 3300 | 10 x 20 | 13 x 20 | 13 x 25 | 16 x 25 | 16 x 35 | 18 x 35 | – | – |
| 4700 | 13 x 20 | 13 x 25 | 16 x 25 | 16 x 31 | 18 x 35 | – | – | – |
| 6800 | 13 x 25 | 16 x 25 | 16 x 31 | 18 x 35 | – | – | – | – |
| 10 000 | 16 x 25 | 16 x 35 | 18 x 35 | – | – | – | – | – |
| 22 000 | 18 x 40 | – | – | – | – | – | – | – |

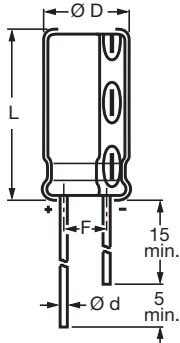
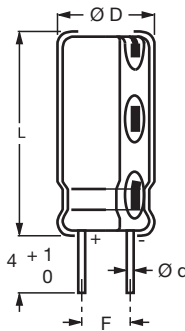
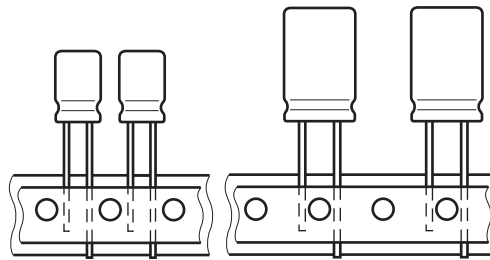
DIMENSIONS in millimeters AND AVAILABLE FORMS


Fig. 2 - Form CA


 Fig. 3 - Form CB:
Cut leads


Dimensions of pitch F see Table 1 and Table 2

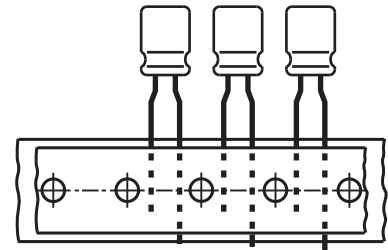
 Fig. 4 - Form TNA, Form TFA:
Taped in box (ammopack), straight leads

 Case $\varnothing D = 5$ mm to 8 mm; pitch F is 5 mm

 Fig. 5 - Form TFA:
Taped in box (ammopack), formed leads

Table 1

| DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES | | | | | | | | | |
|--|-----------|-----------------|-----------------------|-----------|---------------|----------------|----------------------|---------|---------------|
| NOMINAL CASE SIZE $\varnothing D \times L$ | CASE CODE | $\varnothing d$ | $\varnothing D_{max}$ | L_{max} | F | MASS (g) | PACKAGING QUANTITIES | | |
| | | | | | | | FORM CA | FORM CB | FORM TFA, TNA |
| 5 x 11 | 11 | 0.5 | 5.5 | 12.5 | 2.0 ± 0.5 | ≈ 0.4 | 5000 | – | 2000 |
| 6.3 x 11 | 12 | 0.5 | 6.8 | 12.5 | 2.5 ± 0.5 | ≈ 0.6 | 5000 | – | 2000 |
| 8 x 11.5 | 13 | 0.6 | 8.5 | 12.5 | 3.5 ± 0.5 | ≈ 1.1 | 5000 | – | 1000 |
| 10 x 12 | 14 | 0.6 | 10.5 | 13.5 | 5.0 ± 0.5 | ≈ 1.6 | 3000 | 1000 | 500 |
| 10 x 16 | 15 | 0.6 | 10.5 | 17.5 | 5.0 ± 0.5 | ≈ 1.9 | 2500 | 1000 | 500 |
| 10 x 20 | 16 | 0.6 | 10.5 | 22.0 | 5.0 ± 0.5 | ≈ 2.2 | 2000 | 800 | 500 |
| 13 x 20 | 17 | 0.6 | 13.5 | 22.0 | 5.0 ± 0.5 | ≈ 4.0 | 1500 | 400 | 300 |
| 13 x 25 | 18 | 0.6 | 13.5 | 27.0 | 5.0 ± 0.5 | ≈ 5.0 | 1000 | 400 | 300 |
| 16 x 25 | 19 | 0.8 | 16.5 | 27.0 | 7.5 ± 0.5 | ≈ 8.0 | 750 | 200 | 200 |
| 16 x 31 | 20 | 0.8 | 16.5 | 33.5 | 7.5 ± 0.5 | ≈ 9.0 | 600 | 200 | 200 |
| 16 x 35 | 21 | 0.8 | 16.5 | 37.5 | 7.5 ± 0.5 | ≈ 11.0 | 500 | 200 | – |
| 18 x 35 | 22 | 0.8 | 18.5 | 37.5 | 7.5 ± 0.5 | ≈ 14.5 | 400 | 150 | – |
| 18 x 40 | 23 | 0.8 | 18.5 | 42.0 | 7.5 ± 0.5 | ≈ 16.0 | 400 | 150 | – |

Note

- Detailed tape dimensions see section "Packaging".



| ELECTRICAL DATA | |
|-----------------|---|
| SYMBOL | DESCRIPTION |
| C_R | Rated capacitance at 100 Hz, tolerance $\pm 20\%$ |
| I_R | Rated RMS ripple current at 100 Hz, 85 °C |
| I_{L2} | Max. leakage current after 2 min at U_R |
| $\tan \delta$ | Max. dissipation factor at 100 Hz |

ORDERING EXAMPLE

Electrolytic capacitor 038 series

470 μF / 25 V; $\pm 20\%$

Nominal case size: \varnothing 10 mm x 12 mm; form TFA

Ordering code: MAL2 038 36471 E3

Former 12NC: 2222 038 36471

Note

- Unless otherwise specified, all electrical values in Table 2 apply at $T_{amb} = 20\text{ °C}$, $P = 86\text{ kPa}$ 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 $\varnothing D \times L$ (mm) | I_R 100 Hz 85 °C (mA) | I_{L2} 2 min (μA) | $\tan \delta$ 100 Hz | FREQ. CODE ⁽¹⁾ | ORDERING CODE MAL2038 | | | | | | | |
| | | | | | | | 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 | 220 | 5 x 11 | 200 | 14 | 0.23 | MF2 | 53221E3 | 2.0 | - | - | 33221E3 | 5.0 | 73221E3 | 2.5 |
| | 330 | 6.3 x 11 | 270 | 21 | 0.23 | MF2 | 53331E3 | 2.5 | - | - | 33331E3 | 5.0 | 73331E3 | 2.5 |
| | 470 | 6.3 x 11 | 320 | 30 | 0.23 | MF2 | 53471E3 | 2.5 | - | - | 33471E3 | 5.0 | 73471E3 | 2.5 |
| | 1000 | 8 x 11.5 | 540 | 63 | 0.23 | MF2 | 53102E3 | 3.5 | - | - | 33102E3 | 5.0 | 73102E3 | 3.5 |
| | 2200 | 10 x 16 | 785 | 139 | 0.25 | MF3 | 53222E3 | 5.0 | 63222E3 | 5.0 | 33222E3 | 5.0 | - | - |
| | 3300 | 10 x 20 | 1185 | 208 | 0.27 | MF3 | 53332E3 | 5.0 | 63332E3 | 5.0 | 33332E3 | 5.0 | - | - |
| | 4700 | 13 x 20 | 1545 | 296 | 0.29 | MF3 | 53472E3 | 5.0 | 63472E3 | 5.0 | 33472E3 | 5.0 | - | - |
| | 6800 | 13 x 25 | 1880 | 428 | 0.33 | MF3 | 53682E3 | 5.0 | 63682E3 | 5.0 | 33682E3 | 5.0 | - | - |
| | 10 000 | 16 x 25 | 2330 | 630 | 0.41 | MF3 | 53103E3 | 7.5 | 63103E3 | 7.5 | 33103E3 | 7.5 | - | - |
| | 22 000 | 18 x 40 | 3320 | 1386 | 0.65 | MF3 | 53223E3 | 7.5 | 63223E3 | 7.5 | - | - | - | - |
| 10 | 100 | 5 x 11 | 145 | 10 | 0.20 | MF2 | 54101E3 | 2.0 | - | - | 34101E3 | 5.0 | 74101E3 | 2.5 |
| | 220 | 5 x 11 | 160 | 22 | 0.20 | MF2 | 54221E3 | 2.0 | - | - | 34221E3 | 5.0 | 74221E3 | 2.5 |
| | 330 | 6.3 x 11 | 290 | 33 | 0.20 | MF2 | 54331E3 | 2.5 | - | - | 34331E3 | 5.0 | 74331E3 | 2.5 |
| | 470 | 6.3 x 11 | 350 | 47 | 0.20 | MF2 | 54471E3 | 2.5 | - | - | 34471E3 | 5.0 | 74471E3 | 2.5 |
| | 1000 | 10 x 12 | 650 | 100 | 0.20 | MF2 | 54102E3 | 5.0 | 64102E3 | 5.0 | 34102E3 | 5.0 | - | - |
| | 2200 | 10 x 20 | 1070 | 220 | 0.22 | MF3 | 54222E3 | 5.0 | 64222E3 | 5.0 | 34222E3 | 5.0 | - | - |
| | 3300 | 13 x 20 | 1420 | 330 | 0.24 | MF3 | 54332E3 | 5.0 | 64332E3 | 5.0 | 34332E3 | 5.0 | - | - |
| | 4700 | 13 x 25 | 1780 | 470 | 0.26 | MF3 | 54472E3 | 5.0 | 64472E3 | 5.0 | 34472E3 | 5.0 | - | - |
| | 6800 | 16 x 25 | 2220 | 680 | 0.30 | MF3 | 54682E3 | 7.5 | 64682E3 | 7.5 | 34682E3 | 7.5 | - | - |
| | 10 000 | 16 x 35 | 2760 | 1000 | 0.38 | MF3 | 54103E3 | 7.5 | 64103E3 | 7.5 | - | - | - | - |
| 16 | 100 | 5 x 11 | 160 | 16 | 0.16 | MF2 | 55101E3 | 2.0 | - | - | 35101E3 | 5.0 | 75101E3 | 2.5 |
| | 220 | 6.3 x 11 | 260 | 35 | 0.16 | MF2 | 55221E3 | 2.5 | - | - | 35221E3 | 5.0 | 75221E3 | 2.5 |
| | 330 | 8 x 11.5 | 370 | 53 | 0.16 | MF2 | 55331E3 | 3.5 | - | - | 35331E3 | 5.0 | 75331E3 | 3.5 |
| | 470 | 8 x 11.5 | 440 | 75 | 0.16 | MF2 | 55471E3 | 3.5 | - | - | 35471E3 | 5.0 | 75471E3 | 3.5 |
| | 1000 | 10 x 16 | 785 | 160 | 0.16 | MF2 | 55102E3 | 5.0 | 65102E3 | 5.0 | 35102E3 | 5.0 | - | - |
| | 2200 | 13 x 20 | 1295 | 352 | 0.18 | MF3 | 55222E3 | 5.0 | 65222E3 | 5.0 | 35222E3 | 5.0 | - | - |
| | 3300 | 13 x 25 | 1655 | 528 | 0.20 | MF3 | 55332E3 | 5.0 | 65332E3 | 5.0 | 35332E3 | 5.0 | - | - |
| | 4700 | 16 x 25 | 2090 | 752 | 0.22 | MF3 | 55472E3 | 7.5 | 65472E3 | 7.5 | 35472E3 | 7.5 | - | - |
| | 6800 | 16 x 31 | 2520 | 1088 | 0.26 | MF3 | 55682E3 | 7.5 | 65682E3 | 7.5 | 35682E3 | 7.5 | - | - |
| | 10 000 | 18 x 35 | 2920 | 1600 | 0.34 | MF3 | 55103E3 | 7.5 | 65103E3 | 7.5 | - | - | - | - |



| 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 | FREQ. CODE (1) | ORDERING CODE MAL2038 | | | | | | | |
| | | | | | | | BULK PACKAGING | | | | TAPED AMMOPACK | | | |
| | | | | | | | LONG LEADS | | CUT LEADS | | FORM TFA | F (mm) | FORM TNA | F (mm) |
| | | | | | | | FORM CA | F (mm) | FORM CB | F (mm) | | | | |
| 25 | 100 | 6.3 x 11 | 190 | 25 | 0.14 | MF2 | 56101E3 | 2.5 | - | - | 36101E3 | 5.0 | 76101E3 | 2.5 |
| | 220 | 8 x 11.5 | 320 | 55 | 0.14 | MF2 | 56221E3 | 3.5 | - | - | 36221E3 | 5.0 | 76221E3 | 3.5 |
| | 330 | 8 x 11.5 | 440 | 83 | 0.14 | MF2 | 56331E3 | 3.5 | - | - | 36331E3 | 5.0 | 76331E3 | 3.5 |
| | 470 | 10 x 12 | 545 | 118 | 0.14 | MF2 | 56471E3 | 5.0 | 66471E3 | 5.0 | 36471E3 | 5.0 | - | - |
| | 1000 | 10 x 20 | 955 | 250 | 0.14 | MF2 | 56102E3 | 5.0 | 66102E3 | 5.0 | 36102E3 | 5.0 | - | - |
| | 2200 | 13 x 25 | 1540 | 550 | 0.16 | MF3 | 56222E3 | 5.0 | 66222E3 | 5.0 | 36222E3 | 5.0 | - | - |
| | 3300 | 16 x 25 | 1975 | 825 | 0.18 | MF3 | 56332E3 | 7.5 | 66332E3 | 7.5 | 36332E3 | 7.5 | - | - |
| | 4700 | 16 x 31 | 2420 | 1175 | 0.20 | MF3 | 56472E3 | 7.5 | 66472E3 | 7.5 | 36472E3 | 7.5 | - | - |
| | 6800 | 18 x 35 | 2880 | 1700 | 0.24 | MF3 | 56682E3 | 7.5 | 66682E3 | 7.5 | - | - | - | - |
| 35 | 47 | 5 x 11 | 130 | 17 | 0.12 | MF1 | 50479E3 | 2.0 | - | - | 30479E3 | 5.0 | 70479E3 | 2.5 |
| | 100 | 6.3 x 11 | 210 | 35 | 0.12 | MF2 | 50101E3 | 2.5 | - | - | 30101E3 | 5.0 | 70101E3 | 2.5 |
| | 220 | 8 x 11.5 | 385 | 77 | 0.12 | MF2 | 50221E3 | 3.5 | - | - | 30221E3 | 5.0 | 70221E3 | 3.5 |
| | 330 | 10 x 12 | 490 | 116 | 0.12 | MF2 | 50331E3 | 5.0 | 60331E3 | 5.0 | 30331E3 | 5.0 | - | - |
| | 470 | 10 x 16 | 740 | 165 | 0.12 | MF2 | 50471E3 | 5.0 | 60471E3 | 5.0 | 30471E3 | 5.0 | - | - |
| | 1000 | 13 x 20 | 1145 | 350 | 0.12 | MF2 | 50102E3 | 5.0 | 60102E3 | 5.0 | 30102E3 | 5.0 | - | - |
| | 2200 | 16 x 25 | 1785 | 770 | 0.14 | MF3 | 50222E3 | 7.5 | 60222E3 | 7.5 | 30222E3 | 7.5 | - | - |
| | 3300 | 16 x 35 | 2275 | 1155 | 0.16 | MF3 | 50332E3 | 7.5 | 60332E3 | 7.5 | - | - | - | - |
| | 4700 | 18 x 35 | 2700 | 1645 | 0.18 | MF3 | 50472E3 | 7.5 | 60472E3 | 7.5 | - | - | - | - |
| 50 | 22 | 5 x 11 | 95 | 11 | 0.10 | MF1 | 51229E3 | 2.0 | - | - | 31229E3 | 5.0 | 71229E3 | 2.5 |
| | 33 | 5 x 11 | 125 | 17 | 0.10 | MF1 | 51339E3 | 2.0 | - | - | 31339E3 | 5.0 | 71339E3 | 2.5 |
| | 47 | 6.3 x 11 | 165 | 24 | 0.10 | MF1 | 51479E3 | 2.5 | - | - | 31479E3 | 5.0 | 71479E3 | 2.5 |
| | 100 | 8 x 11.5 | 260 | 50 | 0.10 | MF2 | 51101E3 | 3.5 | - | - | 31101E3 | 5.0 | 71101E3 | 3.5 |
| | 220 | 10 x 12 | 455 | 110 | 0.10 | MF2 | 51221E3 | 5.0 | 61221E3 | 5.0 | 31221E3 | 5.0 | - | - |
| | 330 | 10 x 16 | 585 | 165 | 0.10 | MF2 | 51331E3 | 5.0 | 61331E3 | 5.0 | 31331E3 | 5.0 | - | - |
| | 470 | 10 x 20 | 755 | 235 | 0.10 | MF2 | 51471E3 | 5.0 | 61471E3 | 5.0 | 31471E3 | 5.0 | - | - |
| | 1000 | 13 x 25 | 1340 | 500 | 0.10 | MF2 | 51102E3 | 5.0 | 61102E3 | 5.0 | 31102E3 | 5.0 | - | - |
| | 2200 | 16 x 31 | 1885 | 1100 | 0.12 | MF3 | 51222E3 | 7.5 | 61222E3 | 7.5 | 31222E3 | 7.5 | - | - |
| 3300 | 18 x 35 | 2500 | 1650 | 0.14 | MF3 | 51332E3 | 7.5 | 61332E3 | 7.5 | - | - | - | - | |
| 63 | 2.2 | 5 x 11 | 28 | 3.0 | 0.09 | MF1 | 58228E3 | 2.0 | - | - | 38228E3 | 5.0 | 78228E3 | 2.5 |
| | 3.3 | 5 x 11 | 34 | 3.0 | 0.09 | MF1 | 58338E3 | 2.0 | - | - | 38338E3 | 5.0 | 78338E3 | 2.5 |
| | 4.7 | 5 x 11 | 45 | 3.0 | 0.09 | MF1 | 58478E3 | 2.0 | - | - | 38478E3 | 5.0 | 78478E3 | 2.5 |
| | 10 | 5 x 11 | 70 | 6.3 | 0.09 | MF1 | 58109E3 | 2.0 | - | - | 38109E3 | 5.0 | 78109E3 | 2.5 |
| | 22 | 5 x 11 | 105 | 14 | 0.09 | MF1 | 58229E3 | 2.0 | - | - | 38229E3 | 5.0 | 78229E3 | 2.5 |
| | 33 | 6.3 x 11 | 140 | 21 | 0.09 | MF1 | 58339E3 | 2.5 | - | - | 38339E3 | 5.0 | 78339E3 | 2.5 |
| | 47 | 6.3 x 11 | 170 | 30 | 0.09 | MF1 | 58479E3 | 2.5 | - | - | 38479E3 | 5.0 | 78479E3 | 2.5 |
| | 100 | 10 x 12 | 320 | 63 | 0.09 | MF2 | 58101E3 | 5.0 | 68101E3 | 5.0 | 38101E3 | 5.0 | - | - |
| | 220 | 10 x 16 | 490 | 139 | 0.09 | MF2 | 58221E3 | 5.0 | 68221E3 | 5.0 | 38221E3 | 5.0 | - | - |
| | 330 | 10 x 20 | 710 | 208 | 0.09 | MF2 | 58331E3 | 5.0 | 68331E3 | 5.0 | 38331E3 | 5.0 | - | - |
| | 470 | 13 x 20 | 900 | 296 | 0.09 | MF2 | 58471E3 | 5.0 | 68471E3 | 5.0 | 38471E3 | 5.0 | - | - |
| | 1000 | 16 x 25 | 1560 | 630 | 0.09 | MF2 | 58102E3 | 7.5 | 68102E3 | 7.5 | 38102E3 | 7.5 | - | - |
| | 2200 | 18 x 35 | 1950 | 1386 | 0.11 | MF3 | 58222E3 | 7.5 | 68222E3 | 7.5 | - | - | - | - |



| 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 | FREQ. CODE ⁽¹⁾ | ORDERING CODE MAL2038 | | | | | | | |
| | | | | | | | BULK PACKAGING | | | | TAPED AMMOPACK | | | |
| | | | | | | | LONG LEADS | | CUT LEADS | | | | | |
| | | | | | | | FORM CA | F (mm) | FORM CB | F (mm) | FORM TFA | F (mm) | FORM TNA | F (mm) |
| 100 | 2.2 | 5 x 11 | 33 | 3.0 | 0.08 | MF1 | 59228E3 | 2.0 | - | - | 39228E3 | 5.0 | 79228E3 | 2.5 |
| | 3.3 | 5 x 11 | 40 | 3.3 | 0.08 | MF1 | 59338E3 | 2.0 | - | - | 39338E3 | 5.0 | 79338E3 | 2.5 |
| | 4.7 | 5 x 11 | 48 | 4.7 | 0.08 | MF1 | 59478E3 | 2.0 | - | - | 39478E3 | 5.0 | 79478E3 | 2.5 |
| | 10 | 6.3 x 11 | 80 | 10 | 0.08 | MF1 | 59109E3 | 2.5 | - | - | 39109E3 | 5.0 | 79109E3 | 2.5 |
| | 22 | 6.3 x 11 | 115 | 22 | 0.08 | MF1 | 59229E3 | 2.5 | - | - | 39229E3 | 5.0 | 79229E3 | 2.5 |
| | 33 | 8 x 11.5 | 145 | 33 | 0.08 | MF1 | 59339E3 | 3.5 | - | - | 39339E3 | 5.0 | 79339E3 | 3.5 |
| | 47 | 10 x 12 | 235 | 47 | 0.08 | MF1 | 59479E3 | 5.0 | 69479E3 | 5.0 | 39479E3 | 5.0 | - | - |
| | 100 | 10 x 20 | 370 | 100 | 0.08 | MF2 | 59101E3 | 5.0 | 69101E3 | 5.0 | 39101E3 | 5.0 | - | - |
| | 220 | 13 x 25 | 675 | 220 | 0.08 | MF2 | 59221E3 | 5.0 | 69221E3 | 5.0 | 39221E3 | 5.0 | - | - |
| | 330 | 13 x 25 | 825 | 330 | 0.08 | MF2 | 59331E3 | 5.0 | 69331E3 | 5.0 | 39331E3 | 5.0 | - | - |
| | 470 | 16 x 25 | 1070 | 470 | 0.08 | MF2 | 59471E3 | 7.5 | 69471E3 | 7.5 | 39471E3 | 7.5 | - | - |
| | 1000 | 18 x 40 | 2410 | 1000 | 0.08 | MF2 | 59102E3 | 7.5 | 69102E3 | 7.5 | - | - | - | - |

Note

⁽¹⁾ Determines the applicable row in the table “Multiplier of Ripple Current (I_R) as a Function of Frequency”

| ADDITIONAL ELECTRICAL DATA | | |
|------------------------------------|---|--|
| PARAMETER | CONDITIONS | VALUE |
| Voltage | | |
| Surge voltage | | $U_S \leq 1.15 \times U_R$ |
| Reverse voltage | | $U_{REV} \leq 1 V$ |
| Current | | |
| Leakage current | After 2 min at U _R | $I_{L2} \leq 0.01 C_R \times U_R$ or 3 μA, whichever is greater |
| | After 5 min at U _R | $I_{L5} \leq 0.002 C_R \times U_R + 3 \mu A$ |
| Inductance | | |
| Equivalent series inductance (ESL) | Case Ø D ≤ 8 mm | Typ. 13 nH |
| | Case Ø D = 10 mm | Typ. 16 nH |
| | Case Ø D ≥ 12.5 mm | Typ. 18 nH |
| Resistance | | |
| Equivalent series resistance (ESR) | Calculated from tan δ _{max} and C _R (see Table 2) | $ESR = \tan \delta / 2 \pi f C_R$ |

CAPACITANCE (C)

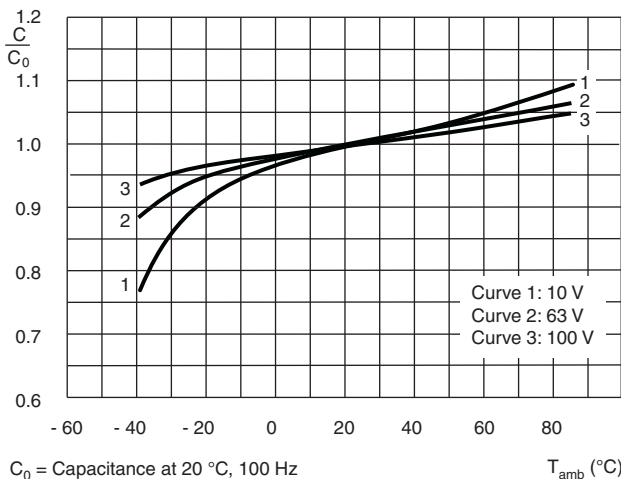


Fig. 6 - Typical multiplier of capacitance as a function of ambient temperature

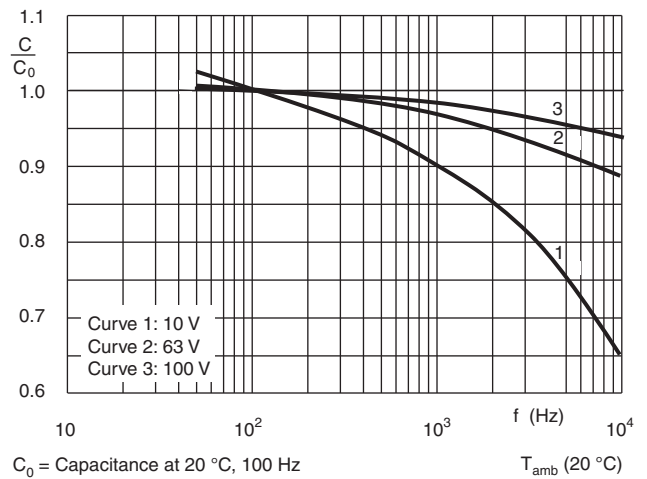


Fig. 7 - Typical multiplier of capacitance as a function of frequency

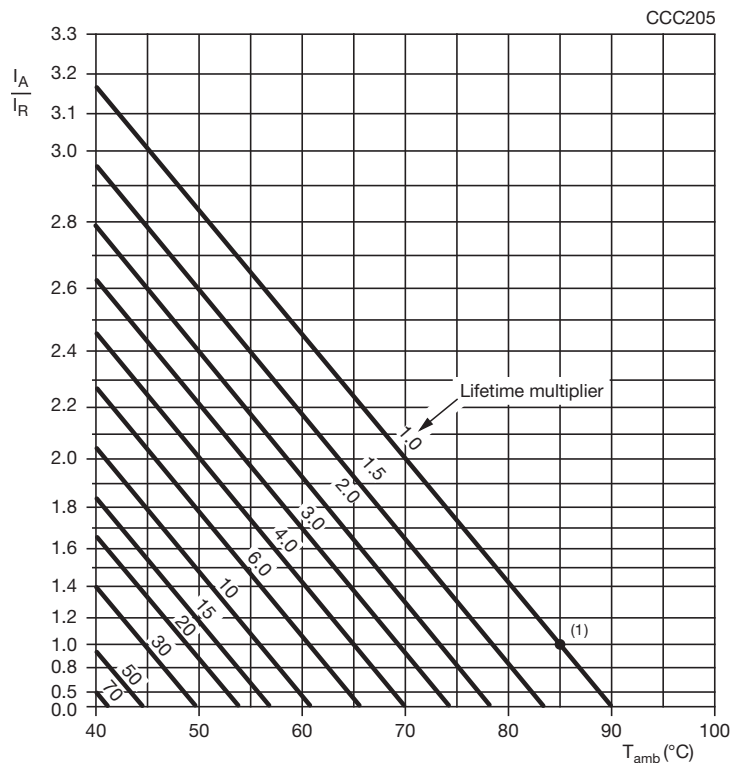
RIPPLE CURRENT AND USEFUL LIFE

Table 3

| ENDURANCE TEST DURATION AND USEFUL LIFE | | |
|---|------------------------------|--------------------------------|
| NOMINAL CASE SIZE Ø D x L (mm) | ENDURANCE AT 85 °C (h) | USEFUL LIFE AT 85 °C (h) |
| 5 x 11 | 2000 | 2500 |
| 6.3 x 11 | 2000 | 2500 |
| 8 x 11.5 | 2000 | 2500 |
| 10 x 12 | 3000 | 3500 |
| 10 x 16 | 3000 | 3500 |
| 10 x 20 | 3000 | 3500 |
| 13 x 20 | 3000 | 3500 |
| 13 x 25 | 3000 | 3500 |
| 16 x 25 | 3000 | 3500 |
| 16 x 31 | 3000 | 3500 |
| 16 x 35 | 3000 | 3500 |
| 18 x 35 | 3000 | 3500 |
| 18 x 40 | 3000 | 3500 |

Note

- Multiplier of useful life code: CCC205



I_A = Actual ripple current at 100 Hz
 I_R = Rated ripple current at 100 Hz, 85 °C
 Useful life at 85 °C and I_R applied:
 Case $\varnothing D \leq 8$ mm: 2500 h
 Case $\varnothing D \geq 10$ mm: 3500 h

Fig. 8 - 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 | | | | | |
|---|------------------------------------|------------|------------|-------------|-----------------|
| FREQ. CODE | FREQUENCY (Hz) | | | | |
| | 50 | 100 | 500 | 1000 | ≥ 10 000 |
| | I_R MULTIPLIER | | | | |
| MF1 | 0.70 | 1.00 | 1.30 | 1.40 | 1.50 |
| MF2 | 0.75 | 1.00 | 1.20 | 1.30 | 1.35 |
| MF3 | 0.80 | 1.00 | 1.10 | 1.12 | 1.15 |

Table 5

| TEST PROCEDURES AND REQUIREMENTS | | | |
|---|--|--|--|
| TEST | | PROCEDURE (quick reference) | REQUIREMENTS |
| NAME OF TEST | REFERENCE | | |
| Endurance | IEC 60384-4 / EN 130300 subclause 4.13 | $T_{amb} = 85\text{ °C}$; U_R applied; Case $\varnothing \leq 8\text{ mm}$: 2000 h Case $\varnothing \geq 10\text{ mm}$: 3000 h | $\Delta C/C: \pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ |
| Useful life | CECC 30301 subclause 1.8.1 | $T_{amb} = 85\text{ °C}$; U_R and I_R applied; Case $\varnothing \leq 8\text{ mm}$: 2500 h Case $\varnothing \geq 10\text{ mm}$: 3500 h | $\Delta C/C: \pm 50\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$ |
| Shelf life (storage at high temperature) | IEC 60384-4 / EN 130300 subclause 4.17 | $T_{amb} = 85\text{ °C}$; no voltage applied; 1000 h after test: U_R to be applied for 30 min, 24 h to 48 h before measurement | $\Delta C/C: \pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $I_{L5} \leq 3 \times \text{spec. limit}$ |
| Surge | IEC 60384-4 / EN 130300 subclause 4.14 | From source of $1.15 \times U_R$; $RC = 0.1\text{ s} \pm 0.05\text{ s}$; 1000 cycles of 30 s on, 330 s off, at 85 °C | $\Delta C/C: \pm 25\%$ $\tan \delta \leq 1.5 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ |

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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