

# Aluminum Capacitors

## Radial Standard Ultra Miniature

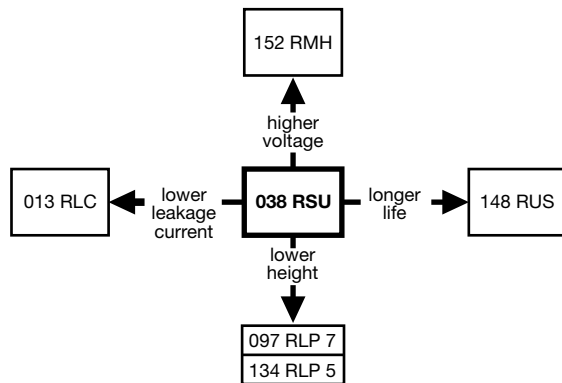
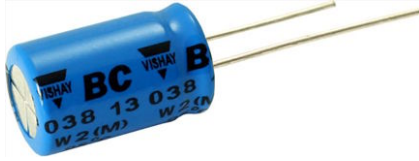


Fig. 1

| 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 <sub>R</sub>             | 0.1 µF to 22 000 µF  |
| Tolerance on C <sub>R</sub>                         | ± 20 %               |
| Rated voltage range, U <sub>R</sub>                 | 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 <sub>R</sub> 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](http://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)

| <b>SELECTION CHART FOR <math>C_R</math>, <math>U_R</math>, AND RELEVANT NOMINAL CASE SIZES (<math>\varnothing D \times L</math> in mm)</b> |           |          |          |          |          |          |          |          |
|--|-----------|----------|----------|----------|----------|----------|----------|----------|
| $C_R$<br>( $\mu F$ )   | $U_R$ (V) |          |          |          |          |          |          |          |
|  | 6.3       | 10       | 16       | 25       | 35       | 50       | 63       | 100      |
| 0.10   | –         | –        | –        | –        | –        | –        | 5 x 11   | –        |
| 0.22   | –         | –        | –        | –        | –        | –        | 5 x 11   | –        |
| 0.33   | –         | –        | –        | –        | –        | –        | 5 x 11   | –        |
| 0.47   | –         | –        | –        | –        | –        | –        | 5 x 11   | 5 x 11   |
| 1.0  | –         | –        | –        | –        | –        | –        | 5 x 11   | 5 x 11   |
| 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   | –        | –        | –        | –        | –        | –        | –        |

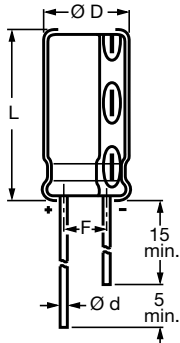
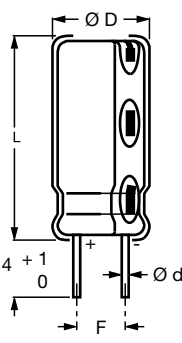
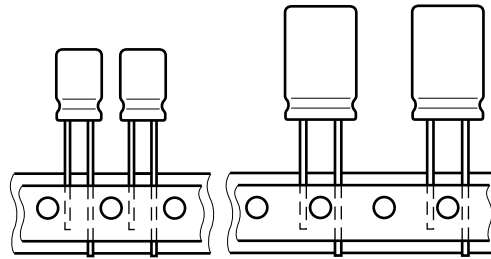
**DIMENSIONS in millimeters AND AVAILABLE FORMS**


Fig. 2 - Form CA


 Fig. 3 - Form CB:  
Cut leads


Dimensions of pitch F see Table 1 and Table 2

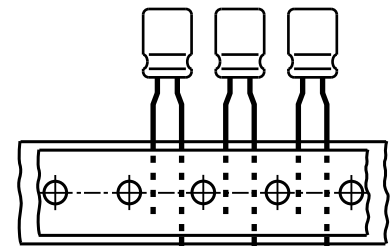
 Fig. 4 - Form TNA, Form TFA:  
Taped in box (ammopack), straight leads

 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**

| <b>DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES</b> |           |                 |                        |            |               |                |                      |         |               |
|---|-----------|-----------------|------------------------|------------|---------------|----------------|----------------------|---------|---------------|
| NOMINAL CASE SIZE<br>$\varnothing D \times L$                   | 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       | $2.0 \pm 0.5$ | $\approx 0.4$  | 5000                 | –       | 2000          |
| 6.3 x 11  | 12        | 0.5             | 6.8                    | 12.5       | $2.5 \pm 0.5$ | $\approx 0.6$  | 5000                 | –       | 2000          |
| 8 x 11.5  | 13        | 0.6             | 8.5                    | 12.5       | $3.5 \pm 0.5$ | $\approx 1.1$  | 5000                 | –       | 1000          |
| 10 x 12   | 14        | 0.6             | 10.5                   | 13.5       | $5.0 \pm 0.5$ | $\approx 1.6$  | 3000                 | 1000    | 500           |
| 10 x 16   | 15        | 0.6             | 10.5                   | 17.5       | $5.0 \pm 0.5$ | $\approx 1.9$  | 2500                 | 1000    | 500           |
| 10 x 20   | 16        | 0.6             | 10.5                   | 22.0       | $5.0 \pm 0.5$ | $\approx 2.2$  | 2000                 | 800     | 500           |
| 13 x 20   | 17        | 0.6             | 13.5                   | 22.0       | $5.0 \pm 0.5$ | $\approx 4.0$  | 1500                 | 400     | 300           |
| 13 x 25   | 18        | 0.6             | 13.5                   | 27.0       | $5.0 \pm 0.5$ | $\approx 5.0$  | 1000                 | 400     | 300           |
| 16 x 25   | 19        | 0.8             | 16.5                   | 27.0       | $7.5 \pm 0.5$ | $\approx 8.0$  | 750                  | 200     | 200           |
| 16 x 31   | 20        | 0.8             | 16.5                   | 33.5       | $7.5 \pm 0.5$ | $\approx 9.0$  | 600                  | 200     | 200           |
| 16 x 35   | 21        | 0.8             | 16.5                   | 37.5       | $7.5 \pm 0.5$ | $\approx 11.0$ | 500                  | 200     | –             |
| 18 x 35   | 22        | 0.8             | 18.5                   | 37.5       | $7.5 \pm 0.5$ | $\approx 14.5$ | 400                  | 150     | –             |
| 18 x 40   | 23        | 0.8             | 18.5                   | 42.0       | $7.5 \pm 0.5$ | $\approx 16.0$ | 400                  | 150     | –             |

**Note**

- Detailed tape dimensions see section "Packaging".



| ELECTRICAL DATA |  |
|-----------------|--|
| SYMBOL          | DESCRIPTION  |
| C <sub>R</sub>  | Rated capacitance at 100 Hz, tolerance ± 20 %      |
| I <sub>R</sub>  | Rated RMS ripple current at 100 Hz, 85 °C          |
| I <sub>L2</sub> | Max. leakage current after 2 min at U <sub>R</sub> |
| tan δ           | Max. dissipation factor at 100 Hz                  |

**ORDERING EXAMPLE**

Electrolytic capacitor 038 series

470 µF/25 V; ± 20 %

Nominal case size: Ø 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<sub>amb</sub> = 20 °C, P = 86 kPa to 106 kPa, RH = 45 % to 75 %.

**Table 2**

| ELECTRICAL DATA AND ORDERING INFORMATION |                                  |   |   |                                  |                 |                             |           |            |           |                |           |             |           |
|--|----------------------------------|---|---|----------------------------------|-----------------|-----------------------------|-----------|------------|-----------|----------------|-----------|-------------|-----------|
| U <sub>R</sub><br>(V)                    | C <sub>R</sub><br>100 Hz<br>(µF) | NOMINAL<br>CASE SIZE<br>Ø D x L<br>(mm) | I <sub>R</sub><br>100 Hz<br>85 °C<br>(mA) | I <sub>L2</sub><br>2 min<br>(µA) | tan δ<br>100 Hz | ORDERING CODE MAL2038 ..... |           |            |           |                |           |             |           |
|  |                                  |   |   |                                  |                 | BULK PACKAGING              |           |            |           | TAPED AMMOPACK |           |             |           |
|  |                                  |   |   |                                  |                 | LONG LEADS                  |           | CUT LEADS  |           | FORM TFA       |           | FORM TNA    |           |
|  |                                  |   |   |                                  |                 | FORM<br>CA                  | F<br>(mm) | FORM<br>CB | F<br>(mm) | FORM<br>TFA    | F<br>(mm) | FORM<br>TNA | F<br>(mm) |
| 6.3                                      | 220                              | 5 x 11                                  | 200                                       | 14                               | 0.23            | 53221E3                     | 2.0       | -          | -         | 33221E3        | 5.0       | 73221E3     | 2.5       |
|  | 330                              | 6.3 x 11                                | 270                                       | 21                               | 0.23            | 53331E3                     | 2.5       | -          | -         | 33331E3        | 5.0       | 73331E3     | 2.5       |
|  | 470                              | 6.3 x 11                                | 320                                       | 30                               | 0.23            | 53471E3                     | 2.5       | -          | -         | 33471E3        | 5.0       | 73471E3     | 2.5       |
|  | 1000                             | 8 x 11.5                                | 540                                       | 63                               | 0.23            | 53102E3                     | 3.5       | -          | -         | 33102E3        | 5.0       | 73102E3     | 3.5       |
|  | 2200                             | 10 x 16                                 | 785                                       | 139                              | 0.25            | 53222E3                     | 5.0       | 63222E3    | 5.0       | 33222E3        | 5.0       | -           | -         |
|  | 3300                             | 10 x 20                                 | 1185                                      | 208                              | 0.27            | 53332E3                     | 5.0       | 63332E3    | 5.0       | 33332E3        | 5.0       | -           | -         |
|  | 4700                             | 13 x 20                                 | 1545                                      | 296                              | 0.29            | 53472E3                     | 5.0       | 63472E3    | 5.0       | 33472E3        | 5.0       | -           | -         |
|  | 6800                             | 13 x 25                                 | 1880                                      | 428                              | 0.33            | 53682E3                     | 5.0       | 63682E3    | 5.0       | 33682E3        | 5.0       | -           | -         |
|  | 10 000                           | 16 x 25                                 | 2330                                      | 630                              | 0.41            | 53103E3                     | 7.5       | 63103E3    | 7.5       | 33103E3        | 7.5       | -           | -         |
|  | 22 000                           | 18 x 40                                 | 3320                                      | 1386                             | 0.65            | 53223E3                     | 7.5       | 63223E3    | 7.5       | -              | -         | -           | -         |
| 10                                       | 100                              | 5 x 11                                  | 145                                       | 10                               | 0.20            | 54101E3                     | 2.0       | -          | -         | 34101E3        | 5.0       | 74101E3     | 2.5       |
|  | 220                              | 5 x 11                                  | 160                                       | 22                               | 0.20            | 54221E3                     | 2.0       | -          | -         | 34221E3        | 5.0       | 74221E3     | 2.5       |
|  | 330                              | 6.3 x 11                                | 290                                       | 33                               | 0.20            | 54331E3                     | 2.5       | -          | -         | 34331E3        | 5.0       | 74331E3     | 2.5       |
|  | 470                              | 6.3 x 11                                | 350                                       | 47                               | 0.20            | 54471E3                     | 2.5       | -          | -         | 34471E3        | 5.0       | 74471E3     | 2.5       |
|  | 1000                             | 10 x 12                                 | 650                                       | 100                              | 0.20            | 54102E3                     | 5.0       | 64102E3    | 5.0       | 34102E3        | 5.0       | -           | -         |
|  | 2200                             | 10 x 20                                 | 1070                                      | 220                              | 0.22            | 54222E3                     | 5.0       | 64222E3    | 5.0       | 34222E3        | 5.0       | -           | -         |
|  | 3300                             | 13 x 20                                 | 1420                                      | 330                              | 0.24            | 54332E3                     | 5.0       | 64332E3    | 5.0       | 34332E3        | 5.0       | -           | -         |
|  | 4700                             | 13 x 25                                 | 1780                                      | 470                              | 0.26            | 54472E3                     | 5.0       | 64472E3    | 5.0       | 34472E3        | 5.0       | -           | -         |
|  | 6800                             | 16 x 25                                 | 2220                                      | 680                              | 0.30            | 54682E3                     | 7.5       | 64682E3    | 7.5       | 34682E3        | 7.5       | -           | -         |
|  | 10 000                           | 16 x 35                                 | 2760                                      | 1000                             | 0.38            | 54103E3                     | 7.5       | 64103E3    | 7.5       | -              | -         | -           | -         |
| 16                                       | 100                              | 5 x 11                                  | 160                                       | 16                               | 0.16            | 55101E3                     | 2.0       | -          | -         | 35101E3        | 5.0       | 75101E3     | 2.5       |
|  | 220                              | 6.3 x 11                                | 260                                       | 35                               | 0.16            | 55221E3                     | 2.5       | -          | -         | 35221E3        | 5.0       | 75221E3     | 2.5       |
|  | 330                              | 8 x 11.5                                | 370                                       | 53                               | 0.16            | 55331E3                     | 3.5       | -          | -         | 35331E3        | 5.0       | 75331E3     | 3.5       |
|  | 470                              | 8 x 11.5                                | 440                                       | 75                               | 0.16            | 55471E3                     | 3.5       | -          | -         | 35471E3        | 5.0       | 75471E3     | 3.5       |
|  | 1000                             | 10 x 16                                 | 785                                       | 160                              | 0.16            | 55102E3                     | 5.0       | 65102E3    | 5.0       | 35102E3        | 5.0       | -           | -         |
|  | 2200                             | 13 x 20                                 | 1295                                      | 352                              | 0.18            | 55222E3                     | 5.0       | 65222E3    | 5.0       | 35222E3        | 5.0       | -           | -         |
|  | 3300                             | 13 x 25                                 | 1655                                      | 528                              | 0.20            | 55332E3                     | 5.0       | 65332E3    | 5.0       | 35332E3        | 5.0       | -           | -         |
|  | 4700                             | 16 x 25                                 | 2090                                      | 752                              | 0.22            | 55472E3                     | 7.5       | 65472E3    | 7.5       | 35472E3        | 7.5       | -           | -         |
|  | 6800                             | 16 x 31                                 | 2520                                      | 1088                             | 0.26            | 55682E3                     | 7.5       | 65682E3    | 7.5       | 35682E3        | 7.5       | -           | -         |
|  | 10 000                           | 18 x 35                                 | 2920                                      | 1600                             | 0.34            | 55103E3                     | 7.5       | 65103E3    | 7.5       | -              | -         | -           | -         |
| 25                                       | 100                              | 6.3 x 11                                | 190                                       | 25                               | 0.14            | 56101E3                     | 2.5       | -          | -         | 36101E3        | 5.0       | 76101E3     | 2.5       |
|  | 220                              | 8 x 11.5                                | 320                                       | 55                               | 0.14            | 56221E3                     | 3.5       | -          | -         | 36221E3        | 5.0       | 76221E3     | 3.5       |
|  | 330                              | 8 x 11.5                                | 440                                       | 83                               | 0.14            | 56331E3                     | 3.5       | -          | -         | 36331E3        | 5.0       | 76331E3     | 3.5       |
|  | 470                              | 10 x 12                                 | 545                                       | 118                              | 0.14            | 56471E3                     | 5.0       | 66471E3    | 5.0       | 36471E3        | 5.0       | -           | -         |
|  | 1000                             | 10 x 20                                 | 955                                       | 250                              | 0.14            | 56102E3                     | 5.0       | 66102E3    | 5.0       | 36102E3        | 5.0       | -           | -         |
|  | 2200                             | 13 x 25                                 | 1540                                      | 550                              | 0.16            | 56222E3                     | 5.0       | 66222E3    | 5.0       | 36222E3        | 5.0       | -           | -         |
|  | 3300                             | 16 x 25                                 | 1975                                      | 825                              | 0.18            | 56332E3                     | 7.5       | 66332E3    | 7.5       | 36332E3        | 7.5       | -           | -         |
|  | 4700                             | 16 x 31                                 | 2420                                      | 1175                             | 0.20            | 56472E3                     | 7.5       | 66472E3    | 7.5       | 36472E3        | 7.5       | -           | -         |
|  | 6800                             | 18 x 35                                 | 2880                                      | 1700                             | 0.24            | 56682E3                     | 7.5       | 66682E3    | 7.5       | -              | -         | -           | -         |



| ELECTRICAL DATA AND ORDERING INFORMATION |                                  |   |   |                                  |                 |                             |           |            |           |                |           |             |           |
|--|----------------------------------|---|---|----------------------------------|-----------------|-----------------------------|-----------|------------|-----------|----------------|-----------|-------------|-----------|
| U <sub>R</sub><br>(V)                    | C <sub>R</sub><br>100 Hz<br>(μF) | NOMINAL<br>CASE SIZE<br>Ø D x L<br>(mm) | I <sub>R</sub><br>100 Hz<br>85 °C<br>(mA) | I <sub>L2</sub><br>2 min<br>(μA) | tan δ<br>100 Hz | ORDERING CODE MAL2038 ..... |           |            |           |                |           |             |           |
|  |                                  |   |   |                                  |                 | BULK PACKAGING              |           |            |           | TAPED AMMOPACK |           |             |           |
|  |                                  |   |   |                                  |                 | LONG LEADS                  |           | CUT LEADS  |           | FORM TFA       |           | FORM TNA    |           |
|  |                                  |   |   |                                  |                 | FORM<br>CA                  | F<br>(mm) | FORM<br>CB | F<br>(mm) | FORM<br>TFA    | F<br>(mm) | FORM<br>TNA | F<br>(mm) |
| 35                                       | 47                               | 5 x 11                                  | 130                                       | 17                               | 0.12            | 50479E3                     | 2.0       | -          | -         | 30479E3        | 5.0       | 70479E3     | 2.5       |
|  | 100                              | 6.3 x 11                                | 210                                       | 35                               | 0.12            | 50101E3                     | 2.5       | -          | -         | 30101E3        | 5.0       | 70101E3     | 2.5       |
|  | 220                              | 8 x 11.5                                | 385                                       | 77                               | 0.12            | 50221E3                     | 3.5       | -          | -         | 30221E3        | 5.0       | 70221E3     | 3.5       |
|  | 330                              | 10 x 12                                 | 490                                       | 116                              | 0.12            | 50331E3                     | 5.0       | 60331E3    | 5.0       | 30331E3        | 5.0       | -           | -         |
|  | 470                              | 10 x 16                                 | 740                                       | 165                              | 0.12            | 50471E3                     | 5.0       | 60471E3    | 5.0       | 30471E3        | 5.0       | -           | -         |
|  | 1000                             | 13 x 20                                 | 1145                                      | 350                              | 0.12            | 50102E3                     | 5.0       | 60102E3    | 5.0       | 30102E3        | 5.0       | -           | -         |
|  | 2200                             | 16 x 25                                 | 1785                                      | 770                              | 0.14            | 50222E3                     | 7.5       | 60222E3    | 7.5       | 30222E3        | 7.5       | -           | -         |
|  | 3300                             | 16 x 35                                 | 2275                                      | 1155                             | 0.16            | 50332E3                     | 7.5       | 60332E3    | 7.5       | -              | -         | -           | -         |
|  | 4700                             | 18 x 35                                 | 2700                                      | 1645                             | 0.18            | 50472E3                     | 7.5       | 60472E3    | 7.5       | -              | -         | -           | -         |
| 50                                       | 22                               | 5 x 11                                  | 95  | 11                               | 0.10            | 51229E3                     | 2.0       | -          | -         | 31229E3        | 5.0       | 71229E3     | 2.5       |
|  | 33                               | 5 x 11                                  | 125                                       | 17                               | 0.10            | 51339E3                     | 2.0       | -          | -         | 31339E3        | 5.0       | 71339E3     | 2.5       |
|  | 47                               | 6.3 x 11                                | 165                                       | 24                               | 0.10            | 51479E3                     | 2.5       | -          | -         | 31479E3        | 5.0       | 71479E3     | 2.5       |
|  | 100                              | 8 x 11.5                                | 260                                       | 50                               | 0.10            | 51101E3                     | 3.5       | -          | -         | 31101E3        | 5.0       | 71101E3     | 3.5       |
|  | 220                              | 10 x 12                                 | 455                                       | 110                              | 0.10            | 51221E3                     | 5.0       | 61221E3    | 5.0       | 31221E3        | 5.0       | -           | -         |
|  | 330                              | 10 x 16                                 | 585                                       | 165                              | 0.10            | 51331E3                     | 5.0       | 61331E3    | 5.0       | 31331E3        | 5.0       | -           | -         |
|  | 470                              | 10 x 20                                 | 755                                       | 235                              | 0.10            | 51471E3                     | 5.0       | 61471E3    | 5.0       | 31471E3        | 5.0       | -           | -         |
|  | 1000                             | 13 x 25                                 | 1340                                      | 500                              | 0.10            | 51102E3                     | 5.0       | 61102E3    | 5.0       | 31102E3        | 5.0       | -           | -         |
|  | 2200                             | 16 x 31                                 | 1885                                      | 1100                             | 0.12            | 51222E3                     | 7.5       | 61222E3    | 7.5       | 31222E3        | 7.5       | -           | -         |
| 3300                                     | 18 x 35                          | 2500                                    | 1650                                      | 0.14                             | 51332E3         | 7.5                         | 61332E3   | 7.5        | -         | -              | -         | -           |           |
| 63                                       | 0.10                             | 5 x 11                                  | 3.0                                       | 3.0                              | 0.09            | 58107E3                     | 2.0       | -          | -         | 38107E3        | 5.0       | 78107E3     | 2.5       |
|  | 0.22                             | 5 x 11                                  | 4.5                                       | 3.0                              | 0.09            | 58227E3                     | 2.0       | -          | -         | 38227E3        | 5.0       | 78227E3     | 2.5       |
|  | 0.33                             | 5 x 11                                  | 7.5                                       | 3.0                              | 0.09            | 58337E3                     | 2.0       | -          | -         | 38337E3        | 5.0       | 78337E3     | 2.5       |
|  | 0.47                             | 5 x 11                                  | 9.5                                       | 3.0                              | 0.09            | 58477E3                     | 2.0       | -          | -         | 38477E3        | 5.0       | 78477E3     | 2.5       |
|  | 1.0                              | 5 x 11                                  | 17  | 3.0                              | 0.09            | 58108E3                     | 2.0       | -          | -         | 38108E3        | 5.0       | 78108E3     | 2.5       |
|  | 2.2                              | 5 x 11                                  | 28  | 3.0                              | 0.09            | 58228E3                     | 2.0       | -          | -         | 38228E3        | 5.0       | 78228E3     | 2.5       |
|  | 3.3                              | 5 x 11                                  | 34  | 3.0                              | 0.09            | 58338E3                     | 2.0       | -          | -         | 38338E3        | 5.0       | 78338E3     | 2.5       |
|  | 4.7                              | 5 x 11                                  | 45  | 3.0                              | 0.09            | 58478E3                     | 2.0       | -          | -         | 38478E3        | 5.0       | 78478E3     | 2.5       |
|  | 10                               | 5 x 11                                  | 70  | 6.3                              | 0.09            | 58109E3                     | 2.0       | -          | -         | 38109E3        | 5.0       | 78109E3     | 2.5       |
|  | 22                               | 5 x 11                                  | 105                                       | 14                               | 0.09            | 58229E3                     | 2.0       | -          | -         | 38229E3        | 5.0       | 78229E3     | 2.5       |
|  | 33                               | 6.3 x 11                                | 140                                       | 21                               | 0.09            | 58339E3                     | 2.5       | -          | -         | 38339E3        | 5.0       | 78339E3     | 2.5       |
|  | 47                               | 6.3 x 11                                | 170                                       | 30                               | 0.09            | 58479E3                     | 2.5       | -          | -         | 38479E3        | 5.0       | 78479E3     | 2.5       |
|  | 100                              | 10 x 12                                 | 320                                       | 63                               | 0.09            | 58101E3                     | 5.0       | 68101E3    | 5.0       | 38101E3        | 5.0       | -           | -         |
|  | 220                              | 10 x 16                                 | 490                                       | 139                              | 0.09            | 58221E3                     | 5.0       | 68221E3    | 5.0       | 38221E3        | 5.0       | -           | -         |
|  | 330                              | 10 x 20                                 | 710                                       | 208                              | 0.09            | 58331E3                     | 5.0       | 68331E3    | 5.0       | 38331E3        | 5.0       | -           | -         |
|  | 470                              | 13 x 20                                 | 900                                       | 296                              | 0.09            | 58471E3                     | 5.0       | 68471E3    | 5.0       | 38471E3        | 5.0       | -           | -         |
| 1000                                     | 16 x 25                          | 1560                                    | 630                                       | 0.09                             | 58102E3         | 7.5                         | 68102E3   | 7.5        | 38102E3   | 7.5            | -         | -           |           |
| 2200                                     | 18 x 35                          | 1950                                    | 1386                                      | 0.11                             | 58222E3         | 7.5                         | 68222E3   | 7.5        | -         | -              | -         | -           |           |
| 100                                      | 0.47                             | 5 x 11                                  | 12  | 3.0                              | 0.08            | 59477E3                     | 2.0       | -          | -         | 39477E3        | 5.0       | 79477E3     | 2.5       |
|  | 1.0                              | 5 x 11                                  | 22  | 3.0                              | 0.08            | 59108E3                     | 2.0       | -          | -         | 39108E3        | 5.0       | 79108E3     | 2.5       |
|  | 2.2                              | 5 x 11                                  | 33  | 3.0                              | 0.08            | 59228E3                     | 2.0       | -          | -         | 39228E3        | 5.0       | 79228E3     | 2.5       |
|  | 3.3                              | 5 x 11                                  | 40  | 3.3                              | 0.08            | 59338E3                     | 2.0       | -          | -         | 39338E3        | 5.0       | 79338E3     | 2.5       |
|  | 4.7                              | 5 x 11                                  | 48  | 4.7                              | 0.08            | 59478E3                     | 2.0       | -          | -         | 39478E3        | 5.0       | 79478E3     | 2.5       |
|  | 10                               | 6.3 x 11                                | 80  | 10                               | 0.08            | 59109E3                     | 2.5       | -          | -         | 39109E3        | 5.0       | 79109E3     | 2.5       |
|  | 22                               | 6.3 x 11                                | 115                                       | 22                               | 0.08            | 59229E3                     | 2.5       | -          | -         | 39229E3        | 5.0       | 79229E3     | 2.5       |
|  | 33                               | 8 x 11.5                                | 145                                       | 33                               | 0.08            | 59339E3                     | 3.5       | -          | -         | 39339E3        | 5.0       | 79339E3     | 3.5       |
|  | 47                               | 10 x 12                                 | 235                                       | 47                               | 0.08            | 59479E3                     | 5.0       | 69479E3    | 5.0       | 39479E3        | 5.0       | -           | -         |
|  | 100                              | 10 x 20                                 | 370                                       | 100                              | 0.08            | 59101E3                     | 5.0       | 69101E3    | 5.0       | 39101E3        | 5.0       | -           | -         |
|  | 220                              | 13 x 25                                 | 675                                       | 220                              | 0.08            | 59221E3                     | 5.0       | 69221E3    | 5.0       | 39221E3        | 5.0       | -           | -         |
|  | 330                              | 13 x 25                                 | 825                                       | 330                              | 0.08            | 59331E3                     | 5.0       | 69331E3    | 5.0       | 39331E3        | 5.0       | -           | -         |
| 470                                      | 16 x 25                          | 1070                                    | 470                                       | 0.08                             | 59471E3         | 7.5                         | 69471E3   | 7.5        | 39471E3   | 7.5            | -         | -           |           |
| 1000                                     | 18 x 40                          | 2410                                    | 1000                                      | 0.08                             | 59102E3         | 7.5                         | 69102E3   | 7.5        | -         | -              | -         | -           |           |

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

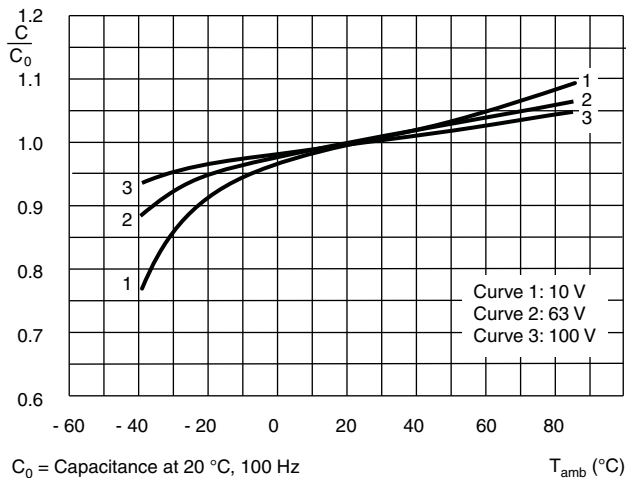
**CAPACITANCE (C)**


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

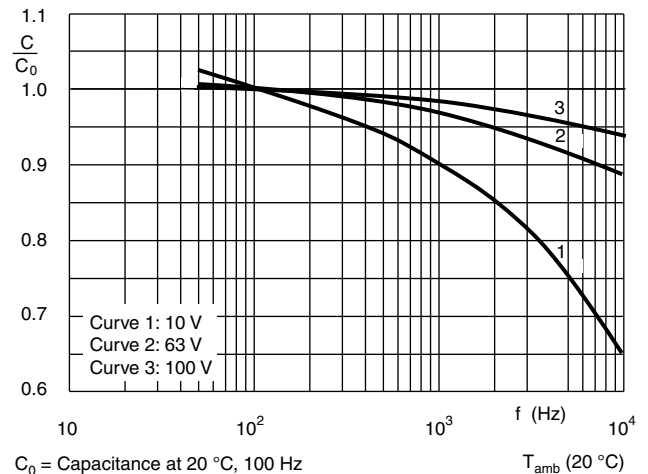
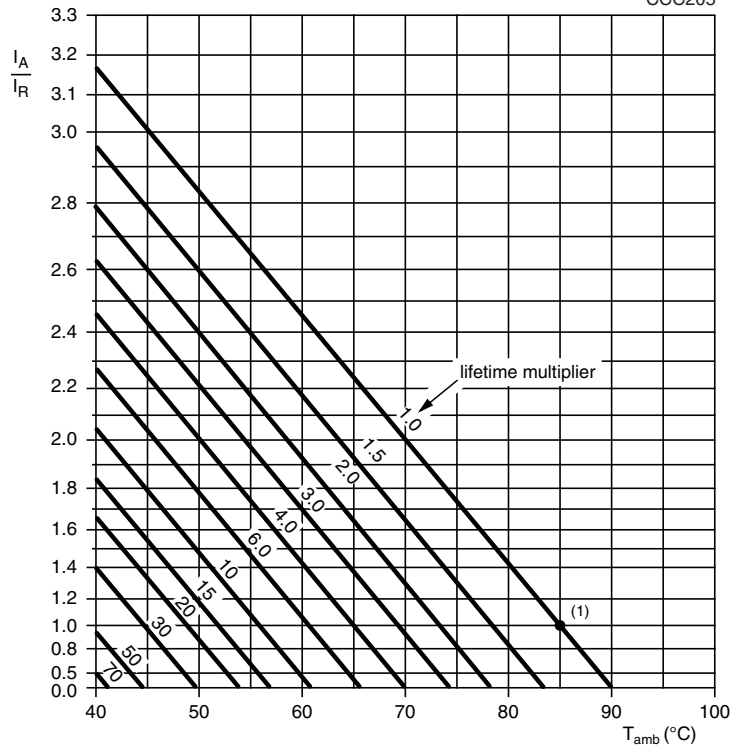


Fig. 7 - Typical multiplier of capacitance as a function of frequency

**RIPPLE CURRENT AND USEFUL LIFE**

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 3**

| <b>MULTIPLIER OF RIPPLE CURRENT (<math>I_R</math>) AS A FUNCTION OF FREQUENCY</b> |  |  |   |
|---|--|--|---|
| <b>FREQUENCY (Hz)</b>   | <b><math>I_R</math> MULTIPLIER</b>           |  |   |
|   | <b><math>C_R &lt; 100 \mu\text{F}</math></b> | <b><math>C_R = 100 \mu\text{F TO } 1000 \mu\text{F}</math></b> | <b><math>C_R &gt; 1000 \mu\text{F}</math></b> |
| 50  | 0.70   | 0.75   | 0.80  |
| 100   | 1.00   | 1.00   | 1.00  |
| 500   | 1.30   | 1.20   | 1.10  |
| 1000  | 1.40   | 1.30   | 1.12  |
| $\geq 10\,000$  | 1.50   | 1.35   | 1.15  |

**Table 4**

| <b>TEST PROCEDURES AND REQUIREMENTS</b>  |  |  |  |
|--|--|--|--|
| <b>TEST</b>                              |  | <b>PROCEDURE (quick reference)</b>   | <b>REQUIREMENTS</b>  |
| <b>NAME OF TEST</b>                      | <b>REFERENCE</b>                           |  |  |
| Endurance                                | IEC 60384-4/<br>EN130300<br>subclause 4.13 | $T_{\text{amb}} = 85 \text{ }^\circ\text{C}$ ; $U_R$ applied;<br>Case $\varnothing \leq 8$ mm: 2000 h<br>Case $\varnothing \geq 10$ mm: 3000 h           | $\Delta C/C: \pm 20 \%$<br>$\tan \delta \leq 2 \times \text{spec. limit}$<br>$I_{L5} \leq \text{spec. limit}$  |
| Useful life                              | CECC 30301<br>subclause 1.8.1              | $T_{\text{amb}} = 85 \text{ }^\circ\text{C}$ ; $U_R$ and $I_R$ applied;<br>Case $\varnothing \leq 8$ mm: 2500 h<br>Case $\varnothing \geq 10$ mm: 3500 h | $\Delta C/C: \pm 50 \%$<br>$\tan \delta \leq 3 \times \text{spec. limit}$<br>$I_{L5} \leq \text{spec. limit}$<br>no short or open circuit<br>total failure percentage: $\leq 1 \%$ |
| Shelf life (storage at high temperature) | IEC 60384-4/<br>EN130300<br>subclause 4.17 | $T_{\text{amb}} = 85 \text{ }^\circ\text{C}$ ; no voltage applied; 1000 h after test: $U_R$ to be applied for 30 min, 24 h to 48 h before measurement    | $\Delta C/C: \pm 20 \%$<br>$\tan \delta \leq 2 \times \text{spec. limit}$<br>$I_{L5} \leq 3 \times \text{spec. limit}$   |
| Surge                                    | IEC 60384-4/<br>EN130300<br>subclause 4.14 | From source of $1.15 \times U_R$ ;<br>$RC = 0.1 \text{ s} \pm 0.05 \text{ s}$ ;<br>1000 cycles of 30 s on, 330 s off, at $85 \text{ }^\circ\text{C}$     | $\Delta C/C: \pm 25 \%$<br>$\tan \delta \leq 1.5 \times \text{spec. limit}$<br>$I_{L5} \leq \text{spec. limit}$  |



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