

## Aluminum Capacitors Radial Standard Ultra Miniature

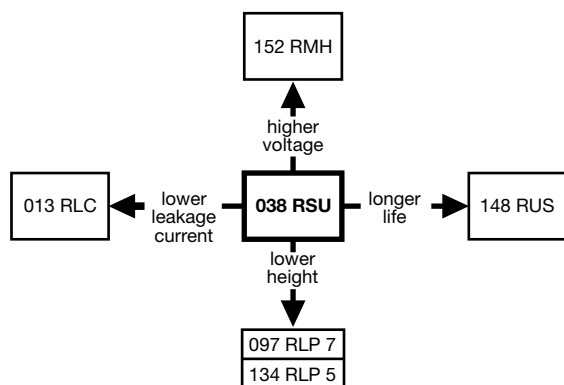
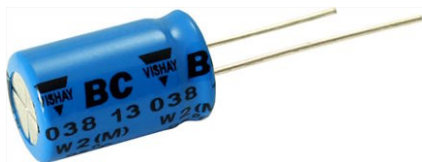


Fig. 1


**RoHS**  
COMPLIANT

### FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case, insulated with a blue sleeve
- Pressure relief for case  $\varnothing D \geq 6.3$  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)

### 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  $\mu F$ )
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for  $\pm 20\%$ )
- Rated voltage (in V)
- Date code, in accordance with IEC 60062
- Code indicating factory of origin
- Name of manufacturer
- Negative terminal identification
- Series number (038)

| QUICK REFERENCE DATA                                 |                               |
|------------------------------------------------------|-------------------------------|
| DESCRIPTION                                          | VALUE                         |
| Nominal case sizes ( $\varnothing D \times L$ in mm) | 5 x 11 to 18 x 40             |
| Rated capacitance range, $C_R$                       | 0.1 $\mu F$ to 22 000 $\mu F$ |
| Tolerance on $C_R$                                   | $\pm 20\%$                    |
| 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 $\varnothing D \leq 8$ mm                  | 2000 h                        |
| Case size $\varnothing D \geq 10$ mm                 | 3000 h                        |
| Useful life at 85 °C:                                |                               |
| Case size $\varnothing D \leq 8$ mm                  | 2500 h                        |
| Case size $\varnothing D \geq 10$ mm                 | 3500 h                        |
| Useful life at 40 °C, 1.4 x $I_R$ applied:           |                               |
| Case size $\varnothing D \leq 8$ mm                  | 60 000 h                      |
| Case size $\varnothing D \geq 10$ 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                     |

**SELECTION CHART FOR  $C_R$ ,  $U_R$ , AND RELEVANT NOMINAL CASE SIZES ( $\varnothing D \times L$  in mm)**

| $C_R$<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   | –        | –        | –        | –        | –        | –        | –        |

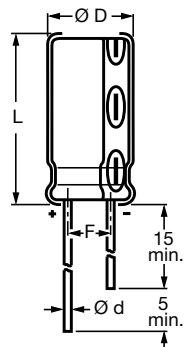
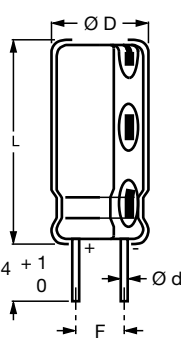
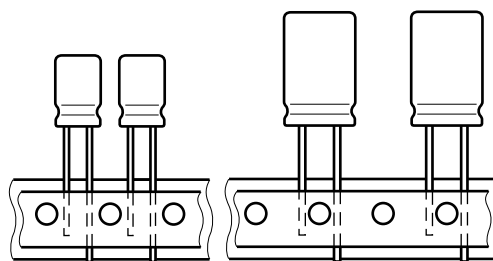
**DIMENSIONS in millimeters AND AVAILABLE FORMS**


Fig. 2 - Form CA


Fig. 3 - Form CB:  
Cut leads


Dimensions of pitch F see Table 1 and Table 2

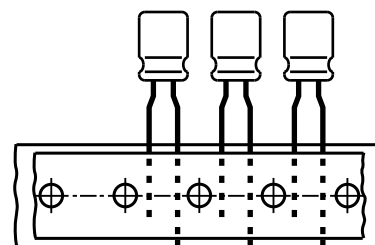
Fig. 4 - Form TNA, Form TFA:  
Taped in box (ammopack), straight leads

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

**DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES**

| NOMINAL<br>CASE SIZE<br>$\varnothing D \times L$ | CASE<br>CODE | $\varnothing d$ | $\varnothing D_{max}$ | $L_{max}$ | F             | MASS<br>(g)    | PACKAGING QUANTITIES |            |                  |
|--------------------------------------------------|--------------|-----------------|-----------------------|-----------|---------------|----------------|----------------------|------------|------------------|
|                                                  |              |                 |                       |           |               |                | FORM<br>CA           | FORM<br>CB | FORM<br>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                                       |
| $C_R$           | 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                 |

**Note**

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

**Table 2**

| ELECTRICAL DATA AND ORDERING INFORMATION |                                      |                                                          |                                  |                                        |                         |                             |           |            |           |                |           |             |           |
|------------------------------------------|--------------------------------------|----------------------------------------------------------|----------------------------------|----------------------------------------|-------------------------|-----------------------------|-----------|------------|-----------|----------------|-----------|-------------|-----------|
| $U_R$<br>(V)                             | $C_R$<br>100 Hz<br>( $\mu\text{F}$ ) | NOMINAL<br>CASE SIZE<br>$\varnothing D \times L$<br>(mm) | $I_R$<br>100 Hz<br>85 °C<br>(mA) | $I_{L2}$<br>2 min<br>( $\mu\text{A}$ ) | $\tan \delta$<br>100 Hz | ORDERING CODE MAL2038 ..... |           |            |           |                |           |             |           |
|                                          |                                      |                                                          |                                  |                                        |                         | BULK PACKAGING              |           |            |           | TAPED AMMOPACK |           |             |           |
|                                          |                                      |                                                          |                                  |                                        |                         | LONG LEADS                  |           | CUT LEADS  |           |                |           |             |           |
|                                          |                                      |                                                          |                                  |                                        |                         | 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       | -              | -         | -           | -         |

**ORDERING EXAMPLE**

Electrolytic capacitor 038 series

470  $\mu\text{F}$ /25 V;  $\pm 20\%$ Nominal case size:  $\varnothing 10\text{ mm} \times 12\text{ mm}$ ; form TFA

Ordering code: MAL2 038 36471 E3

Former 12NC: 2222 038 36471

**ELECTRICAL DATA AND ORDERING INFORMATION**

| $U_R$<br>(V) | $C_R$<br>100 Hz<br>( $\mu$ F) | NOMINAL<br>CASE SIZE<br>$\varnothing$ D x L<br>(mm) | $I_R$<br>100 Hz<br>85 °C<br>(mA) | $I_{L2}$<br>2 min<br>( $\mu$ A) | $\tan \delta$<br>100 Hz | ORDERING CODE MAL2038 ..... |           |            |           |                |           |             |           |
|--------------|-------------------------------|-----------------------------------------------------|----------------------------------|---------------------------------|-------------------------|-----------------------------|-----------|------------|-----------|----------------|-----------|-------------|-----------|
|              |                               |                                                     |                                  |                                 |                         | BULK PACKAGING              |           |            |           | TAPED AMMOPACK |           |             |           |
|              |                               |                                                     |                                  |                                 |                         | LONG LEADS                  |           | CUT LEADS  |           |                |           |             |           |
|              |                               |                                                     |                                  |                                 |                         | 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       | -           | -         |
| 63           | 3300                          | 18 x 35                                             | 2500                             | 1650                            | 0.14                    | 51332E3                     | 7.5       | 61332E3    | 7.5       | -              | -         | -           | -         |
|              | 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                    |                                                              | $U_{rev} \leq 1 \text{ V}$                                                  |
| <b>Current</b>                     |                                                              |                                                                             |
| Leakage current                    | After 2 min at $U_R$                                         | $I_{L2} \leq 0.01 C_R \times U_R$ or $3 \mu\text{A}$ , whichever is greater |
|                                    | After 5 min at $U_R$                                         | $I_{L5} \leq 0.002 C_R \times U_R + 3 \mu\text{A}$                          |
| <b>Inductance</b>                  |                                                              |                                                                             |
| Equivalent series inductance (ESL) | Case $\varnothing D \leq 8 \text{ mm}$                       | Typ. 13 nH                                                                  |
|                                    | Case $\varnothing D = 10 \text{ mm}$                         | Typ. 16 nH                                                                  |
|                                    | Case $\varnothing D \geq 12.5 \text{ mm}$                    | Typ. 18 nH                                                                  |
| <b>Resistance</b>                  |                                                              |                                                                             |
| Equivalent series resistance (ESR) | Calculated from $\tan \delta_{\max}$ and $C_R$ (see Table 2) | $\text{ESR} = \tan \delta / 2 \pi f C_R$                                    |

## CAPACITANCE (C)

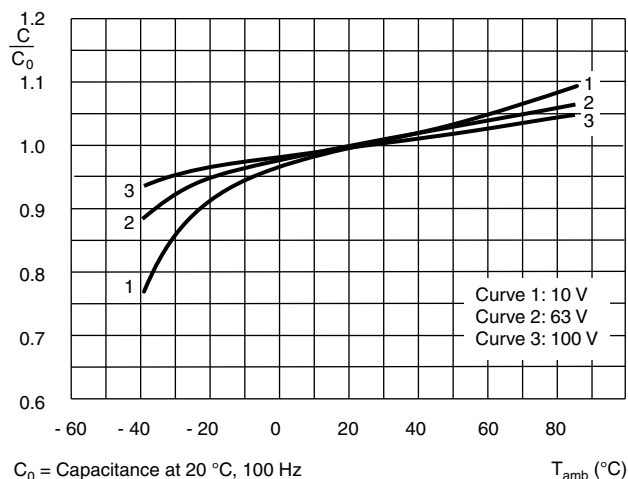


Fig. 6 - Typical multiplier of capacitance as a function of ambient temperature

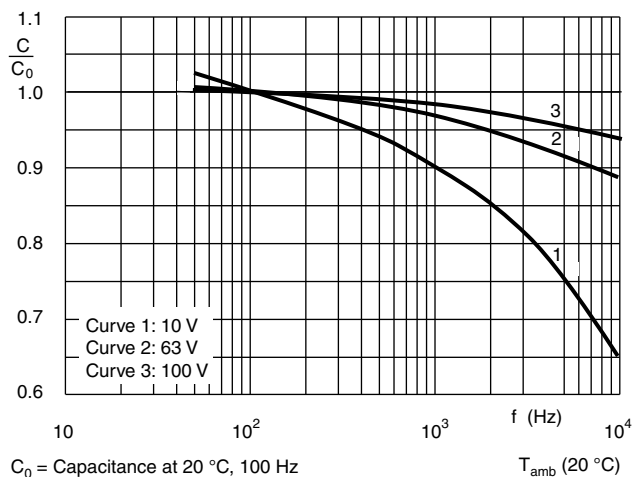
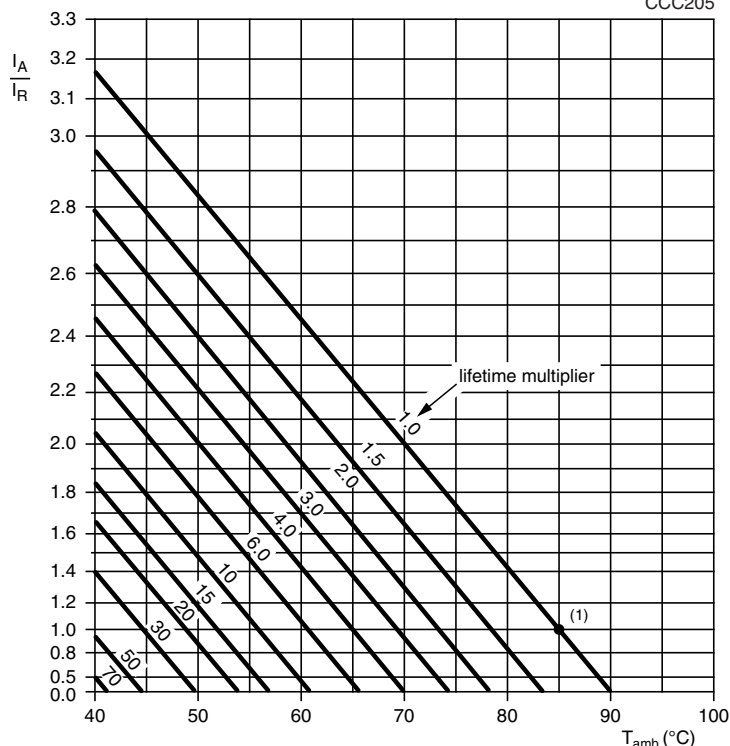


Fig. 7 - Typical multiplier of capacitance as a function of frequency

## 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

| MULTIPLIER OF RIPPLE CURRENT ( $I_R$ ) AS A FUNCTION OF FREQUENCY |                   |                                   |                    |
|-------------------------------------------------------------------|-------------------|-----------------------------------|--------------------|
| FREQUENCY<br>(Hz)                                                 | $I_R$ MULTIPLIER  |                                   |                    |
|                                                                   | $C_R < 100 \mu F$ | $C_R = 100 \mu F$ TO $1000 \mu F$ | $C_R > 1000 \mu F$ |
| 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

| TEST PROCEDURES AND REQUIREMENTS               |                                            |                                                                                                                                            |                                                                                                                                                                                  |
|------------------------------------------------|--------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TEST                                           |                                            | PROCEDURE<br>(quick reference)                                                                                                             | REQUIREMENTS                                                                                                                                                                     |
| NAME OF TEST                                   | REFERENCE                                  |                                                                                                                                            |                                                                                                                                                                                  |
| Endurance                                      | IEC 60384-4/<br>EN130300<br>subclause 4.13 | $T_{amb} = 85\text{ °C}$ ; $U_R$ 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              | $T_{amb} = 85\text{ °C}$ ; $U_R$ 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<br>(storage at high<br>temperature) | IEC 60384-4/<br>EN130300<br>subclause 4.17 | $T_{amb} = 85\text{ °C}$ ; no voltage applied; 1000 h<br>after test: $U_R$ to be applied for 30 min, 24 h to 48 h<br>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,<br>330 s off, at $85\text{ °C}$ | $\Delta C/C: \pm 25\%$<br>$\tan \delta \leq 1.5 \times \text{spec. limit}$<br>$I_{L5} \leq \text{spec. limit}$                                                                   |



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