

## Aluminum Electrolytic Capacitors Radial Miniature, Low Impedance

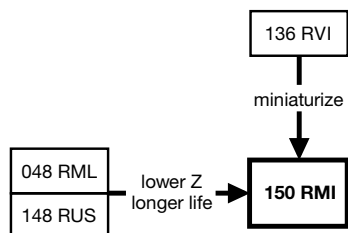
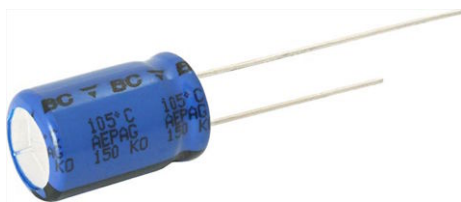


Fig. 1

### QUICK REFERENCE DATA

| DESCRIPTION                                        | VALUE                  |
|----------------------------------------------------|------------------------|
| Nominal case sizes (Ø D x L in mm)                 | 8 x 12 to 18 x 40      |
| Rated capacitance range, C <sub>R</sub>            | 22 µF to 8200 µF       |
| Tolerance on C <sub>R</sub>                        | ± 20 %                 |
| Rated voltage range, U <sub>R</sub>                | 10 V to 100 V          |
| Category temperature range                         | -55 °C to +105 °C      |
| Endurance test at 105 °C                           | 3000 h to 6000 h       |
| Useful life at 105 °C                              | 4000 h to 10 000 h     |
| Useful life at 40 °C, 1.8 x I <sub>R</sub> applied | 200 000 h to 500 000 h |
| Shelf life at 0 V, 105 °C                          | 1000 h                 |
| Based on sectional specification                   | IEC 60384-4 / EN130300 |
| Climatic category IEC 60068                        | 55 / 105 / 56          |

### FEATURES

- Very long useful life: 4000 h to 10 000 h at 105 °C, high stability, high reliability
- Very low impedance and low ESR in smaller case sizes than the 136 RVI series
- Excellent ripple current capability
- AEC-Q200 qualified
- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case with pressure relief, insulated with a blue sleeve
- Charge and discharge proof
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)

AUTOMOTIVE  
GRADE

**RoHS**  
COMPLIANT

### APPLICATIONS

- Power supplies (SMPS, DC/DC converters) for general industrial, EDP, audio-video, automotive, and telecommunications
- Smoothing, filtering, buffering

### 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
- Upper category temperature (105 °C)
- Negative terminal identification
- Series number (150)

### SELECTION CHART FOR C<sub>R</sub>, U<sub>R</sub>, AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

| C <sub>R</sub><br>(µF) | U <sub>R</sub> (V) |           |           |           |           |           |         |
|------------------------|--------------------|-----------|-----------|-----------|-----------|-----------|---------|
|                        | 10                 | 16        | 25        | 35        | 50        | 63        | 100     |
| 22                     | -                  | -         | -         | -         | -         | -         | 8 x 12  |
| 47                     | -                  | -         | -         | -         | -         | 8 x 12    | -       |
| 100                    | -                  | -         | -         | 8 x 12    | -         | 10 x 12   | -       |
| 150                    | -                  | -         | -         | -         | 10 x 12   | 10 x 16   | -       |
| 220                    | -                  | 8 x 12    | 8 x 12    | 8 x 15    | 10 x 16   | 10 x 20   | -       |
| 330                    | -                  | -         | -         | 10 x 12   | -         | -         | -       |
| 470                    | -                  | 8 x 12    | 10 x 12   | 10 x 16   | 10 x 20   | 12.5 x 20 | 18 x 20 |
| 680                    | 8 x 12             | 8 x 15    | 10 x 16   | 10 x 20   | 12.5 x 20 | 12.5 x 25 | -       |
| 1000                   | -                  | 10 x 12   | -         | -         | -         | 16 x 20   | -       |
| 1200                   | 10 x 12            | 10 x 16   | 10 x 20   | 12.5 x 20 | 12.5 x 25 | 16 x 20   | -       |
| 1500                   | -                  | -         | -         | -         | -         | 16 x 25   | -       |
| 2200                   | 10 x 16            | 10 x 20   | 12.5 x 20 | 12.5 x 25 | 16 x 25   | 16 x 31   | -       |
| 3300                   | -                  | -         | -         | 16 x 20   | -         | -         | -       |
| 4700                   | -                  | -         | -         | -         | 16 x 31   | -         | -       |
| 6800                   | -                  | 12.5 x 20 | 12.5 x 25 | 16 x 20   | 16 x 31   | -         | -       |
| 8200                   | -                  | -         | -         | 12.5 x 35 | -         | -         | -       |
|                        | 12.5 x 20          | 12.5 x 25 | 16 x 20   | 16 x 31   | -         | 18 x 40   | -       |
|                        | -                  | -         | 12.5 x 35 | -         | -         | -         | -       |
|                        | 12.5 x 25          | 16 x 20   | 16 x 31   | 18 x 31   | 18 x 40   | -         | -       |
|                        | 16 x 25            | 16 x 31   | 16 x 35   | 18 x 40   | -         | -         | -       |
|                        | 16 x 31            | 16 x 35   | 18 x 40   | -         | -         | -         | -       |
|                        | -                  | 18 x 40   | -         | -         | -         | -         | -       |

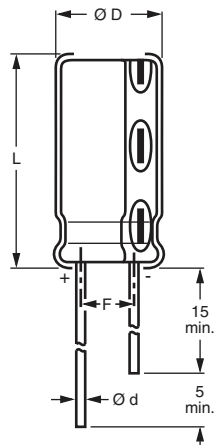
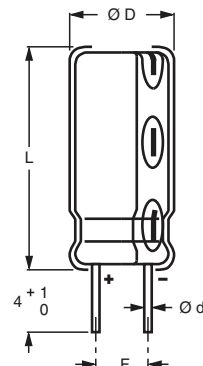
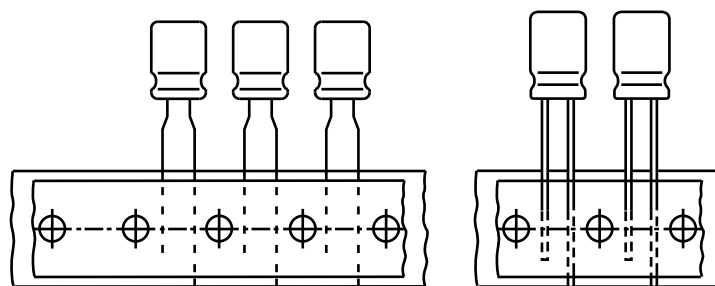
**DIMENSIONS in millimeters AND AVAILABLE FORMS**

Fig. 2 - **Form CA:** Long leads

Fig. 3 - **Form CB:** Cut leads

Formed leads for  $\varnothing D = 8 \text{ mm}$  with pitch  $F = 5 \text{ mm}$ 

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

Table 1

| <b>DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES</b> |              |                 |                               |                   |               |                |                      |            |             |
|-----------------------------------------------------------------|--------------|-----------------|-------------------------------|-------------------|---------------|----------------|----------------------|------------|-------------|
| NOMINAL<br>CASE SIZE<br>$\varnothing D \times L$                | CASE<br>CODE | $\varnothing d$ | $\varnothing D_{\text{max.}}$ | $L_{\text{max.}}$ | F             | MASS<br>(g)    | PACKAGING QUANTITIES |            |             |
|                                                                 |              |                 |                               |                   |               |                | FORM<br>CA           | FORM<br>CB | FORM<br>TFA |
| 8 x 12                                                          | 13           | 0.6             | 8.5                           | 13.0              | $3.5 \pm 0.5$ | $\approx 1.1$  | 5000                 | 5000       | 1000        |
| 8 x 15                                                          | 13L          | 0.6             | 8.5                           | 16.0              | $3.5 \pm 0.5$ | $\approx 1.3$  | 5000                 | 5000       | 1000        |
| 10 x 12                                                         | 14           | 0.6             | 10.5                          | 13.5              | $5.0 \pm 0.5$ | $\approx 1.6$  | 1000                 | 500        | 800         |
| 10 x 16                                                         | 15           | 0.6             | 10.5                          | 17.5              | $5.0 \pm 0.5$ | $\approx 1.9$  | 500                  | 500        | 800         |
| 10 x 20                                                         | 16           | 0.6             | 10.5                          | 22.0              | $5.0 \pm 0.5$ | $\approx 2.2$  | 500                  | 500        | 800         |
| 12.5 x 20                                                       | 17           | 0.6             | 13.0                          | 22.0              | $5.0 \pm 0.5$ | $\approx 4.0$  | 500                  | 500        | 500         |
| 12.5 x 25                                                       | 18           | 0.6             | 13.0                          | 27.0              | $5.0 \pm 0.5$ | $\approx 5.0$  | 250                  | 250        | 500         |
| 12.5 x 35                                                       | 18LL         | 0.6             | 13.0                          | 37.5              | $5.0 \pm 0.5$ | $\approx 6.0$  | 250                  | 250        | -           |
| 16 x 20                                                         | 19a          | 0.8             | 16.5                          | 22.0              | $7.5 \pm 0.5$ | $\approx 6.0$  | 250                  | 250        | 250         |
| 16 x 25                                                         | 19           | 0.8             | 16.5                          | 27.0              | $7.5 \pm 0.5$ | $\approx 8.0$  | 250                  | 250        | 250         |
| 16 x 31                                                         | 20           | 0.8             | 16.5                          | 33.5              | $7.5 \pm 0.5$ | $\approx 9.0$  | 100                  | 100        | 250         |
| 16 x 35                                                         | 21           | 0.8             | 16.5                          | 37.5              | $7.5 \pm 0.5$ | $\approx 11.0$ | 100                  | 100        | -           |
| 18 x 20                                                         | 1820         | 0.8             | 18.5                          | 22.0              | $7.5 \pm 0.5$ | $\approx 8.0$  | 100                  | 100        | -           |
| 18 x 31                                                         | 1831         | 0.8             | 18.5                          | 33.5              | $7.5 \pm 0.5$ | $\approx 12.5$ | 100                  | 100        | -           |
| 18 x 40                                                         | 1840         | 0.8             | 18.5                          | 42.5              | $7.5 \pm 0.5$ | $\approx 16.5$ | 100                  | 100        | -           |



| ELECTRICAL DATA |                                                   |
|-----------------|---------------------------------------------------|
| SYMBOL          | DESCRIPTION                                       |
| $C_R$           | Rated capacitance at 100 Hz, tolerance $\pm 20\%$ |
| $I_R$           | Rated RMS ripple current at 100 kHz, 105 °C       |
| $I_{L2}$        | Max. leakage current after 2 min at $U_R$         |
| $\tan \delta$   | Max. dissipation factor at 100 Hz                 |
| Z               | Max. impedance at 100 kHz                         |

**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 <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 kHz<br>105 °C<br>(mA) | I <sub>L2</sub><br>2 min<br>(μA) | tan δ<br>100 Hz | Z<br>100 kHz<br>+20 °C<br>(Ω) | Z<br>100 kHz<br>-40 °C<br>(Ω) | ORDERING CODE<br>MAL2150..... |         |          |
|                                          |                                  |                                         |                                             |                                  |                 |                               |                               | BULK PACKAGING                |         | TAPED    |
|                                          |                                  |                                         |                                             |                                  |                 |                               |                               | FORM CA                       | FORM CB | FORM TFA |
| 10                                       | 470                              | 8 x 12                                  | 555                                         | 47                               | 0.19            | 0.117                         | 0.870                         | 54471E3                       | 84471E3 | 34471E3  |
|                                          | 680                              | 10 x 12                                 | 730                                         | 71                               | 0.19            | 0.097                         | 0.680                         | 54681E3                       | 64681E3 | 34681E3  |
|                                          | 1000                             | 10 x 16                                 | 950                                         | 103                              | 0.19            | 0.066                         | 0.460                         | 54102E3                       | 64102E3 | 34102E3  |
|                                          | 2200                             | 12.5 x 20                               | 1460                                        | 223                              | 0.21            | 0.037                         | 0.260                         | 54222E3                       | 64222E3 | 34222E3  |
|                                          | 3300                             | 12.5 x 25                               | 1950                                        | 333                              | 0.21            | 0.029                         | 0.200                         | 54332E3                       | 64332E3 | 34332E3  |
|                                          | 4700                             | 16 x 25                                 | 2390                                        | 473                              | 0.23            | 0.022                         | 0.150                         | 54472E3                       | 64472E3 | 34472E3  |
|                                          | 6800                             | 16 x 31                                 | 2890                                        | 683                              | 0.25            | 0.019                         | 0.130                         | 54682E3                       | 64682E3 | 34682E3  |
| 16                                       | 220                              | 8 x 12                                  | 555                                         | 35                               | 0.16            | 0.117                         | 0.870                         | 55221E3                       | 85221E3 | 35221E3  |
|                                          | 330                              | 8 x 12                                  | 555                                         | 53                               | 0.16            | 0.117                         | 0.870                         | 55331E3                       | 85331E3 | 35331E3  |
|                                          | 470                              | 8 x 15                                  | 730                                         | 78                               | 0.16            | 0.085                         | 0.750                         | 95475E3                       | 95478E3 | 95473E3  |
|                                          | 470                              | 10 x 12                                 | 730                                         | 78                               | 0.16            | 0.097                         | 0.680                         | 55471E3                       | 65471E3 | 35471E3  |
|                                          | 680                              | 10 x 16                                 | 950                                         | 112                              | 0.16            | 0.066                         | 0.460                         | 55681E3                       | 65681E3 | 35681E3  |
|                                          | 1000                             | 10 x 20                                 | 1180                                        | 163                              | 0.16            | 0.049                         | 0.340                         | 55102E3                       | 65102E3 | 35102E3  |
|                                          | 1500                             | 12.5 x 20                               | 1460                                        | 243                              | 0.16            | 0.037                         | 0.260                         | 55152E3                       | 65152E3 | 35152E3  |
|                                          | 2200                             | 12.5 x 25                               | 1950                                        | 355                              | 0.18            | 0.029                         | 0.200                         | 55222E3                       | 65222E3 | 35222E3  |
|                                          | 3300                             | 16 x 20                                 | 1840                                        | 531                              | 0.20            | 0.028                         | 0.200                         | 55332E3                       | 65332E3 | 35332E3  |
|                                          | 4700                             | 16 x 31                                 | 2890                                        | 755                              | 0.22            | 0.019                         | 0.130                         | 55472E3                       | 65472E3 | 35472E3  |
|                                          | 6800                             | 16 x 35                                 | 3100                                        | 1091                             | 0.24            | 0.018                         | 0.130                         | 55682E3                       | 65682E3 | -        |
| 8200                                     | 18 x 40                          | 3500                                    | 1315                                        | 0.28                             | 0.018           | 0.130                         | 55822E3                       | 65822E3                       | -       |          |
| 25                                       | 220                              | 8 x 12                                  | 555                                         | 55                               | 0.14            | 0.117                         | 0.870                         | 56221E3                       | 86221E3 | 36221E3  |
|                                          | 330                              | 10 x 12                                 | 730                                         | 86                               | 0.14            | 0.097                         | 0.680                         | 56331E3                       | 66331E3 | 36331E3  |
|                                          | 470                              | 10 x 16                                 | 950                                         | 121                              | 0.14            | 0.066                         | 0.460                         | 56471E3                       | 66471E3 | 36471E3  |
|                                          | 680                              | 10 x 20                                 | 1180                                        | 173                              | 0.14            | 0.049                         | 0.340                         | 56681E3                       | 66681E3 | 36681E3  |
|                                          | 1000                             | 12.5 x 20                               | 1460                                        | 253                              | 0.14            | 0.037                         | 0.260                         | 56102E3                       | 66102E3 | 36102E3  |
|                                          | 1500                             | 12.5 x 25                               | 1950                                        | 378                              | 0.14            | 0.029                         | 0.200                         | 56152E3                       | 66152E3 | 36152E3  |
|                                          | 2200                             | 12.5 x 35                               | 2510                                        | 553                              | 0.16            | 0.028                         | 0.200                         | 96225E3                       | 96226E3 | -        |
|                                          | 2200                             | 16 x 20                                 | 1840                                        | 553                              | 0.16            | 0.028                         | 0.200                         | 56222E3                       | 66222E3 | 36222E3  |
|                                          | 3300                             | 16 x 31                                 | 2890                                        | 828                              | 0.16            | 0.019                         | 0.130                         | 56332E3                       | 66332E3 | 36332E3  |
|                                          | 4700                             | 16 x 35                                 | 3100                                        | 1178                             | 0.18            | 0.018                         | 0.130                         | 56472E3                       | 66472E3 | -        |
|                                          | 6800                             | 18 x 40                                 | 3500                                        | 1703                             | 0.22            | 0.018                         | 0.130                         | 56682E3                       | 66682E3 | -        |
| 35                                       | 100                              | 8 x 12                                  | 555                                         | 35                               | 0.12            | 0.117                         | 0.870                         | 50101E3                       | 80101E3 | 30101E3  |
|                                          | 220                              | 8 x 15                                  | 730                                         | 77                               | 0.12            | 0.085                         | 0.750                         | 90225E3                       | 90228E3 | 90223E3  |
|                                          | 220                              | 10 x 12                                 | 730                                         | 80                               | 0.12            | 0.097                         | 0.680                         | 50221E3                       | 60221E3 | 30221E3  |
|                                          | 330                              | 10 x 16                                 | 950                                         | 118                              | 0.12            | 0.066                         | 0.460                         | 50331E3                       | 60331E3 | 30331E3  |
|                                          | 470                              | 10 x 20                                 | 1180                                        | 167                              | 0.12            | 0.049                         | 0.340                         | 50471E3                       | 60471E3 | 30471E3  |
|                                          | 680                              | 12.5 x 20                               | 1460                                        | 241                              | 0.12            | 0.037                         | 0.260                         | 50681E3                       | 60681E3 | 30681E3  |
|                                          | 1000                             | 12.5 x 25                               | 1950                                        | 353                              | 0.12            | 0.029                         | 0.200                         | 50102E3                       | 60102E3 | 30102E3  |
|                                          | 1000                             | 16 x 20                                 | 1840                                        | 353                              | 0.12            | 0.028                         | 0.200                         | 90105E3                       | 90106E3 | 90103E3  |
|                                          | 1500                             | 12.5 x 35                               | 2510                                        | 528                              | 0.12            | 0.028                         | 0.200                         | 90186E3                       | 90187E3 | -        |
|                                          | 1500                             | 16 x 20                                 | 1840                                        | 528                              | 0.12            | 0.028                         | 0.200                         | 50152E3                       | 60152E3 | 30152E3  |
|                                          | 2200                             | 16 x 31                                 | 2890                                        | 773                              | 0.14            | 0.019                         | 0.130                         | 50222E3                       | 60222E3 | 30222E3  |
|                                          | 3300                             | 18 x 31                                 | 3000                                        | 1155                             | 0.16            | 0.019                         | 0.130                         | 50332E3                       | 60332E3 | -        |
|                                          | 4700                             | 18 x 40                                 | 3300                                        | 1648                             | 0.18            | 0.018                         | 0.130                         | 50472E3                       | 60472E3 | -        |

**ORDERING EXAMPLE**

Electrolytic capacitor 150 series

470  $\mu\text{F}$  / 16 V;  $\pm 20\%$ Nominal case size:  $\varnothing 10\text{ mm} \times 12\text{ mm}$ ; Form TFA

Ordering Code: MAL215035471E3

Former 12NC: 2222 150 35471

**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 kHz<br>105 °C<br>(mA) | $I_{L2}$<br>2 min<br>( $\mu$ A) | $\tan \delta$<br>100 Hz | Z<br>100 kHz<br>+20 °C<br>( $\Omega$ ) | Z<br>100 kHz<br>-40 °C<br>( $\Omega$ ) | ORDERING CODE<br>MAL2150..... |         |          |
|--------------|-------------------------------|-----------------------------------------------------|------------------------------------|---------------------------------|-------------------------|----------------------------------------|----------------------------------------|-------------------------------|---------|----------|
|              |                               |                                                     |                                    |                                 |                         |                                        |                                        | BULK PACKAGING                |         | TAPED    |
|              |                               |                                                     |                                    |                                 |                         |                                        |                                        | FORM CA                       | FORM CB | FORM TFA |
| 50           | 150                           | 10 x 12                                             | 500                                | 78                              | 0.10                    | 0.200                                  | 1.400                                  | 51151E3                       | 61151E3 | 31151E3  |
|              | 220                           | 10 x 16                                             | 700                                | 113                             | 0.10                    | 0.120                                  | 0.840                                  | 51221E3                       | 61221E3 | 31221E3  |
|              | 330                           | 10 x 20                                             | 900                                | 168                             | 0.10                    | 0.090                                  | 0.630                                  | 51331E3                       | 61331E3 | 31331E3  |
|              | 470                           | 12.5 x 20                                           | 1100                               | 238                             | 0.10                    | 0.062                                  | 0.430                                  | 51471E3                       | 61471E3 | 31471E3  |
|              | 680                           | 12.5 x 25                                           | 1400                               | 343                             | 0.10                    | 0.048                                  | 0.340                                  | 51681E3                       | 61681E3 | 31681E3  |
|              | 1000                          | 16 x 25                                             | 1800                               | 503                             | 0.10                    | 0.034                                  | 0.240                                  | 51102E3                       | 61102E3 | 31102E3  |
|              | 1200                          | 16 x 31                                             | 2200                               | 603                             | 0.10                    | 0.027                                  | 0.190                                  | 51122E3                       | 61122E3 | 31122E3  |
|              | 1500                          | 16 x 31                                             | 2200                               | 753                             | 0.10                    | 0.027                                  | 0.190                                  | 51152E3                       | 61152E3 | 31152E3  |
| 63           | 3300                          | 18 x 40                                             | 3200                               | 1653                            | 0.14                    | 0.024                                  | 0.168                                  | 51332E3                       | 61332E3 | -        |
|              | 47                            | 8 x 12                                              | 405                                | 30                              | 0.09                    | 0.342                                  | 2.350                                  | 58479E3                       | 68479E3 | 38479E3  |
|              | 100                           | 10 x 12                                             | 420                                | 66                              | 0.10                    | 0.270                                  | 1.890                                  | 58101E3                       | 68101E3 | 38101E3  |
|              | 150                           | 10 x 16                                             | 560                                | 97                              | 0.10                    | 0.190                                  | 1.330                                  | 58151E3                       | 68151E3 | 38151E3  |
|              | 220                           | 10 x 20                                             | 700                                | 141                             | 0.10                    | 0.150                                  | 1.050                                  | 58221E3                       | 68221E3 | 38221E3  |
|              | 330                           | 12.5 x 20                                           | 930                                | 211                             | 0.10                    | 0.095                                  | 0.670                                  | 58331E3                       | 68331E3 | 38331E3  |
|              | 470                           | 12.5 x 25                                           | 1200                               | 299                             | 0.10                    | 0.067                                  | 0.470                                  | 58471E3                       | 68471E3 | 38471E3  |
|              | 470                           | 16 x 20                                             | 1100                               | 299                             | 0.10                    | 0.074                                  | 0.520                                  | 98475E3                       | 98476E3 | 98473E3  |
|              | 680                           | 16 x 20                                             | 1100                               | 431                             | 0.10                    | 0.074                                  | 0.520                                  | 58681E3                       | 68681E3 | 38681E3  |
|              | 680                           | 16 x 25                                             | 1500                               | 431                             | 0.10                    | 0.054                                  | 0.380                                  | 98685E3                       | 98686E3 | 98683E3  |
|              | 1000                          | 16 x 31                                             | 1900                               | 633                             | 0.10                    | 0.042                                  | 0.295                                  | 58102E3                       | 68102E3 | 38102E3  |
| 100          | 2200                          | 18 x 40                                             | 3100                               | 1389                            | 0.12                    | 0.033                                  | 0.231                                  | 58222E3                       | 68222E3 | -        |
|              | 22                            | 8 x 12                                              | 230                                | 22                              | 0.08                    | 0.68                                   | 27.0                                   | 59229E3                       | 69229E3 | 39229E3  |
|              | 330                           | 18 x 20                                             | 1700                               | 330                             | 0.07                    | 0.074                                  | 2.0                                    | 90183E3                       | 90185E3 | -        |

**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 $U_R$                                        | $I_{L2} \leq 0.01 C_R \times U_R + 3 \mu\text{A}$ |
| <b>Inductance</b>                  |                                                             |                                                   |
| Equivalent series inductance (ESL) | Case $\varnothing$ D $\leq 10 \text{ mm}$                   | 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) | $ESR = \tan \delta / 2 \pi f C_R$                 |

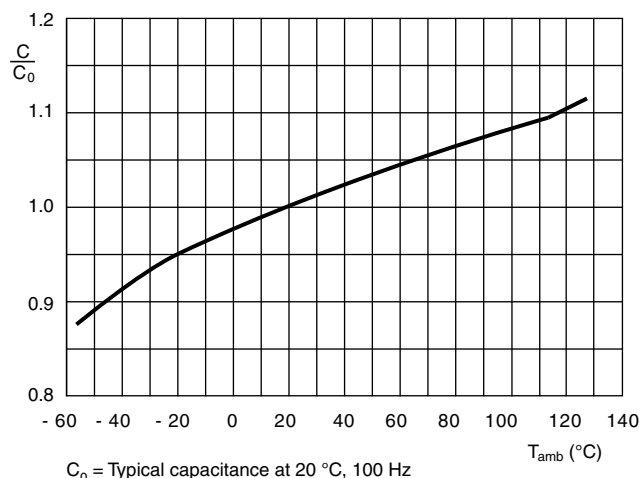
**CAPACITANCE (C)**


Fig. 5 - Typical multiplier of capacitance as a function of ambient temperature

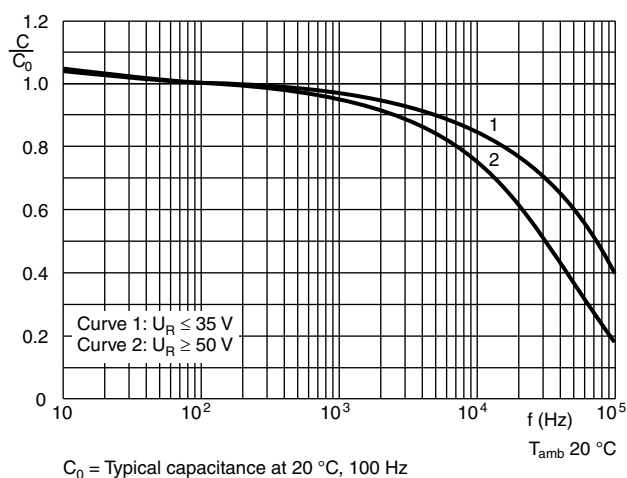


Fig. 6 - Typical multiplier of capacitance as a function of frequency

## EQUIVALENT SERIES RESISTANCE (ESR)

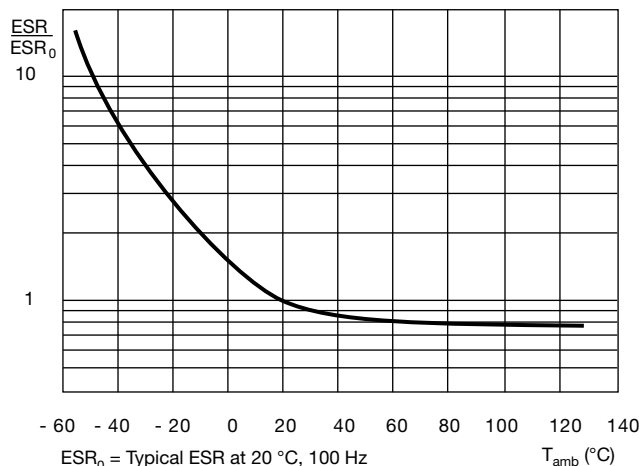


Fig. 7 - Typical multiplier of ESR as a function of ambient temperature

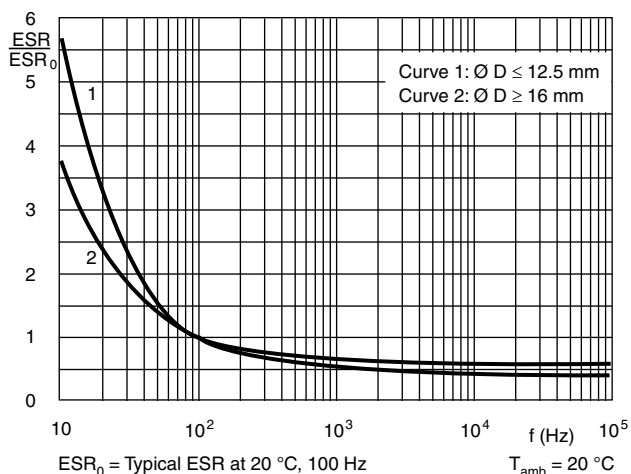


Fig. 8 - Typical multiplier of ESR as a function of frequency

## IMPEDANCE (Z)

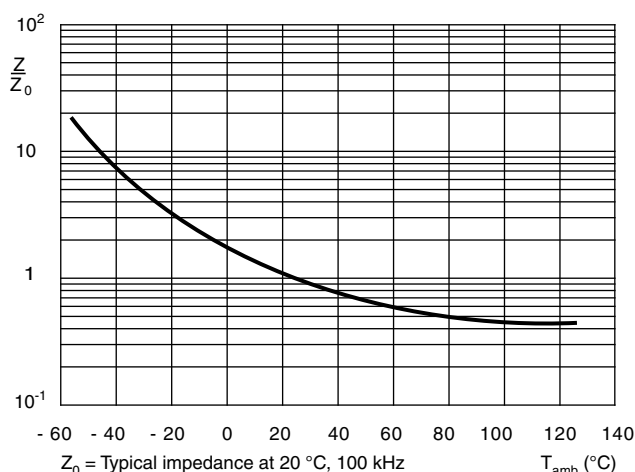


Fig. 9 - Typical multiplier of impedance as a function of ambient temperature

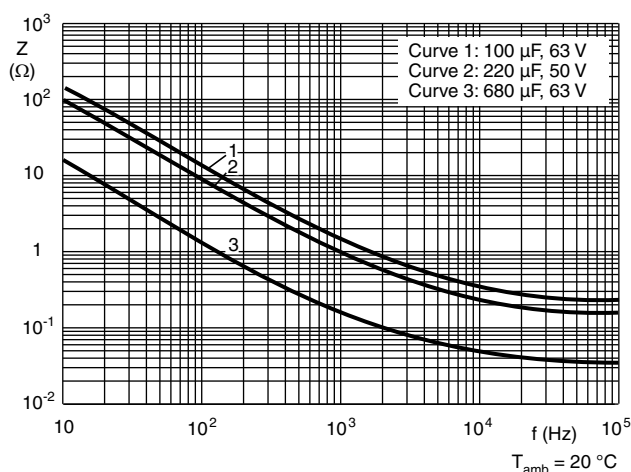


Fig. 10 - Typical impedance as a function of frequency

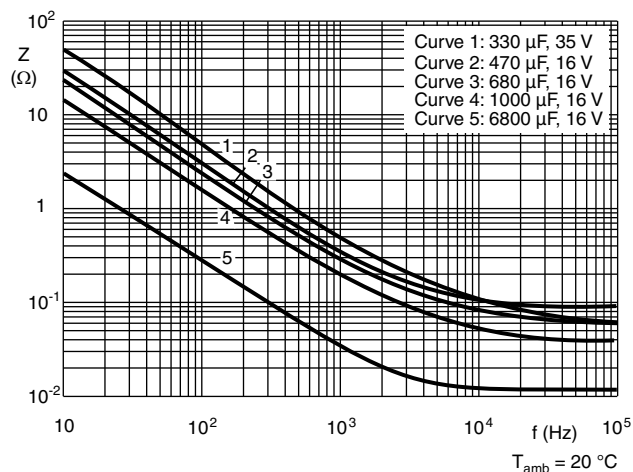


Fig. 11 - Typical impedance as a function of frequency

# RIPPLE CURRENT AND USEFUL LIFE

Table 3

| ENDURANCE TEST DURATION AND USEFUL LIFE |           |                               |                                 |
|-----------------------------------------|-----------|-------------------------------|---------------------------------|
| NOMINAL CASE SIZE<br>Ø D x L<br>(mm)    | CASE CODE | ENDURANCE<br>AT 105 °C<br>(h) | USEFUL LIFE<br>AT 105 °C<br>(h) |
| 8 x 12                                  | 13        | 3000                          | 4000                            |
| 8 x 15                                  | 13L       | 3000                          | 4000                            |
| 10 x 12                                 | 14        | 3000                          | 4000                            |
| 10 x 16                                 | 15        | 3000                          | 6000                            |
| 10 x 20                                 | 16        | 3000                          | 6000                            |
| 12.5 x 20                               | 17        | 3000                          | 7000                            |
| 12.5 x 25                               | 18        | 5000                          | 8000                            |
| 12.5 x 35                               | 18LL      | 5000                          | 8000                            |
| 16 x 20                                 | 19a       | 3000                          | 7000                            |
| 16 x 25                                 | 19        | 5000                          | 10 000                          |
| 16 x 31                                 | 20        | 5000                          | 10 000                          |
| 16 x 35                                 | 21        | 5000                          | 10 000                          |
| 18 x 20                                 | 1820      | 3000                          | 7000                            |
| 18 x 31                                 | 1831      | 6000                          | 10 000                          |
| 18 x 40                                 | 1840      | 8000                          | 10 000                          |

## Note

- Multiplier of useful life code: CCC206

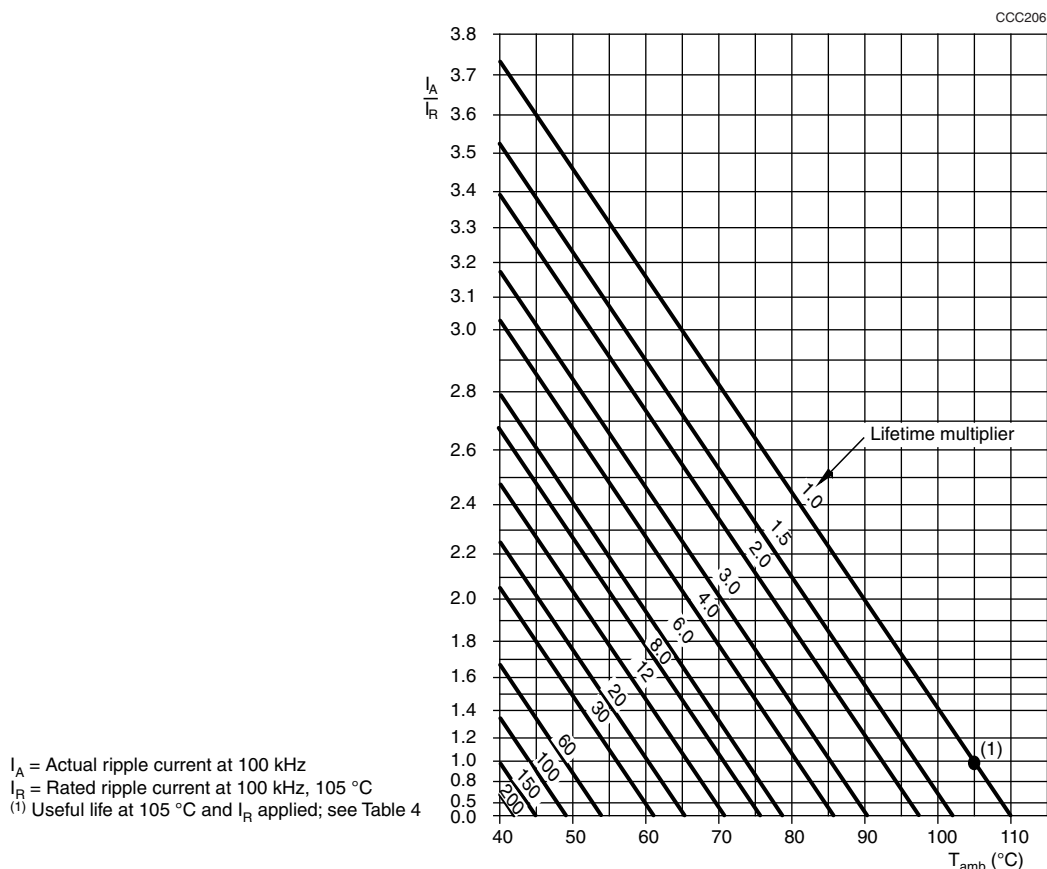


Fig. 12 - Multiplier of useful life as a function of ambient temperature and ripple current load

**Table 4**

| <b>MULTIPLIER OF RIPPLE CURRENT (<math>I_R</math>) AS A FUNCTION OF FREQUENCY</b> |                                    |            |             |             |               |               |                |
|-----------------------------------------------------------------------------------|------------------------------------|------------|-------------|-------------|---------------|---------------|----------------|
| <b>NOMINAL CASE SIZE<br/><math>\varnothing D \times L</math><br/>(mm)</b>         | <b>FREQUENCY (Hz)</b>              |            |             |             |               |               |                |
|                                                                                   | <b>100</b>                         | <b>300</b> | <b>1000</b> | <b>3000</b> | <b>10 000</b> | <b>30 000</b> | <b>100 000</b> |
|                                                                                   | <b><math>I_R</math> MULTIPLIER</b> |            |             |             |               |               |                |
| 8 x 12                                                                            | 0.65                               | 0.76       | 0.85        | 0.89        | 0.90          | 0.97          | 1.00           |
| 8 x 15                                                                            | 0.65                               | 0.76       | 0.85        | 0.89        | 0.90          | 0.97          | 1.00           |
| 10 x 12                                                                           | 0.65                               | 0.76       | 0.85        | 0.89        | 0.90          | 0.97          | 1.00           |
| 10 x 16                                                                           | 0.65                               | 0.76       | 0.85        | 0.89        | 0.90          | 0.97          | 1.00           |
| 10 x 20                                                                           | 0.65                               | 0.76       | 0.85        | 0.89        | 0.90          | 0.97          | 1.00           |
| 12.5 x 20                                                                         | 0.65                               | 0.76       | 0.85        | 0.89        | 0.90          | 0.97          | 1.00           |
| 12.5 x 25                                                                         | 0.65                               | 0.76       | 0.85        | 0.89        | 0.90          | 0.97          | 1.00           |
| 12.5 x 35                                                                         | 0.65                               | 0.76       | 0.85        | 0.89        | 0.90          | 0.97          | 1.00           |
| 16 x 20                                                                           | 0.76                               | 0.85       | 0.91        | 0.94        | 0.96          | 0.98          | 1.00           |
| 16 x 25                                                                           | 0.76                               | 0.85       | 0.91        | 0.94        | 0.96          | 0.98          | 1.00           |
| 16 x 31                                                                           | 0.76                               | 0.85       | 0.91        | 0.94        | 0.96          | 0.98          | 1.00           |
| 16 x 35                                                                           | 0.76                               | 0.85       | 0.91        | 0.94        | 0.96          | 0.98          | 1.00           |
| 18 x 20                                                                           | 0.76                               | 0.85       | 0.91        | 0.94        | 0.96          | 0.98          | 1.00           |
| 18 x 31                                                                           | 0.76                               | 0.85       | 0.91        | 0.94        | 0.96          | 0.98          | 1.00           |
| 18 x 40                                                                           | 0.76                               | 0.85       | 0.91        | 0.94        | 0.96          | 0.98          | 1.00           |

**Table 5**

| <b>TEST PROCEDURES AND REQUIREMENTS</b>        |                                          |                                                                                                                                                         |                                                                                                                                                                                  |
|------------------------------------------------|------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TEST</b>                                    |                                          | <b>PROCEDURE<br/>(quick reference)</b>                                                                                                                  | <b>REQUIREMENTS</b>                                                                                                                                                              |
| <b>NAME OF TEST</b>                            | <b>REFERENCE</b>                         |                                                                                                                                                         |                                                                                                                                                                                  |
| Endurance                                      | IEC 60384-4 / EN130300<br>subclause 4.13 | $T_{amb} = 105\text{ }^{\circ}\text{C}$ ; $U_R$ applied;<br>for test duration see Table 3                                                               | $\Delta C/C: \pm 20\%$<br>$\tan \delta \leq 2 \times \text{spec. limit}$<br>$I_{L2} \leq \text{spec. limit}$                                                                     |
| Useful life                                    | CECC 30301<br>subclause 1.8.1            | $T_{amb} = 105\text{ }^{\circ}\text{C}$ ; $U_R$ and $I_R$ applied;<br>for test duration see Table 3                                                     | $\Delta C/C: \pm 30\%$<br>$\tan \delta \leq 3 \times \text{spec. limit}$<br>$I_{L2} \leq \text{spec. limit}$<br>no short or open circuit<br>total failure percentage: $\leq 1\%$ |
| Shelf life<br>(storage at high<br>temperature) | IEC 60384-4 / EN130300<br>subclause 4.17 | $T_{amb} = 105\text{ }^{\circ}\text{C}$ ; 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>$I_{L2} \leq \text{spec. limit}$                                                                     |

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



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