

## Aluminum Electrolytic Capacitors Radial Miniature, Low Impedance



Fig. 1


**RoHS**  
COMPLIANT

### 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)

### 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  $\mu\text{F}$ )
- 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
- Upper category temperature (105 °C)
- Negative terminal identification
- Series number (150)

### QUICK REFERENCE DATA

| DESCRIPTION  | VALUE                                  |
|--|--|
| Nominal case sizes ( $\varnothing D \times L$ in mm) | 8 x 12 to 18 x 40                      |
| Rated capacitance range, $C_R$                       | 22 $\mu\text{F}$ to 8200 $\mu\text{F}$ |
| Tolerance on $C_R$                                   | $\pm 20\%$                             |
| Rated voltage range, $U_R$                           | 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 $I_R$ 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                          |

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

| $C_R$<br>( $\mu\text{F}$ ) | $U_R$ (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   | -       |
|                            | -         | -         | -         | 10 x 12   | -         | -         | -       |
| 330                        | -         | 8 x 12    | 10 x 12   | 10 x 16   | 10 x 20   | 12.5 x 20 | 18 x 20 |
| 470                        | 8 x 12    | 8 x 15    | 10 x 16   | 10 x 20   | 12.5 x 20 | 12.5 x 25 | -       |
|                            | -         | 10 x 12   | -         | -         | -         | 16 x 20   | -       |
| 680                        | 10 x 12   | 10 x 16   | 10 x 20   | 12.5 x 20 | 12.5 x 25 | 16 x 20   | -       |
|                            | -         | -         | -         | -         | -         | 16 x 25   | -       |
| 1000                       | 10 x 16   | 10 x 20   | 12.5 x 20 | 12.5 x 25 | 16 x 25   | 16 x 31   | -       |
|                            | -         | -         | -         | 16 x 20   | -         | -         | -       |
| 1200                       | -         | -         | -         | -         | 16 x 31   | -         | -       |
| 1500                       | -         | 12.5 x 20 | 12.5 x 25 | 16 x 20   | 16 x 31   | -         | -       |
|                            | -         | -         | -         | 12.5 x 35 | -         | -         | -       |
| 2200                       | 12.5 x 20 | 12.5 x 25 | 16 x 20   | 16 x 31   | -         | 18 x 40   | -       |
|                            | -         | -         | 12.5 x 35 | -         | -         | -         | -       |
| 3300                       | 12.5 x 25 | 16 x 20   | 16 x 31   | 18 x 31   | 18 x 40   | -         | -       |
| 4700                       | 16 x 25   | 16 x 31   | 16 x 35   | 18 x 40   | -         | -         | -       |
| 6800                       | 16 x 31   | 16 x 35   | 18 x 40   | -         | -         | -         | -       |
| 8200                       | -         | 18 x 40   | -         | -         | -         | -         | -       |

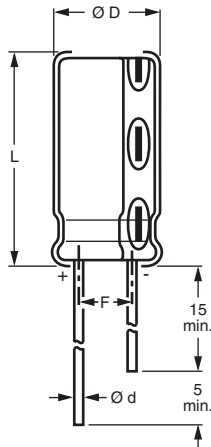
**DIMENSIONS in millimeters AND AVAILABLE FORMS**


Fig. 2 - Form CA: Long leads

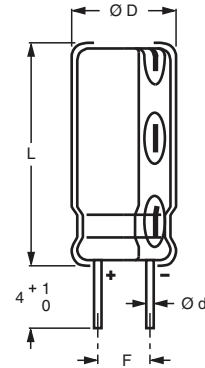


Fig. 3 - Form CB: Cut leads

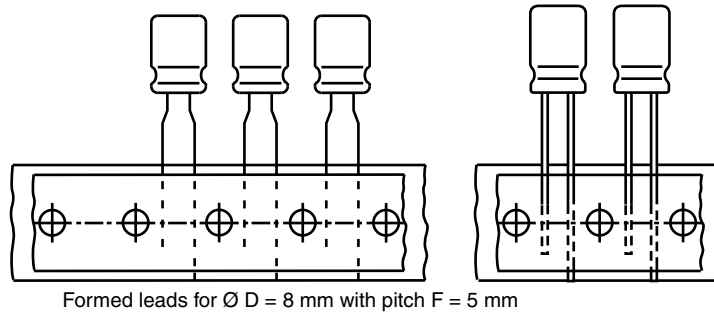


Fig. 4 - Form TFA: Taped in box (ammopack)

Table 1

| DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES |           |     |                     |                   |           |          |                      |         |          |
|--|-----------|-----|---------------------|-------------------|-----------|----------|----------------------|---------|----------|
| NOMINAL CASE SIZE<br>Ø D x L                             | CASE CODE | Ø d | Ø D <sub>max.</sub> | L <sub>max.</sub> | F         | MASS (g) | PACKAGING QUANTITIES |         |          |
|  |           |     |                     |                   |           |          | FORM CA              | FORM CB | FORM TFA |
| 8 x 12   | 13        | 0.6 | 8.5                 | 13.0              | 3.5 ± 0.5 | ≈ 1.1    | 5000                 | 5000    | 1000     |
| 8 x 15   | 13L       | 0.6 | 8.5                 | 16.0              | 3.5 ± 0.5 | ≈ 1.3    | 5000                 | 5000    | 1000     |
| 10 x 12  | 14        | 0.6 | 10.5                | 13.5              | 5.0 ± 0.5 | ≈ 1.6    | 1000                 | 500     | 800      |
| 10 x 16  | 15        | 0.6 | 10.5                | 17.5              | 5.0 ± 0.5 | ≈ 1.9    | 500                  | 500     | 800      |
| 10 x 20  | 16        | 0.6 | 10.5                | 22.0              | 5.0 ± 0.5 | ≈ 2.2    | 500                  | 500     | 800      |
| 12.5 x 20  | 17        | 0.6 | 13.0                | 22.0              | 5.0 ± 0.5 | ≈ 4.0    | 500                  | 500     | 500      |
| 12.5 x 25  | 18        | 0.6 | 13.0                | 27.0              | 5.0 ± 0.5 | ≈ 5.0    | 250                  | 250     | 500      |
| 12.5 x 35  | 18LL      | 0.6 | 13.0                | 37.5              | 5.0 ± 0.5 | ≈ 6.0    | 250                  | 250     | -        |
| 16 x 20  | 19a       | 0.8 | 16.5                | 22.0              | 7.5 ± 0.5 | ≈ 6.0    | 250                  | 250     | 250      |
| 16 x 25  | 19        | 0.8 | 16.5                | 27.0              | 7.5 ± 0.5 | ≈ 8.0    | 250                  | 250     | 250      |
| 16 x 31  | 20        | 0.8 | 16.5                | 33.5              | 7.5 ± 0.5 | ≈ 9.0    | 100                  | 100     | 250      |
| 16 x 35  | 21        | 0.8 | 16.5                | 37.5              | 7.5 ± 0.5 | ≈ 11.0   | 100                  | 100     | -        |
| 18 x 20  | 1820      | 0.8 | 18.5                | 22.0              | 7.5 ± 0.5 | ≈ 8.0    | 100                  | 100     | -        |
| 18 x 31  | 1831      | 0.8 | 18.5                | 33.5              | 7.5 ± 0.5 | ≈ 12.5   | 100                  | 100     | -        |
| 18 x 40  | 1840      | 0.8 | 18.5                | 42.5              | 7.5 ± 0.5 | ≈ 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 |                                      |  |                                    |  |                         |  |  |                               |         |          |         |
|--|--------------------------------------|--|------------------------------------|--|-------------------------|--|--|-------------------------------|---------|----------|---------|
| $U_R$<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 kHz<br>105 °C<br>(mA) | $I_{L2}$<br>2 min<br>( $\mu\text{A}$ ) | $\tan \delta$<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 |         |
| 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  |         |
| 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 <sub>R</sub> (V)                       | C <sub>R</sub> 100 Hz (μF) | NOMINAL CASE SIZE Ø D x L (mm) | I <sub>R</sub> 100 kHz 105 °C (mA) | I <sub>L2</sub> 2 min (μA) | tan δ 100 Hz | Z 100 kHz +20 °C (Ω) | Z 100 kHz -40 °C (Ω) | ORDERING CODE 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                    | 68476E3 | 38473E3  |
|  | 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                    | 68686E3 | 38683E3  |
|  | 1000                       | 16 x 31                        | 1900                               | 633                        | 0.10         | 0.042                | 0.295                | 58102E3                    | 68102E3 | 38102E3  |
| 2200                                     | 18 x 40                    | 3100                           | 1389                               | 0.12                       | 0.033        | 0.231                | 58222E3              | 68222E3                    | -       |          |
| 100                                      | 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                    |   | $U_{rev} \leq 1 V$                          |
| <b>Current</b>                     |   |   |
| Leakage current                    | After 2 min at U <sub>R</sub>   | $I_{L2} \leq 0.01 C_R \times U_R + 3 \mu A$ |
| <b>Inductance</b>                  |   |   |
| Equivalent series inductance (ESL) | Case Ø D ≤ 10 mm  | Typ. 16 nH                                  |
|                                    | Case Ø D ≥ 12.5 mm  | Typ. 18 nH                                  |
| <b>Resistance</b>                  |   |   |
| Equivalent series resistance (ESR) | Calculated from tan δ <sub>max</sub> and C <sub>R</sub> (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

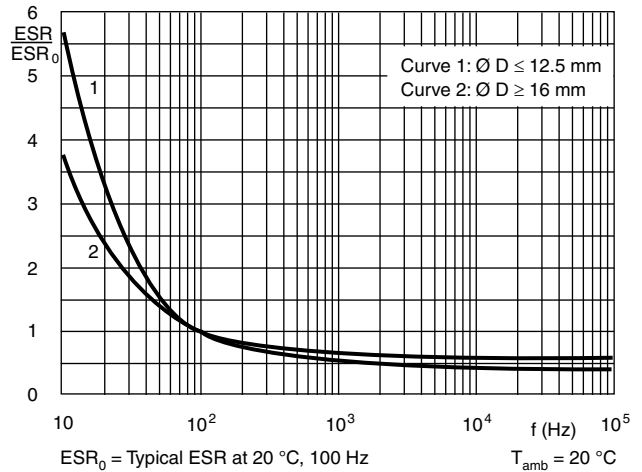


Fig. 8 - Typical multiplier of ESR as a function of frequency

**IMPEDANCE (Z)**



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

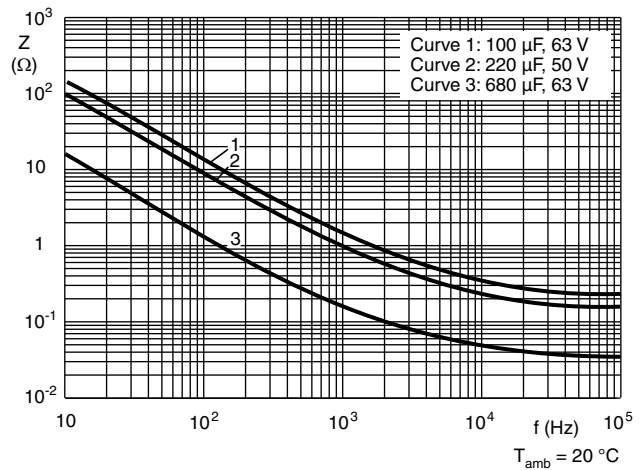


Fig. 10 - Typical impedance as a function of frequency



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

| MULTIPLIER OF RIPPLE CURRENT ( $I_R$ ) AS A FUNCTION OF FREQUENCY |                  |      |      |      |        |        |         |
|---|------------------|------|------|------|--------|--------|---------|
| NOMINAL CASE SIZE<br>$\varnothing D \times L$<br>(mm)             | FREQUENCY (Hz)   |      |      |      |        |        |         |
|   | 100              | 300  | 1000 | 3000 | 10 000 | 30 000 | 100 000 |
|   | $I_R$ MULTIPLIER |      |      |      |        |        |         |
| 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

| TEST PROCEDURES AND REQUIREMENTS               |  |   |  |
|--|--|---|--|
| TEST   |  | PROCEDURE<br>(quick reference)  | REQUIREMENTS   |
| NAME OF TEST                                   | REFERENCE                                |   |  |
| 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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