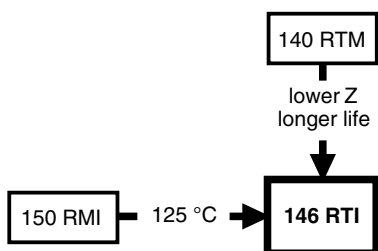
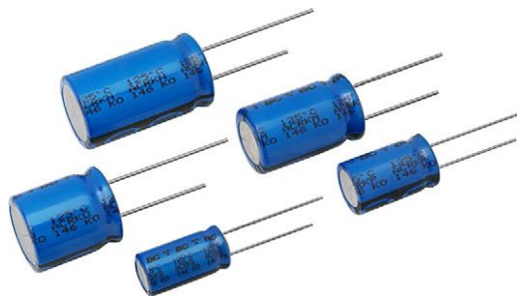


## Aluminum Electrolytic Capacitors Radial, High Temperature, Low Impedance



### FEATURES

- Very long useful life: 2500 h to 6000 h at 125 °C
- High stability, high reliability
- Very low ESR
- AEC-Q200 qualified
- Excellent ripple current capability
- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case with pressure relief, insulated with a blue PET 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 industrial, automotive, telecommunications and military
- Smoothing, filtering and 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
- Logo of manufacturer
- Upper category temperature (125 °C)
- Negative terminal identification
- Series number (146)

### QUICK REFERENCE DATA

| DESCRIPTION                                     | VALUE                                  |
|-------------------------------------------------|----------------------------------------|
| Nominal case sizes ( $\varnothing$ D x L in mm) | 10 x 12 to 18 x 35                     |
| Rated capacitance range, $C_R$                  | 68 $\mu\text{F}$ to 6800 $\mu\text{F}$ |
| Tolerance on $C_R$                              | $\pm 20\%$                             |
| Rated voltage range, $U_R$                      | 16 V to 63 V                           |
| Category temperature range                      | -55 °C to +125 °C                      |
| Endurance test at 125 °C                        | 2000 h to 5000 h                       |
| Useful life at 125 °C                           | 2500 h to 6000 h                       |
| Useful life at 40 °C, 1.8 x $I_R$ applied       | 400 000 h                              |
| Shelf life at 0 V, 125 °C                       | 1000 h                                 |
| Based on sectional specification                | IEC 60384-4 / EN 130300                |
| Climatic category IEC 60068                     | 55 / 125 / 56                          |

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

| $C_R$<br>( $\mu\text{F}$ ) | $U_R$ (V) |           |           |           |           |
|----------------------------|-----------|-----------|-----------|-----------|-----------|
|                            | 16        | 25        | 35        | 50        | 63        |
| 68                         | -         | -         | -         | -         | 10 x 12   |
| 100                        | -         | -         | -         | 10 x 12   | 10 x 16   |
| 150                        | -         | -         | -         | -         | 10 x 20   |
| 220                        | -         | -         | 10 x 12   | 10 x 16   | 12.5 x 20 |
| 330                        | -         | 10 x 12   | 10 x 16   | 10 x 20   | 12.5 x 25 |
| 390                        | -         | -         | -         | -         | 16 x 20   |
| 470                        | 10 x 12   | 10 x 16   | 10 x 20   | 12.5 x 20 | 18 x 20   |
| 560                        | -         | -         | -         | -         | 16 x 25   |
| 680                        | 10 x 16   | 10 x 20   | 12.5 x 20 | 12.5 x 25 | 18 x 25   |
|                            | -         | -         | -         | -         | 16 x 31   |
| 820                        | -         | -         | -         | 16 x 20   | 16 x 35   |
| 1000                       | 10 x 20   | 12.5 x 20 | 12.5 x 25 | 18 x 20   | 18 x 31   |
|                            | -         | -         | -         | 16 x 25   | -         |

**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) |           |         |         |         |
|----------------------|-----------|-----------|---------|---------|---------|
|                      | 16        | 25        | 35      | 50      | 63      |
| 1200                 | -         | -         | 16 x 20 | 18 x 25 | 18 x 35 |
|                      | -         | -         | -       | 16 x 31 | -       |
| 1500                 | 12.5 x 20 | 12.5 x 25 | 18 x 20 | 16 x 35 | -       |
| 1800                 | -         | 16 x 20   | 16 x 25 | 18 x 31 | -       |
|                      | 12.5 x 25 | -         | 18 x 25 | 18 x 35 | -       |
| 2200                 | -         | -         | 16 x 31 | -       | -       |
|                      | 16 x 20   | 18 x 20   | 16 x 35 | -       | -       |
| 2700                 | -         | 16 x 25   | 18 x 31 | -       | -       |
| 3300                 | 18 x 20   | 16 x 31   | 18 x 35 | -       | -       |
| 3900                 | 16 x 25   | 18 x 25   | -       | -       | -       |
|                      | 18 x 25   | 16 x 35   | -       | -       | -       |
| 4700                 | 16 x 31   | 18 x 31   | -       | -       | -       |
|                      | 16 x 35   | 18 x 35   | -       | -       | -       |
| 5600                 | -         | -         | -       | -       | -       |
| 6800                 | 18 x 31   | -         | -       | -       | -       |

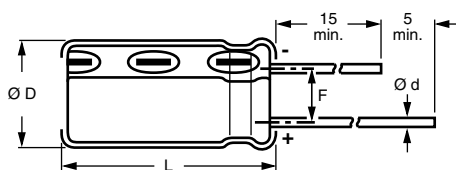
**DIMENSIONS in millimeters AND AVAILABLE FORMS**


Fig. 2 - Form CA: Long leads

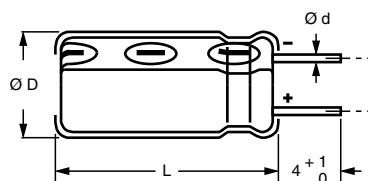


Fig. 3 - Form CB: Cut leads

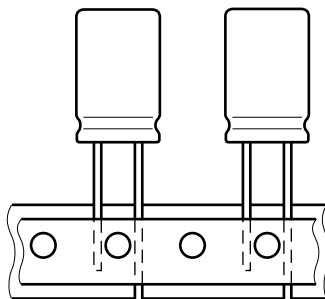


Fig. 4 - Form TFA: Taped in box (ammopack)

Table 1

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

| NOMINAL<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 |
| 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         |
| 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        | 250         |
| 18 x 25                                          | 1825         | 0.8             | 18.5                   | 27.0       | $7.5 \pm 0.5$ | $\approx 10.0$ | 100                  | 100        | 250         |
| 18 x 31                                          | 1831         | 0.8             | 18.5                   | 33.5       | $7.5 \pm 0.5$ | $\approx 12.5$ | 100                  | 100        | 250         |
| 18 x 35                                          | 22           | 0.8             | 18.5                   | 37.5       | $7.5 \pm 0.5$ | $\approx 14.5$ | 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, 125 °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>125 °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>MAL2146..... |         |          |
|                                          |                                      |                                                          |                                    |                                        |                         |                                          |                                          | BULK PACKAGING                |         | TAPED    |
|                                          |                                      |                                                          |                                    |                                        |                         |                                          |                                          | FORM CA                       | FORM CB | FORM TFA |
| 16                                       | 470                                  | 10 x 12                                                  | 620                                | 78                                     | 0.16                    | 0.120                                    | 0.750                                    | 55471E3                       | 65471E3 | 35471E3  |
|                                          | 680                                  | 10 x 16                                                  | 1100                               | 112                                    | 0.16                    | 0.075                                    | 0.450                                    | 55681E3                       | 65681E3 | 35681E3  |
|                                          | 1000                                 | 10 x 20                                                  | 1250                               | 163                                    | 0.16                    | 0.060                                    | 0.360                                    | 55102E3                       | 65102E3 | 35102E3  |
|                                          | 1500                                 | 12.5 x 20                                                | 1600                               | 243                                    | 0.16                    | 0.043                                    | 0.258                                    | 55152E3                       | 65152E3 | 35152E3  |
|                                          | 2200                                 | 12.5 x 25                                                | 2000                               | 355                                    | 0.18                    | 0.033                                    | 0.198                                    | 55222E3                       | 65222E3 | 35222E3  |
|                                          | 2700                                 | 16 x 20                                                  | 1900                               | 435                                    | 0.18                    | 0.034                                    | 0.204                                    | 55272E3                       | 65272E3 | 35272E3  |
|                                          | 3300                                 | 18 x 20                                                  | 2000                               | 531                                    | 0.20                    | 0.033                                    | 0.198                                    | 55332E3                       | 65332E3 | 35332E3  |
|                                          | 3900                                 | 16 x 25                                                  | 2500                               | 627                                    | 0.20                    | 0.024                                    | 0.144                                    | 55392E3                       | 65392E3 | 35392E3  |
|                                          | 4700                                 | 18 x 25                                                  | 2800                               | 755                                    | 0.22                    | 0.025                                    | 0.150                                    | 55472E3                       | 65472E3 | 35472E3  |
|                                          | 4700                                 | 16 x 31                                                  | 3000                               | 755                                    | 0.22                    | 0.021                                    | 0.126                                    | 95475E3                       | 95476E3 | 95473E3  |
|                                          | 5600                                 | 16 x 35                                                  | 3200                               | 899                                    | 0.24                    | 0.018                                    | 0.108                                    | 55562E3                       | 65562E3 | -        |
|                                          | 6800                                 | 18 x 31                                                  | 3100                               | 1091                                   | 0.24                    | 0.022                                    | 0.132                                    | 55682E3                       | 65682E3 | 35682E3  |
| 25                                       | 330                                  | 10 x 12                                                  | 620                                | 85                                     | 0.14                    | 0.120                                    | 0.750                                    | 56331E3                       | 66331E3 | 36331E3  |
|                                          | 470                                  | 10 x 16                                                  | 1100                               | 121                                    | 0.14                    | 0.075                                    | 0.450                                    | 56471E3                       | 66471E3 | 36471E3  |
|                                          | 680                                  | 10 x 20                                                  | 1250                               | 173                                    | 0.14                    | 0.060                                    | 0.360                                    | 56681E3                       | 66681E3 | 36681E3  |
|                                          | 1000                                 | 12.5 x 20                                                | 1600                               | 253                                    | 0.14                    | 0.043                                    | 0.258                                    | 56102E3                       | 66102E3 | 36102E3  |
|                                          | 1500                                 | 12.5 x 25                                                | 2000                               | 378                                    | 0.14                    | 0.033                                    | 0.198                                    | 56152E3                       | 66152E3 | 36152E3  |
|                                          | 1800                                 | 16 x 20                                                  | 1900                               | 453                                    | 0.14                    | 0.034                                    | 0.204                                    | 56182E3                       | 66182E3 | 36182E3  |
|                                          | 2700                                 | 18 x 20                                                  | 2000                               | 678                                    | 0.16                    | 0.033                                    | 0.198                                    | 56272E3                       | 66272E3 | 36272E3  |
|                                          | 2700                                 | 16 x 25                                                  | 2500                               | 678                                    | 0.16                    | 0.024                                    | 0.144                                    | 96275E3                       | 96276E3 | 96273E3  |
|                                          | 3300                                 | 16 x 31                                                  | 3000                               | 828                                    | 0.18                    | 0.021                                    | 0.126                                    | 56332E3                       | 66332E3 | 36332E3  |
|                                          | 3900                                 | 18 x 25                                                  | 2800                               | 978                                    | 0.18                    | 0.025                                    | 0.150                                    | 56392E3                       | 66392E3 | 36392E3  |
|                                          | 4700                                 | 16 x 35                                                  | 3200                               | 1178                                   | 0.20                    | 0.018                                    | 0.108                                    | 56472E3                       | 66472E3 | -        |
|                                          | 4700                                 | 18 x 31                                                  | 3100                               | 1178                                   | 0.20                    | 0.022                                    | 0.132                                    | 96475E3                       | 96476E3 | 96473E3  |
| 35                                       | 5600                                 | 18 x 35                                                  | 3100                               | 1403                                   | 0.22                    | 0.019                                    | 0.114                                    | 56562E3                       | 66562E3 | -        |
|                                          | 220                                  | 10 x 12                                                  | 620                                | 80                                     | 0.12                    | 0.120                                    | 0.750                                    | 50221E3                       | 60221E3 | 30221E3  |
|                                          | 330                                  | 10 x 16                                                  | 1100                               | 119                                    | 0.12                    | 0.075                                    | 0.450                                    | 50331E3                       | 60331E3 | 30331E3  |
|                                          | 470                                  | 10 x 20                                                  | 1250                               | 168                                    | 0.12                    | 0.060                                    | 0.360                                    | 50471E3                       | 60471E3 | 30471E3  |
|                                          | 680                                  | 12.5 x 20                                                | 1600                               | 241                                    | 0.12                    | 0.043                                    | 0.258                                    | 50681E3                       | 60681E3 | 30681E3  |
|                                          | 1000                                 | 12.5 x 25                                                | 2000                               | 353                                    | 0.12                    | 0.033                                    | 0.198                                    | 50102E3                       | 60102E3 | 30102E3  |
|                                          | 1200                                 | 16 x 20                                                  | 1900                               | 423                                    | 0.12                    | 0.034                                    | 0.204                                    | 50122E3                       | 60122E3 | 30122E3  |
|                                          | 1500                                 | 18 x 20                                                  | 2000                               | 528                                    | 0.12                    | 0.033                                    | 0.198                                    | 50152E3                       | 60152E3 | 30152E3  |
|                                          | 1800                                 | 16 x 25                                                  | 2500                               | 633                                    | 0.12                    | 0.024                                    | 0.144                                    | 50182E3                       | 60182E3 | 30182E3  |
|                                          | 2200                                 | 18 x 25                                                  | 2800                               | 773                                    | 0.14                    | 0.025                                    | 0.150                                    | 50222E3                       | 60222E3 | 30222E3  |
|                                          | 2200                                 | 16 x 31                                                  | 3000                               | 773                                    | 0.14                    | 0.021                                    | 0.126                                    | 90225E3                       | 90226E3 | 90223E3  |
|                                          | 2700                                 | 16 x 35                                                  | 3200                               | 948                                    | 0.14                    | 0.018                                    | 0.108                                    | 50272E3                       | 60272E3 | -        |
|                                          | 2700                                 | 18 x 31                                                  | 3100                               | 948                                    | 0.14                    | 0.022                                    | 0.132                                    | 90275E3                       | 90276E3 | 90273E3  |
|                                          | 3300                                 | 18 x 35                                                  | 3100                               | 1158                                   | 0.16                    | 0.019                                    | 0.114                                    | 50332E3                       | 60332E3 | -        |

**ORDERING EXAMPLE**

Electrolytic capacitor 146 RTI series

470  $\mu\text{F}$  / 25 V;  $\pm 20\%$ Nominal case size:  $\varnothing 10\text{ mm} \times 16\text{ mm}$ ; Form TFA

Ordering code: MAL214636471E3

**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>125 °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>MAL2146..... |         |          |
|-----------------------|----------------------------------|-----------------------------------------|---------------------------------------------|----------------------------------|-----------------|-------------------------------|-------------------------------|-------------------------------|---------|----------|
|                       |                                  |                                         |                                             |                                  |                 |                               |                               | BULK PACKAGING                |         | TAPED    |
|                       |                                  |                                         |                                             |                                  |                 |                               |                               | FORM CA                       | FORM CB | FORM TFA |
| 50                    | 100                              | 10 x 12                                 | 420                                         | 53                               | 0.10            | 0.190                         | 1.330                         | 51101E3                       | 61101E3 | 31101E3  |
|                       | 220                              | 10 x 16                                 | 900                                         | 113                              | 0.10            | 0.120                         | 0.720                         | 51221E3                       | 61221E3 | 31221E3  |
|                       | 330                              | 10 x 20                                 | 1000                                        | 168                              | 0.10            | 0.090                         | 0.540                         | 51331E3                       | 61331E3 | 31331E3  |
|                       | 470                              | 12.5 x 20                               | 1250                                        | 238                              | 0.10            | 0.065                         | 0.390                         | 51471E3                       | 61471E3 | 31471E3  |
|                       | 680                              | 12.5 x 25                               | 1700                                        | 343                              | 0.10            | 0.050                         | 0.300                         | 51681E3                       | 61681E3 | 31681E3  |
|                       | 820                              | 16 x 20                                 | 1650                                        | 413                              | 0.10            | 0.047                         | 0.282                         | 51821E3                       | 61821E3 | 31821E3  |
|                       | 1000                             | 18 x 20                                 | 1800                                        | 503                              | 0.10            | 0.039                         | 0.234                         | 51102E3                       | 61102E3 | 31102E3  |
|                       | 1000                             | 16 x 25                                 | 2100                                        | 503                              | 0.10            | 0.031                         | 0.186                         | 91105E3                       | 91106E3 | 91103E3  |
|                       | 1200                             | 18 x 25                                 | 2400                                        | 603                              | 0.10            | 0.030                         | 0.180                         | 51122E3                       | 61122E3 | 31122E3  |
|                       | 1200                             | 16 x 31                                 | 2550                                        | 603                              | 0.10            | 0.027                         | 0.162                         | 91125E3                       | 91126E3 | 91123E3  |
|                       | 1500                             | 16 x 35                                 | 2800                                        | 753                              | 0.10            | 0.022                         | 0.132                         | 51152E3                       | 61152E3 | -        |
|                       | 1800                             | 18 x 31                                 | 2700                                        | 903                              | 0.10            | 0.026                         | 0.156                         | 51182E3                       | 61182E3 | 31182E3  |
|                       | 2200                             | 18 x 35                                 | 3000                                        | 1103                             | 0.12            | 0.022                         | 0.132                         | 51222E3                       | 61222E3 | -        |
| 63                    | 68                               | 10 x 12                                 | 400                                         | 46                               | 0.10            | 0.360                         | 2.160                         | 58689E3                       | 68689E3 | 38689E3  |
|                       | 100                              | 10 x 16                                 | 600                                         | 66                               | 0.10            | 0.220                         | 1.320                         | 58101E3                       | 68101E3 | 38101E3  |
|                       | 150                              | 10 x 20                                 | 750                                         | 98                               | 0.10            | 0.150                         | 0.900                         | 58151E3                       | 68151E3 | 38151E3  |
|                       | 220                              | 12.5 x 20                               | 1000                                        | 142                              | 0.10            | 0.098                         | 0.950                         | 58221E3                       | 68221E3 | 38221E3  |
|                       | 330                              | 12.5 x 25                               | 1300                                        | 211                              | 0.10            | 0.076                         | 0.456                         | 58331E3                       | 68331E3 | 38331E3  |
|                       | 390                              | 16 x 20                                 | 1250                                        | 249                              | 0.10            | 0.075                         | 0.450                         | 58391E3                       | 68391E3 | 38391E3  |
|                       | 470                              | 18 x 20                                 | 1500                                        | 299                              | 0.10            | 0.055                         | 0.330                         | 58471E3                       | 68471E3 | 38471E3  |
|                       | 560                              | 16 x 25                                 | 1800                                        | 356                              | 0.10            | 0.048                         | 0.288                         | 58561E3                       | 68561E3 | 38561E3  |
|                       | 680                              | 18 x 25                                 | 2100                                        | 431                              | 0.10            | 0.041                         | 0.246                         | 58681E3                       | 68681E3 | 38681E3  |
|                       | 680                              | 16 x 31                                 | 2200                                        | 431                              | 0.10            | 0.036                         | 0.216                         | 98685E3                       | 98686E3 | 98683E3  |
|                       | 820                              | 16 x 35                                 | 2500                                        | 520                              | 0.10            | 0.029                         | 0.174                         | 58821E3                       | 68821E3 | -        |
|                       | 1000                             | 18 x 31                                 | 2400                                        | 633                              | 0.10            | 0.032                         | 0.192                         | 58102E3                       | 68102E3 | 38102E3  |
|                       | 1200                             | 18 x 35                                 | 2600                                        | 759                              | 0.10            | 0.029                         | 0.174                         | 58122E3                       | 68122E3 | -        |

**ADDITIONAL ELECTRICAL DATA**

| PARAMETER                          | CONDITIONS                                                             | VALUE                                             |
|------------------------------------|------------------------------------------------------------------------|---------------------------------------------------|
| <b>Voltage</b>                     |                                                                        |                                                   |
| Surge voltage                      |                                                                        | $U_s \leq 1.15 \times U_R$                        |
| Reverse voltage                    |                                                                        | $U_{rev} \leq 0.5 \text{ V}$                      |
| <b>Current</b>                     |                                                                        |                                                   |
| Leakage current                    | After 2 min at U <sub>R</sub>                                          | $I_{L2} \leq 0.01 C_R \times U_R + 3 \mu\text{A}$ |
| <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) | $\text{ESR} = \tan \delta / 2 \pi f C_R$          |

## CAPACITANCE (C)

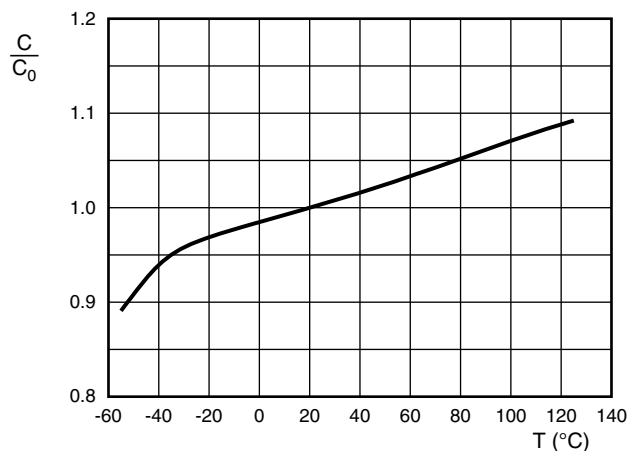


Fig. 5 - Typical multiplier of capacitance at 100 Hz as a function of temperature ( $C_0 = C$  at 20  $^{\circ}\text{C}$ )

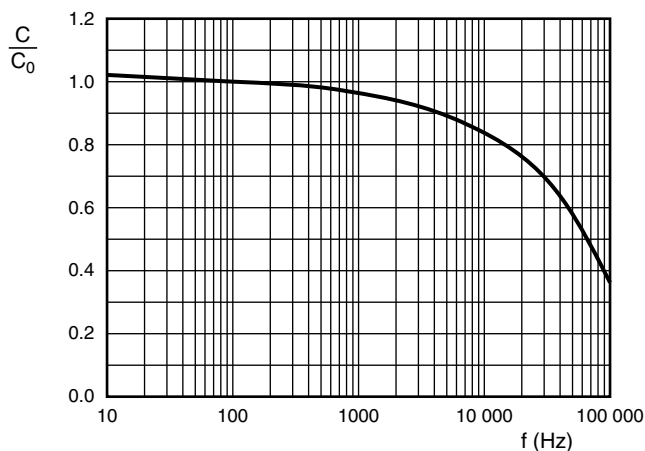


Fig. 6 - Typical multiplier of capacitance as a function of frequency at 20  $^{\circ}\text{C}$  ( $C_0 = C$  at 100 Hz)

## EQUIVALENT SERIES RESISTANCE (ESR)

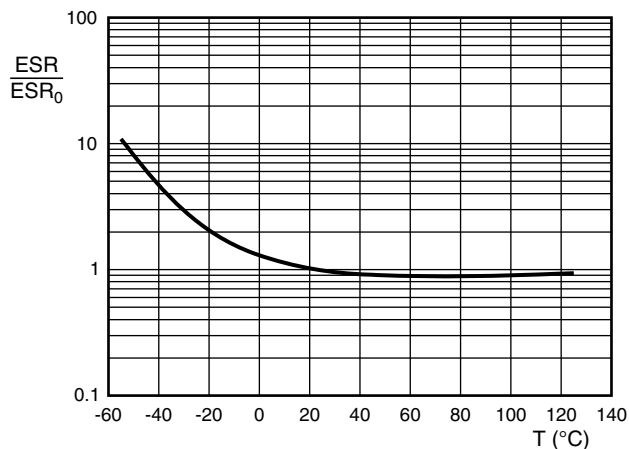


Fig. 7 - Typical multiplier of ESR at 100 Hz as a function of temperature ( $\text{ESR}_0 = \text{ESR}$  at 20  $^{\circ}\text{C}$ )

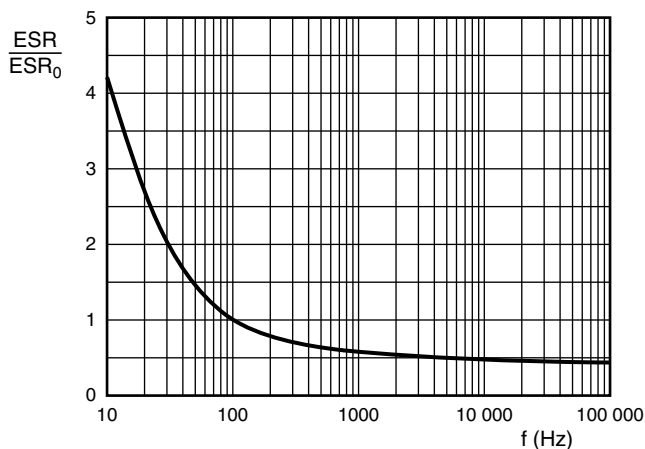


Fig. 8 - Typical multiplier of ESR at 20  $^{\circ}\text{C}$  as a function of frequency ( $\text{ESR}_0 = \text{ESR}$  at 100 Hz)

## IMPEDANCE (Z)

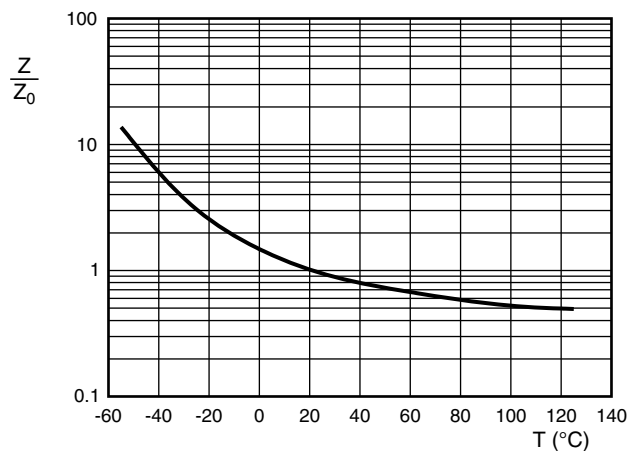


Fig. 9 - Typical multiplier of impedance at 100 kHz as a function of temperature ( $Z_0 = Z$  at 20  $^{\circ}\text{C}$ )

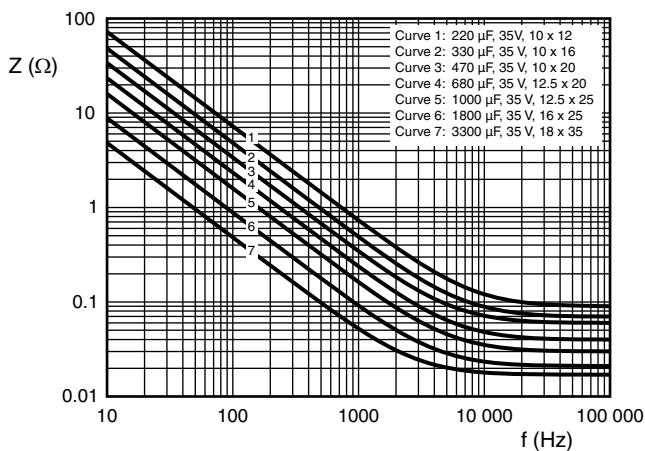


Fig. 10 - Typical impedance  $Z$  at 20  $^{\circ}\text{C}$  as a function of frequency

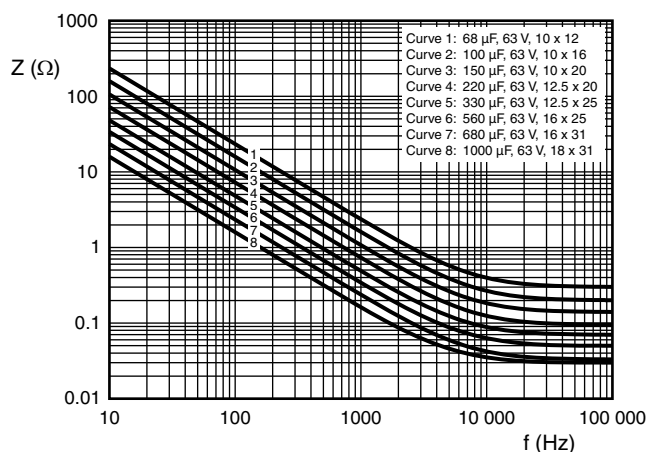


Fig. 11 - Typical impedance Z at 20 °C as a function of frequency

## RIPPLE CURRENT AND USEFUL LIFE

Table 3

| ENDURANCE TEST DURATION AND USEFUL LIFE          |           |                               |                                 |
|--------------------------------------------------|-----------|-------------------------------|---------------------------------|
| NOMINAL CASE SIZE<br>$\varnothing$ D x L<br>(mm) | CASE CODE | ENDURANCE<br>AT 125 °C<br>(h) | USEFUL LIFE<br>AT 125 °C<br>(h) |
| 10 x 12                                          | 14        | 2000                          | 2500                            |
| 10 x 16                                          | 15        | 2000                          | 2500                            |
| 10 x 20                                          | 16        | 2000                          | 3000                            |
| 12.5 x 20                                        | 17        | 2000                          | 3000                            |
| 12.5 x 25                                        | 18        | 3000                          | 5000                            |
| 16 x 20                                          | 19a       | 3000                          | 4000                            |
| 16 x 25                                          | 19        | 3000                          | 5000                            |
| 16 x 31                                          | 20        | 4000                          | 6000                            |
| 16 x 35                                          | 21        | 5000                          | 6000                            |
| 18 x 20                                          | 1820      | 3000                          | 4000                            |
| 18 x 25                                          | 1825      | 3000                          | 5000                            |
| 18 x 31                                          | 1831      | 4000                          | 6000                            |
| 18 x 35                                          | 22        | 5000                          | 6000                            |

### Note

- Multiplier of useful life code: MBC242

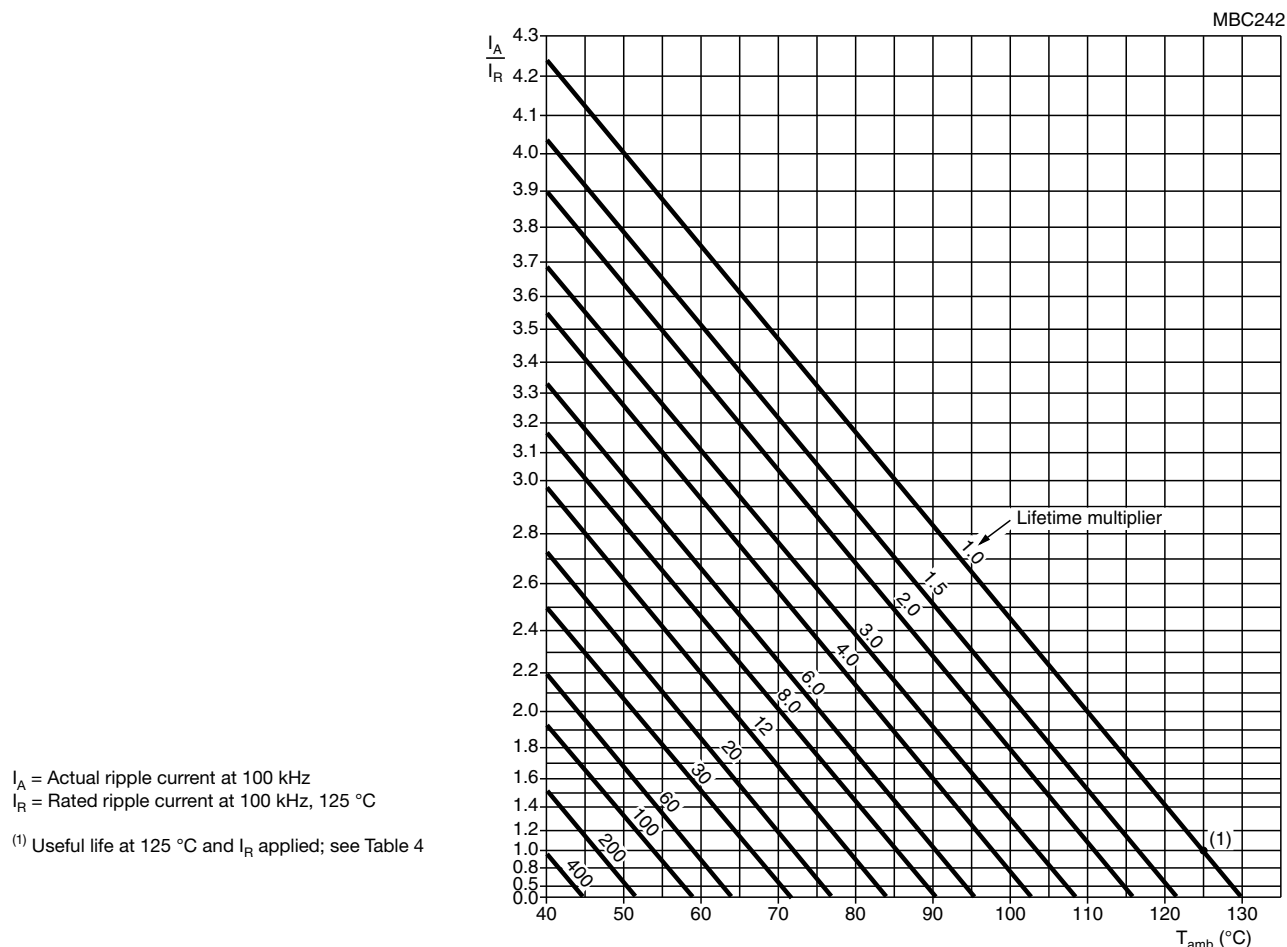


Fig. 12 - Multiplier of useful life as a function of ambient temperature and ripple current load

Table 4

| MULTIPLIER OF RIPPLE CURRENT ( $I_R$ ) AS A FUNCTION OF FREQUENCY |                  |      |      |      |      |        |         |
|-------------------------------------------------------------------|------------------|------|------|------|------|--------|---------|
| $U_R$<br>(V)                                                      | FREQUENCY (Hz)   |      |      |      |      |        |         |
|                                                                   | 50               | 100  | 300  | 1000 | 3000 | 10 000 | 100 000 |
|                                                                   | $I_R$ MULTIPLIER |      |      |      |      |        |         |
| 16                                                                | 0.60             | 0.70 | 0.85 | 0.90 | 0.95 | 1.00   | 1.00    |
| 25                                                                | 0.60             | 0.70 | 0.85 | 0.90 | 0.95 | 1.00   | 1.00    |
| 35                                                                | 0.50             | 0.65 | 0.80 | 0.85 | 0.90 | 0.95   | 1.00    |
| 50                                                                | 0.35             | 0.50 | 0.65 | 0.80 | 0.90 | 0.90   | 1.00    |
| 63                                                                | 0.35             | 0.50 | 0.65 | 0.80 | 0.90 | 0.90   | 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 /<br>EN130300<br>subclause 4.13 | $T_{amb} = 125\text{ }^{\circ}\text{C}$ ; $U_R$ applied;<br>for test duration see Table 3                                                                | $\Delta C/C: \pm 15\%$<br>$\tan \delta \leq 1.3 \times \text{spec. limit}$<br>$Z \leq 2 \times \text{spec. limit}$<br>$I_{L2} \leq \text{spec. limit}$                                                                   |
| Useful life                             | CECC 30301<br>subclause 1.8.1               | $T_{amb} = 125\text{ }^{\circ}\text{C}$ ; $U_R$ 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>$Z \leq 3 \times \text{spec. limit}$<br>$I_{L2} \leq \text{spec. limit}$<br>no short or open circuit<br>total failure percentage: $\leq 1\%$ |
| Shelf life                              | IEC 60384-4 /<br>EN130300<br>subclause 4.17 | $T_{amb} = 125\text{ }^{\circ}\text{C}$ ; no voltage applied;<br>1000 h<br>after test: $U_R$ to be applied for 30 min,<br>24 h o 48 h before measurement | $\Delta C/C: \pm 15\%$<br>$\tan \delta \leq 1.3 \times \text{spec. limit}$<br>$Z \leq 3 \times \text{spec. limit}$<br>$I_{L2} \leq \text{spec. limit}$                                                                   |

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