

## Aluminum Capacitors

### Radial, Ultra High CV per Volume, Semi-Professional

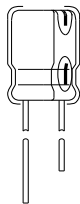
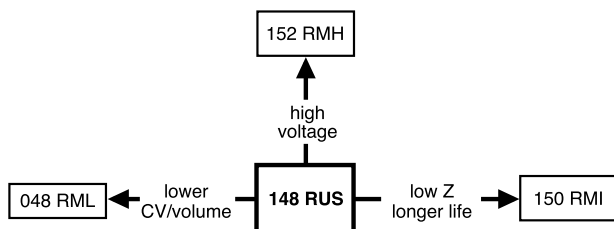


Fig.1 Component outline


**RoHS**  
COMPLIANT

#### FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case with pressure relief, insulated with a blue sleeve
- Charge and discharge proof
- Miniaturized, ultra high CV-product per unit volume
- Very long useful life: 3000 h at 105 °C, high reliability
- Material categorization: For definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)

#### APPLICATIONS

- EDP, telecommunication, industrial, automotive and audio-video
- Smoothing, filtering, buffering in SMPS, timing
- Portable and mobile equipment (small size, low mass)

#### MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance value (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 (148)

#### QUICK REFERENCE DATA

| DESCRIPTION                                          | VALUE                                    |
|------------------------------------------------------|------------------------------------------|
| Nominal case sizes ( $\varnothing D \times L$ in mm) | 10 x 12 to 18 x 35                       |
| Rated capacitance range, $C_R$                       | 47 $\mu\text{F}$ to 22 000 $\mu\text{F}$ |
| Tolerance on $C_R$                                   | $\pm 20\%$                               |
| Rated voltage range, $U_R$                           | 6.3 V to 100 V                           |
| Category temperature range                           | - 40 °C to + 105 °C                      |
| Endurance test at 105 °C:                            |                                          |
| case $\varnothing D = 10$ mm                         | 1000 h                                   |
| case $\varnothing D \geq 12.5$ mm                    | 2000 h                                   |
| Useful life at 105 °C:                               |                                          |
| case $\varnothing D = 10$ mm                         | 2000 h                                   |
| case $\varnothing D \geq 12.5$ mm                    | 3000 h                                   |
| Useful life at 40 °C, $1.6 \times I_R$ applied:      |                                          |
| case $\varnothing D = 10$ mm                         | 140 000 h                                |
| case $\varnothing D \geq 12.5$ mm                    | 200 000 h                                |
| Shelf life at 0 V, 105 °C                            | 1000 h                                   |
| Based on sectional specification                     | IEC 60384-4/EN130300                     |
| Climatic category IEC 60068                          | 40/105/56                                |

#### 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) |    |         |         |         |           |           |           |
|----------------------------|-----------|----|---------|---------|---------|-----------|-----------|-----------|
|                            | 6.3       | 10 | 16      | 25      | 35      | 50        | 63        | 100       |
| 47                         | -         | -  | -       | -       | -       | -         | -         | 10 x 12   |
| 68                         | -         | -  | -       | -       | -       | -         | -         | 10 x 16   |
| 100                        | -         | -  | -       | -       | -       | -         | 10 x 12   | 10 x 20   |
| 150                        | -         | -  | -       | -       | -       | -         | -         | 12.5 x 20 |
| 220                        | -         | -  | -       | -       | -       | 10 x 12   | 10 x 16   | 12.5 x 25 |
|                            | -         | -  | -       | -       | -       | -         | -         | 16 x 20   |
| 330                        | -         | -  | -       | -       | 10 x 12 | 10 x 16   | 12.5 x 20 | 16 x 25   |
| 470                        | -         | -  | -       | 10 x 12 | 10 x 16 | 10 x 20   | 12.5 x 20 | 16 x 31   |
| 680                        | -         | -  | 10 x 12 | 10 x 16 | 10 x 20 | 12.5 x 20 | 12.5 x 25 | -         |
|                            | -         | -  | -       | -       | -       | -         | 16 x 20   | -         |

| SELECTION CHART FOR $C_R$ , $U_R$ AND RELEVANT NOMINAL CASE SIZES ( $\varnothing D \times L$ in mm) |           |           |           |           |           |           |         |     |
|-----------------------------------------------------------------------------------------------------|-----------|-----------|-----------|-----------|-----------|-----------|---------|-----|
| $C_R$<br>( $\mu F$ )                                                                                | $U_R$ (V) |           |           |           |           |           |         |     |
|                                                                                                     | 6.3       | 10        | 16        | 25        | 35        | 50        | 63      | 100 |
| 1000                                                                                                | -         | 10 x 12   | 10 x 16   | 10 x 20   | 12.5 x 20 | 12.5 x 25 | 16 x 25 | -   |
|                                                                                                     | -         | -         | -         | -         | -         | 16 x 20   | -       | -   |
| 1500                                                                                                | -         | 10 x 16   | 10 x 20   | 12.5 x 20 | 12.5 x 25 | 16 x 25   | 16 x 31 | -   |
|                                                                                                     | -         | -         | -         | -         | 16 x 20   | -         | -       | -   |
| 2200                                                                                                | 10 x 16   | 10 x 20   | 12.5 x 20 | 12.5 x 25 | 16 x 25   | 16 x 31   | 18 x 35 | -   |
|                                                                                                     | -         | -         | -         | 16 x 20   | -         | -         | -       | -   |
| 3300                                                                                                | -         | 12.5 x 20 | 12.5 x 25 | 16 x 25   | 16 x 31   | 18 x 35   | -       | -   |
|                                                                                                     | -         | -         | 16 x 20   | -         | -         | -         | -       | -   |
| 4700                                                                                                | 12.5 x 20 | 12.5 x 25 | 16 x 25   | 16 x 31   | 18 x 35   | -         | -       | -   |
|                                                                                                     | -         | 16 x 20   | -         | -         | -         | -         | -       | -   |
| 6800                                                                                                | 16 x 20   | 16 x 25   | 16 x 31   | 18 x 35   | -         | -         | -       | -   |
| 10 000                                                                                              | 16 x 25   | 16 x 31   | 18 x 35   | -         | -         | -         | -       | -   |
| 15 000                                                                                              | 16 x 31   | 18 x 35   | -         | -         | -         | -         | -       | -   |
| 22 000                                                                                              | 18 x 35   | -         | -         | -         | -         | -         | -       | -   |

### DIMENSIONS in millimeters, AND AVAILABLE FORMS

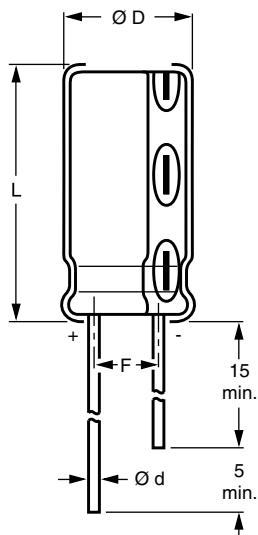


Fig.2 Form CA: Long leads

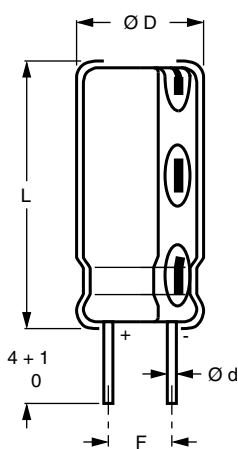


Fig.3 Form CB: Cut leads

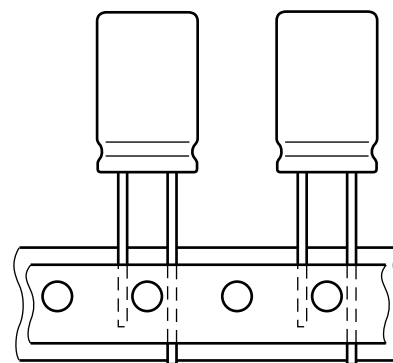


Fig.4 Form TFA: Taped in box (ammopack)

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         |
| 18 x 35                                                  | 22           | 0.8             | 18.5                   | 37.5       | $7.5 \pm 0.5$ | $\approx 14.5$ | 100                  | 100        | -           |

#### Note

Tape dimensions see section 'PACKAGING'.

| ELECTRICAL DATA |                                                   |
|-----------------|---------------------------------------------------|
| SYMBOL          | DESCRIPTION                                       |
| $C_R$           | rated capacitance at 100 Hz, tolerance $\pm 20\%$ |
| $I_R$           | rated RMS ripple current at 100 Hz, 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 Hz<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>MAL2148..... |         |          |
|                                          |                                      |                                                          |                                   |                                        |                         |                                         |                                           | BULK PACKAGING                |         | TAPED    |
|                                          |                                      |                                                          |                                   |                                        |                         |                                         |                                           | FORM CA                       | FORM CB | FORM TFA |
| 6.3                                      | 2200                                 | 10 x 16                                                  | 720                               | 139                                    | 0.30                    | 0.170                                   | 1.90                                      | 53222E3                       | 63222E3 | 33222E3  |
|                                          | 4700                                 | 12.5 x 20                                                | 1100                              | 296                                    | 0.34                    | 0.085                                   | 0.60                                      | 53472E3                       | 63472E3 | 33472E3  |
|                                          | 6800                                 | 16 x 20                                                  | 1210                              | 428                                    | 0.38                    | 0.060                                   | 0.30                                      | 53682E3                       | 63682E3 | 33682E3  |
|                                          | 10000                                | 16 x 25                                                  | 1660                              | 630                                    | 0.46                    | 0.045                                   | 0.25                                      | 53103E3                       | 63103E3 | 33103E3  |
|                                          | 15000                                | 16 x 31                                                  | 2050                              | 945                                    | 0.56                    | 0.033                                   | 0.15                                      | 53153E3                       | 63153E3 | 33153E3  |
|                                          | 22000                                | 18 x 35                                                  | 2350                              | 1386                                   | 0.66                    | 0.032                                   | 0.15                                      | 53223E3                       | 63223E3 | -        |
| 10                                       | 1000                                 | 10 x 12                                                  | 460                               | 100                                    | 0.24                    | 0.240                                   | 3.00                                      | 54102E3                       | 64102E3 | 34102E3  |
|                                          | 1500                                 | 10 x 16                                                  | 620                               | 150                                    | 0.24                    | 0.170                                   | 1.90                                      | 54152E3                       | 64152E3 | 34152E3  |
|                                          | 2200                                 | 10 x 20                                                  | 750                               | 220                                    | 0.26                    | 0.130                                   | 1.50                                      | 54222E3                       | 64222E3 | 34222E3  |
|                                          | 3300                                 | 12.5 x 20                                                | 1010                              | 330                                    | 0.28                    | 0.085                                   | 0.60                                      | 54332E3                       | 64332E3 | 34332E3  |
|                                          | 4700                                 | 12.5 x 25                                                | 1260                              | 470                                    | 0.30                    | 0.065                                   | 0.50                                      | 54472E3                       | 64472E3 | 34472E3  |
|                                          | 4700                                 | 16 x 20                                                  | 1260                              | 470                                    | 0.30                    | 0.060                                   | 0.30                                      | 94475E3                       | 94476E3 | 94473E3  |
|                                          | 6800                                 | 16 x 25                                                  | 1590                              | 680                                    | 0.34                    | 0.045                                   | 0.25                                      | 54682E3                       | 64682E3 | 34682E3  |
|                                          | 10000                                | 16 x 31                                                  | 1910                              | 1000                                   | 0.42                    | 0.033                                   | 0.15                                      | 54103E3                       | 64103E3 | 34103E3  |
| 16                                       | 15000                                | 18 x 35                                                  | 2200                              | 1500                                   | 0.52                    | 0.032                                   | 0.15                                      | 54153E3                       | 64153E3 | -        |
|                                          | 680                                  | 10 x 12                                                  | 450                               | 109                                    | 0.20                    | 0.240                                   | 3.00                                      | 55681E3                       | 65681E3 | 35681E3  |
|                                          | 1000                                 | 10 x 16                                                  | 570                               | 160                                    | 0.20                    | 0.180                                   | 2.00                                      | 55102E3                       | 65102E3 | 35102E3  |
|                                          | 1500                                 | 10 x 20                                                  | 720                               | 240                                    | 0.20                    | 0.130                                   | 1.50                                      | 55152E3                       | 65152E3 | 35152E3  |
|                                          | 2200                                 | 12.5 x 20                                                | 930                               | 352                                    | 0.22                    | 0.090                                   | 0.60                                      | 55222E3                       | 65222E3 | 35222E3  |
|                                          | 3300                                 | 12.5 x 25                                                | 1180                              | 528                                    | 0.24                    | 0.065                                   | 0.50                                      | 55332E3                       | 65332E3 | 35332E3  |
|                                          | 3300                                 | 16 x 20                                                  | 1120                              | 528                                    | 0.24                    | 0.060                                   | 0.30                                      | 95335E3                       | 95336E3 | 95333E3  |
|                                          | 4700                                 | 16 x 25                                                  | 1480                              | 752                                    | 0.26                    | 0.045                                   | 0.25                                      | 55472E3                       | 65472E3 | 35472E3  |
| 25                                       | 6800                                 | 16 x 31                                                  | 1790                              | 1088                                   | 0.30                    | 0.035                                   | 0.20                                      | 55682E3                       | 65682E3 | 35682E3  |
|                                          | 10000                                | 18 x 35                                                  | 2100                              | 1600                                   | 0.36                    | 0.032                                   | 0.20                                      | 55103E3                       | 65103E3 | -        |
|                                          | 470                                  | 10 x 12                                                  | 410                               | 118                                    | 0.16                    | 0.260                                   | 3.20                                      | 56471E3                       | 66471E3 | 36471E3  |
|                                          | 680                                  | 10 x 16                                                  | 550                               | 170                                    | 0.16                    | 0.190                                   | 2.10                                      | 56681E3                       | 66681E3 | 36681E3  |
|                                          | 1000                                 | 10 x 20                                                  | 690                               | 250                                    | 0.16                    | 0.130                                   | 1.50                                      | 56102E3                       | 66102E3 | 36102E3  |
|                                          | 1500                                 | 12.5 x 20                                                | 850                               | 375                                    | 0.16                    | 0.100                                   | 0.70                                      | 56152E3                       | 66152E3 | 36152E3  |
|                                          | 2200                                 | 12.5 x 25                                                | 1110                              | 550                                    | 0.18                    | 0.070                                   | 0.50                                      | 56222E3                       | 66222E3 | 36222E3  |
|                                          | 2200                                 | 16 x 20                                                  | 1050                              | 550                                    | 0.18                    | 0.060                                   | 0.30                                      | 96225E3                       | 96226E3 | 96223E3  |
| 25                                       | 3300                                 | 16 x 25                                                  | 1420                              | 825                                    | 0.20                    | 0.045                                   | 0.25                                      | 56332E3                       | 66332E3 | 36332E3  |
|                                          | 4700                                 | 16 x 31                                                  | 1750                              | 1175                                   | 0.22                    | 0.035                                   | 0.20                                      | 56472E3                       | 66472E3 | 36472E3  |
|                                          | 6800                                 | 18 x 35                                                  | 2050                              | 1700                                   | 0.26                    | 0.033                                   | 0.20                                      | 56682E3                       | 66682E3 | -        |

**ORDERING EXAMPLE**

Electrolytic capacitor 148 series

470  $\mu\text{F}/25\text{ V}$ ;  $\pm 20\%$

Nominal case size:  $\varnothing 10\text{ mm} \times 12\text{ mm}$ ; Form TFA

Ordering Code: MAL214836471E3

Former 12NC: 2222 148 36471

**ELECTRICAL DATA AND ORDERING INFORMATION**

| U <sub>R</sub><br>(V) | C <sub>R</sub><br>100 Hz<br>(μF) | NOMINAL<br>CASE SIZE<br>Ø D x L<br>(mm) | I <sub>R</sub><br>100 Hz<br>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>MAL2148..... |         |          |
|-----------------------|----------------------------------|-----------------------------------------|--------------------------------------------|----------------------------------|-----------------|------------------------------|--------------------------------|-------------------------------|---------|----------|
|                       |                                  |                                         |                                            |                                  |                 |                              |                                | BULK PACKAGING                |         | TAPED    |
|                       |                                  |                                         |                                            |                                  |                 |                              |                                | FORM CA                       | FORM CB | FORM TFA |
| 35                    | 330                              | 10 x 12                                 | 350                                        | 116                              | 0.14            | 0.270                        | 3.30                           | 50331E3                       | 60331E3 | 30331E3  |
|                       | 470                              | 10 x 16                                 | 480                                        | 165                              | 0.14            | 0.190                        | 2.10                           | 50471E3                       | 60471E3 | 30471E3  |
|                       | 680                              | 10 x 20                                 | 580                                        | 238                              | 0.14            | 0.140                        | 1.60                           | 50681E3                       | 60681E3 | 30681E3  |
|                       | 1000                             | 12.5 x 20                               | 810                                        | 350                              | 0.14            | 0.100                        | 0.70                           | 50102E3                       | 60102E3 | 30102E3  |
|                       | 1500                             | 12.5 x 25                               | 950                                        | 525                              | 0.14            | 0.070                        | 0.50                           | 50152E3                       | 60152E3 | 30152E3  |
|                       | 1500                             | 16 x 20                                 | 970                                        | 525                              | 0.14            | 0.063                        | 0.30                           | 90155E3                       | 90156E3 | 90153E3  |
|                       | 2200                             | 16 x 25                                 | 1270                                       | 770                              | 0.16            | 0.045                        | 0.25                           | 50222E3                       | 60222E3 | 30222E3  |
|                       | 3300                             | 16 x 31                                 | 1620                                       | 1155                             | 0.18            | 0.037                        | 0.20                           | 50332E3                       | 60332E3 | 30332E3  |
|                       | 4700                             | 18 x 35                                 | 1930                                       | 1645                             | 0.20            | 0.033                        | 0.20                           | 50472E3                       | 60472E3 | -        |
| 50                    | 220                              | 10 x 12                                 | 330                                        | 110                              | 0.12            | 0.280                        | 3.40                           | 51221E3                       | 61221E3 | 31221E3  |
|                       | 330                              | 10 x 16                                 | 420                                        | 165                              | 0.12            | 0.200                        | 2.20                           | 51331E3                       | 61331E3 | 31331E3  |
|                       | 470                              | 10 x 20                                 | 530                                        | 235                              | 0.12            | 0.140                        | 1.60                           | 51471E3                       | 61471E3 | 31471E3  |
|                       | 680                              | 12.5 x 20                               | 720                                        | 340                              | 0.12            | 0.100                        | 0.70                           | 51681E3                       | 61681E3 | 31681E3  |
|                       | 1000                             | 12.5 x 25                               | 950                                        | 500                              | 0.12            | 0.070                        | 0.50                           | 51102E3                       | 61102E3 | 31102E3  |
|                       | 1000                             | 16 x 20                                 | 880                                        | 500                              | 0.12            | 0.068                        | 0.35                           | 91105E3                       | 91106E3 | 91103E3  |
|                       | 1500                             | 16 x 25                                 | 1180                                       | 750                              | 0.12            | 0.047                        | 0.30                           | 51152E3                       | 61152E3 | 31152E3  |
|                       | 2200                             | 16 x 31                                 | 1520                                       | 1100                             | 0.14            | 0.039                        | 0.20                           | 51222E3                       | 61222E3 | 31222E3  |
|                       | 3300                             | 18 x 35                                 | 1810                                       | 1650                             | 0.16            | 0.035                        | 0.20                           | 51332E3                       | 61332E3 | -        |
| 63                    | 100                              | 10 x 12                                 | 230                                        | 63                               | 0.10            | 0.320                        | 3.90                           | 58101E3                       | 68101E3 | 38101E3  |
|                       | 220                              | 10 x 16                                 | 350                                        | 139                              | 0.10            | 0.240                        | 2.70                           | 58221E3                       | 68221E3 | 38221E3  |
|                       | 330                              | 12.5 x 20                               | 540                                        | 208                              | 0.10            | 0.130                        | 0.90                           | 58331E3                       | 68331E3 | 38331E3  |
|                       | 470                              | 12.5 x 20                               | 540                                        | 296                              | 0.10            | 0.130                        | 0.90                           | 58471E3                       | 68471E3 | 38471E3  |
|                       | 680                              | 12.5 x 25                               | 760                                        | 428                              | 0.10            | 0.085                        | 0.65                           | 58681E3                       | 68681E3 | 38681E3  |
|                       | 680                              | 16 x 20                                 | 820                                        | 428                              | 0.10            | 0.070                        | 0.50                           | 98685E3                       | 98686E3 | 98683E3  |
|                       | 1000                             | 16 x 25                                 | 980                                        | 630                              | 0.10            | 0.049                        | 0.25                           | 58102E3                       | 68102E3 | 38102E3  |
|                       | 1500                             | 16 x 31                                 | 1390                                       | 945                              | 0.10            | 0.042                        | 0.20                           | 58152E3                       | 68152E3 | 38152E3  |
|                       | 2200                             | 18 x 35                                 | 1670                                       | 1386                             | 0.12            | 0.038                        | 0.20                           | 58222E3                       | 68222E3 | -        |
| 100                   | 47                               | 10 x 12                                 | 165                                        | 47                               | 0.08            | 0.640                        | 19.20                          | 59479E3                       | 69479E3 | 39479E3  |
|                       | 68                               | 10 x 16                                 | 190                                        | 68                               | 0.08            | 0.580                        | 17.40                          | 59689E3                       | 69689E3 | 39689E3  |
|                       | 100                              | 10 x 20                                 | 260                                        | 100                              | 0.08            | 0.380                        | 11.40                          | 59101E3                       | 69101E3 | 39101E3  |
|                       | 150                              | 12.5 x 20                               | 360                                        | 150                              | 0.08            | 0.260                        | 7.80                           | 59151E3                       | 69151E3 | 39151E3  |
|                       | 220                              | 12.5 x 25                               | 440                                        | 220                              | 0.08            | 0.170                        | 5.10                           | 59221E3                       | 69221E3 | 39221E3  |
|                       | 220                              | 16 x 20                                 | 590                                        | 220                              | 0.08            | 0.140                        | 4.20                           | 99225E3                       | 99226E3 | 99223E3  |
|                       | 330                              | 16 x 25                                 | 630                                        | 330                              | 0.08            | 0.120                        | 3.60                           | 59331E3                       | 69331E3 | 39331E3  |
|                       | 470                              | 16 x 31                                 | 750                                        | 470                              | 0.08            | 0.100                        | 3.00                           | 59471E3                       | 69471E3 | 39471E3  |

**ADDITIONAL ELECTRICAL DATA**

| PARAMETER                          | CONDITIONS                                                   | VALUE                              |
|------------------------------------|--------------------------------------------------------------|------------------------------------|
| <b>Voltage</b>                     |                                                              |                                    |
| Surge voltage                      |                                                              | $U_S \leq 1.15 U_R$                |
| Reverse voltage                    |                                                              | $U_{REV} \leq 1 V$                 |
| <b>Current</b>                     |                                                              |                                    |
| Leakage current                    | After 2 minutes at $U_R$                                     | $I_{L2} \leq 0.01 C_R \times U_R$  |
|                                    | After 5 minutes at $U_R$                                     | $I_{L5} \leq 0.002 C_R \times U_R$ |
| <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 $\tan \delta_{max.}$ and $C_R$ (see Table 2) | $ESR = \tan \delta / 2 \pi f C_R$  |

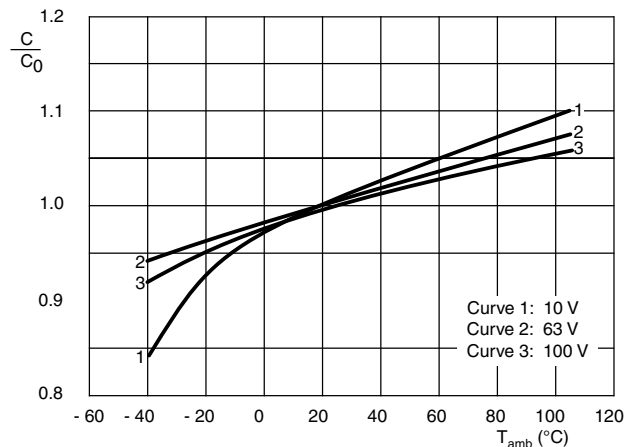
**CAPACITANCE (C)**

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

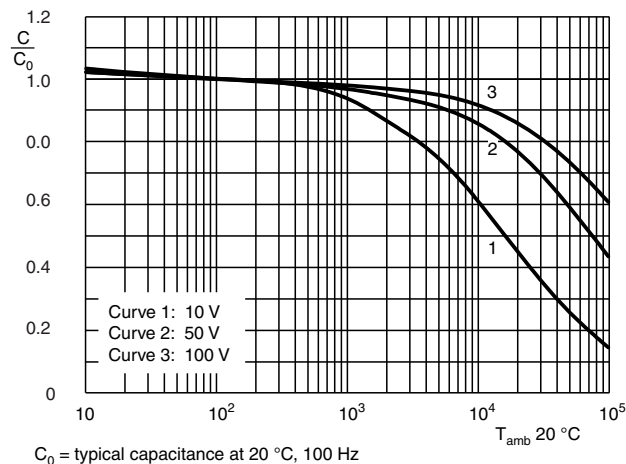


Fig.6 Typical multiplier of capacitance as a function of frequency

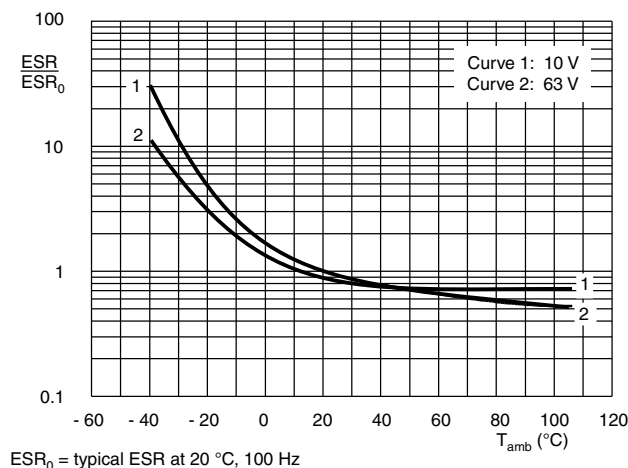
**EQUIVALENT SERIES RESISTANCE (ESR)**

Fig.7 Multiplier of ESR as a function of ambient temperature

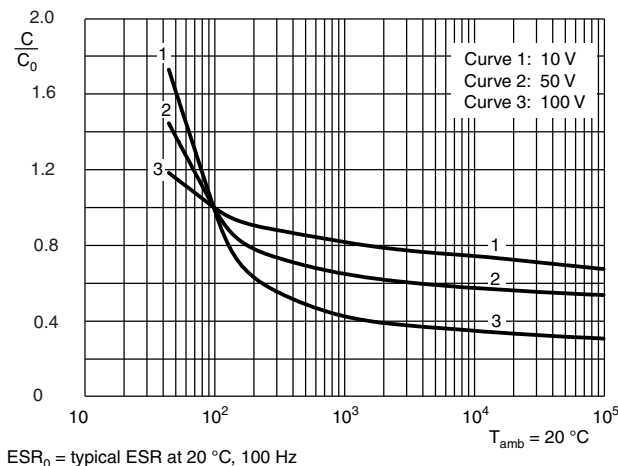


Fig.8 Multiplier of ESR as a function of frequency

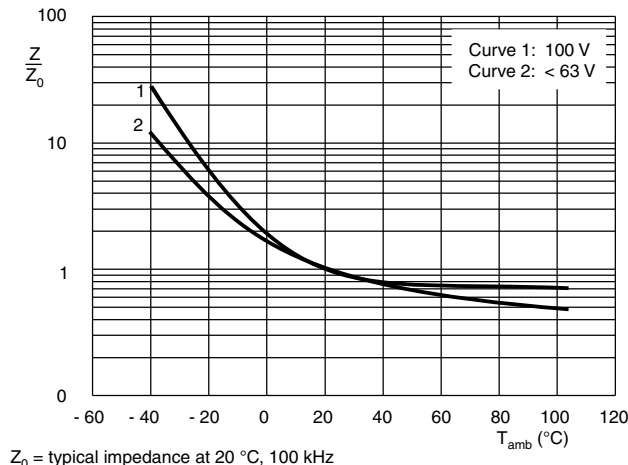
**IMPEDANCE (Z)**

Fig.9 Multiplier of impedance as a function of ambient temperature

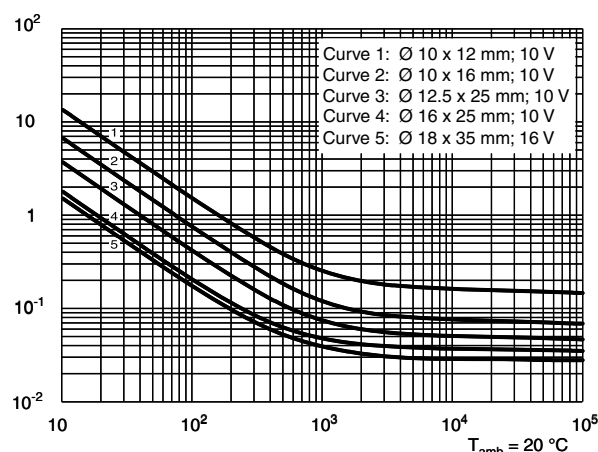


Fig.10 Typical impedance as a function of frequency

## IMPEDANCE (Z)

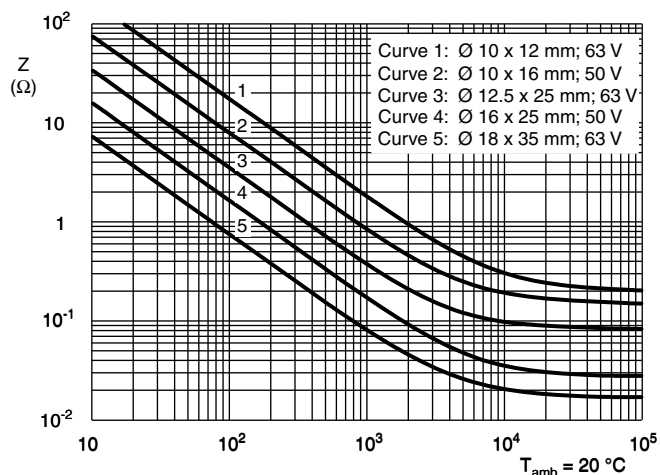
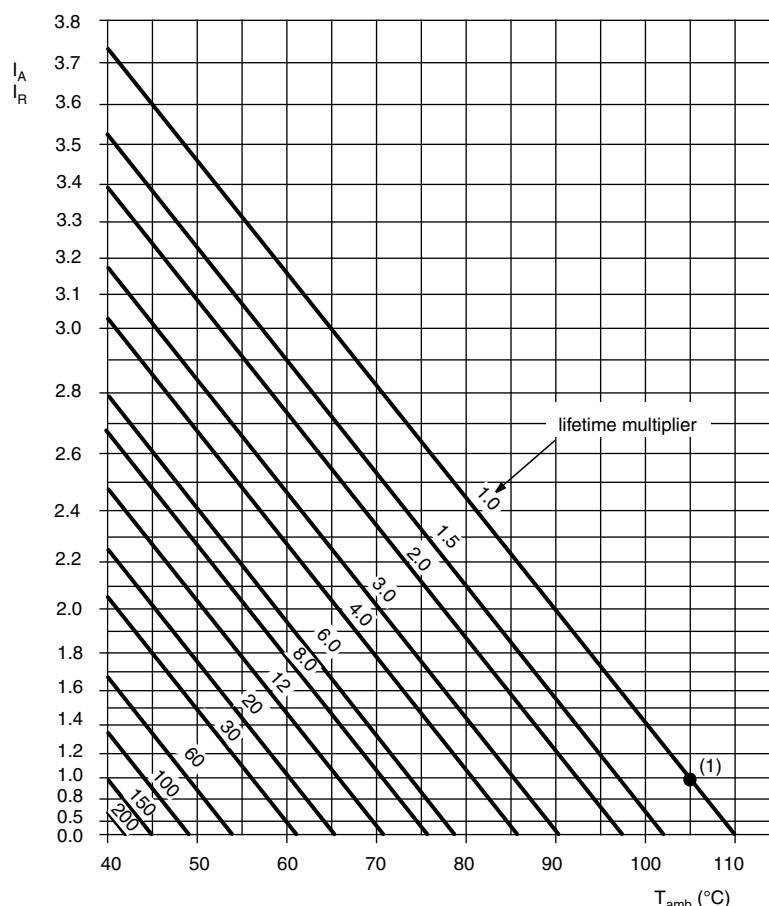


Fig.11 Typical impedance as a function of frequency

## RIPPLE CURRENT AND USEFUL LIFE



$I_A$  = actual ripple current at 100 Hz

$I_R$  = rated ripple current at 100 Hz, 105 °C

(1) Useful life at 105 °C and  $I_R$  applied:

case Ø D = 10 mm: 2000 h

case Ø D ≥ 12.5 mm: 3000 h

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

**MULTIPLIER OF RIPPLE CURRENT ( $I_R$ ) AS A FUNCTION OF FREQUENCY**

| FREQUENCY<br>(Hz) | $I_R$ MULTIPLIER      |              |                       |
|-------------------|-----------------------|--------------|-----------------------|
|                   | $U_R = 6.3$ to $25$ V | $U_R = 35$ V | $U_R = 50$ to $100$ V |
| 50                | 0.95                  | 0.85         | 0.80                  |
| 100               | 1.00                  | 1.00         | 1.00                  |
| 300               | 1.07                  | 1.20         | 1.25                  |
| 1000              | 1.12                  | 1.30         | 1.40                  |
| 3000              | 1.15                  | 1.35         | 1.50                  |
| $\geq 10\,000$    | 1.20                  | 1.40         | 1.60                  |

**TEST PROCEDURES AND REQUIREMENTS**

| TEST                                           |                                            | PROCEDURE<br>(quick reference)                                                                                                                                | REQUIREMENTS                                                                                                                                                                                                                                                                              |
|------------------------------------------------|--------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NAME OF TEST                                   | REFERENCE                                  |                                                                                                                                                               |                                                                                                                                                                                                                                                                                           |
| Endurance                                      | IEC 60384-4/<br>EN130300<br>subclause 4.13 | $T_{amb} = 105\text{ }^{\circ}\text{C}$ ; $U_R$ applied<br>case $\varnothing D = 10$ mm: 1000 h<br>case $\varnothing D \geq 12.5$ mm: 2000 h                  | $U_R = 6.3$ V; $\Delta C/C$ : + 15/- 30 %<br>$U_R \geq 10$ V; $\Delta C/C$ : $\pm 20$ %<br>$\tan \delta \leq 2 \times \text{spec. limit}$<br>$Z \leq 2 \times \text{spec. limit}$<br>$I_{L5} \leq \text{spec. limit}$                                                                     |
| Useful life                                    | CECC 30301<br>subclause 1.8.1              | $T_{amb} = 105\text{ }^{\circ}\text{C}$ ; $U_R$ and $I_R$ applied<br>case $\varnothing D = 10$ mm: 2000 h<br>case $\varnothing D \geq 12.5$ mm: 3000 h        | $U_R = 6.3$ V; $\Delta C/C$ : + 45/- 50 %<br>$U_R \geq 10$ V; $\Delta C/C$ : $\pm 45$ %<br>$\tan \delta \leq 3 \times \text{spec. limit}$<br>$Z \leq 3 \times \text{spec. limit}$<br>$I_{L5} \leq \text{spec. limit}$<br>no short or open circuit<br>total failure percentage: $\leq 1$ % |
| Shelf life<br>(storage at high<br>temperature) | IEC 60384-4/<br>EN130300<br>subclause 4.17 | $T_{amb} = 105\text{ }^{\circ}\text{C}$ ; no voltage applied;<br>1000 h<br><br>after test: $U_R$ to be applied for 30 min,<br>24 h to 48 h before measurement | $U_R = 6.3$ V; $\Delta C/C$ : + 15/- 30 %<br>$U_R \geq 10$ V; $\Delta C/C$ : $\pm 20$ %<br>$\tan \delta \leq 2 \times \text{spec. limit}$<br>$Z \leq 2 \times \text{spec. limit}$<br>$I_{L5} \leq 2 \times \text{spec. limit}$                                                            |
| Surge                                          | IEC 60384-4/<br>EN130300<br>subclause 4.14 | from source of $1.15 \times U_R$ :<br>$RC = 0.1 \pm 0.05$ s; 1000 cycles of 30 s on,<br>330 s off, at $105\text{ }^{\circ}\text{C}$                           | $\Delta C/C$ : $\pm 20$ %<br>$\tan \delta \leq 1.5 \times \text{spec. limit}$<br>$I_{L5} \leq \text{spec. limit}$                                                                                                                                                                         |
| Reverse voltage                                | IEC 60384-4/<br>EN130300<br>subclause 4.15 | $T_{amb} = 105\text{ }^{\circ}\text{C}$ :<br>125 h at $U = -1$ V, followed by 125 h at $U_R$                                                                  | $\Delta C/C$ : $\pm 15$ %<br>$\tan \delta \leq 1.5 \times \text{spec. limit}$<br>$I_{L5} \leq \text{spec. limit}$                                                                                                                                                                         |



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- Техническая поддержка проекта;
- Защита от снятия компонента с производства.



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