

## Aluminum Capacitors Radial, High Temperature Miniature

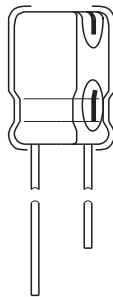
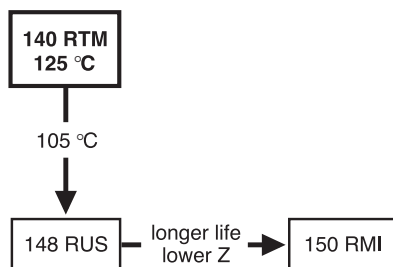


Fig.1 Component outline



| QUICK REFERENCE DATA                               |                      |
|--|----------------------|
| DESCRIPTION  | VALUE                |
| Nominal case sizes (Ø D x L in mm)                 | 10 x 12 to 18 x 31   |
| Rated capacitance range, C <sub>R</sub>            | 22 to 4700 µF        |
| Tolerance on C <sub>R</sub>                        | ± 20 %               |
| Rated voltage range, U <sub>R</sub>                | 6.3 to 63 V          |
| Category temperature range                         | - 55 to + 125 °C     |
| Endurance test at 125 °C                           | 2000 h               |
| Useful life at 125 °C                              | 2500 to 4000 h       |
| Useful life at 40 °C, 1.6 x I <sub>R</sub> applied | 300 000 h            |
| Shelf life at 0 V, 125 °C                          | 500 h                |
| Based on sectional specification                   | IEC 60384-4/EN130300 |
| Climatic category IEC 60068                        | 55/125/56            |

| SELECTION CHART FOR C <sub>R</sub> , U <sub>R</sub> AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm) |                    |           |           |           |           |           |         |
|---|--------------------|-----------|-----------|-----------|-----------|-----------|---------|
| C <sub>R</sub><br>(µF)  | U <sub>R</sub> (V) |           |           |           |           |           |         |
|   | 6.3                | 10        | 16        | 25        | 35        | 50        | 63      |
| 22  | -                  | -         | -         | -         | -         | -         | 10 x 12 |
| 47  | -                  | -         | -         | -         | -         | 10 x 12   | 10 x 12 |
| 100   | -                  | -         | -         | -         | 10 x 12   | 10 x 16   | 10 x 20 |
| 220   | -                  | -         | 10 x 12   | 10 x 16   | 10 x 16   | 12.5 x 20 | 16 x 20 |
| 330   | -                  | 10 x 12   | 10 x 16   | 10 x 20   | -         | 12.5 x 20 | 16 x 20 |
| 470   | -                  | 10 x 16   | 10 x 16   | 10 x 20   | 12.5 x 20 | 12.5 x 25 | 16 x 25 |
|   | -                  | -         | -         | -         | -         | 16 x 20   | -       |
| 1000  | -                  | 10 x 20   | 12.5 x 20 | 12.5 x 25 | 16 x 25   | 16 x 31   | 18 x 31 |
|   | -                  | -         | -         | 16 x 20   | -         | -         | -       |
| 1200  | 10 x 16            | -         | -         | -         | -         | -         | -       |
| 2200  | 10 x 20            | 12.5 x 25 | 16 x 25   | 16 x 31   | 18 x 31   | -         | -       |
|   | -                  | 16 x 20   | -         | -         | -         | -         | -       |
| 3300  | -                  | 16 x 25   | 16 x 31   | 18 x 31   | -         | -         | -       |
| 4700  | -                  | 16 x 31   | 18 x 31   | -         | -         | -         | -       |

**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
- Very long useful life:  
2500 to 4000 h at 125 °C, high stability, high reliability
- Extended temperature range up to 125 °C
- High ripple current capability
- Lead (Pb)-free versions are RoHS compliant


**RoHS  
COMPLIANT**
**APPLICATIONS**

- EDP, telecommunication, industrial, automotive and military
- Smoothing, filtering, buffering in SMPS
- High ambient temperature environments

**MARKING**

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

- Rated capacitance value (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for ± 20 %)
- Rated voltage (in V)
- Date code, in accordance with IEC 60062
- Code indicating factory of origin
- Name of manufacturer
- Upper category temperature (125 °C)
- Negative terminal identification
- Series number (140)

**DIMENSIONS** in millimeters, **AND AVAILABLE FORMS**

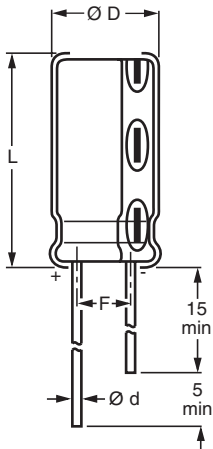


Fig. 2 **Form CA:** Long leads

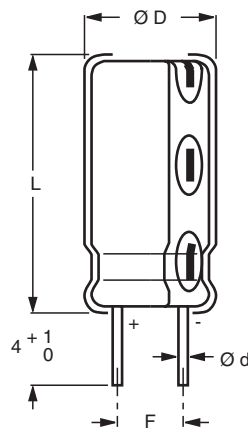


Fig. 3 **Form CB:** Cut leads

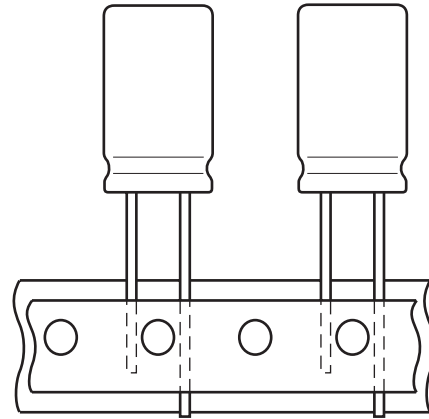


Fig. 4 **Form TFA:** Taped in box (ammopack)

Table 1

| <b>DIMENSIONS</b> in millimeters, <b>MASS AND PACKAGING QUANTITIES</b> |           |     |                     |                   |           |          |                      |         |          |
|--|-----------|-----|---------------------|-------------------|-----------|----------|----------------------|---------|----------|
| NOMINAL CASE SIZE<br>Ø D x L   | CASE CODE | Ø d | Ø D <sub>max.</sub> | L <sub>max.</sub> | F         | MASS (g) | PACKAGING QUANTITIES |         |          |
|  |           |     |                     |                   |           |          | FORM CA              | FORM CB | FORM TFA |
| 10 x 12  | 14        | 0.6 | 10.5                | 13.5              | 5.0 ± 0.5 | ≈ 1.6    | 1000                 | 500     | 800      |
| 10 x 16  | 15        | 0.6 | 10.5                | 17.5              | 5.0 ± 0.5 | ≈ 1.9    | 500                  | 500     | 800      |
| 10 x 20  | 16        | 0.6 | 10.5                | 22.0              | 5.0 ± 0.5 | ≈ 2.2    | 500                  | 500     | 800      |
| 12.5 x 20  | 17        | 0.6 | 13.0                | 22.0              | 5.0 ± 0.5 | ≈ 4.0    | 500                  | 500     | 500      |
| 12.5 x 25  | 18        | 0.6 | 13.0                | 27.0              | 5.0 ± 0.5 | ≈ 5.0    | 250                  | 250     | 500      |
| 16 x 20  | 19a       | 0.8 | 16.5                | 22.0              | 7.5 ± 0.5 | ≈ 6.0    | 250                  | 250     | 250      |
| 16 x 25  | 19        | 0.8 | 16.5                | 27.0              | 7.5 ± 0.5 | ≈ 8.0    | 250                  | 250     | 250      |
| 16 x 31  | 20        | 0.8 | 16.5                | 33.5              | 7.5 ± 0.5 | ≈ 9.0    | 100                  | 100     | 250      |
| 18 x 31  | 1831      | 0.8 | 18.5                | 33.5              | 7.5 ± 0.5 | ≈ 12.5   | 100                  | 100     | -        |

**Note**

Detailed tape dimensions see section 'PACKAGING'.



Aluminum Capacitors  
Radial, High Temperature Miniature

Vishay BCcomponents

| 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       |
| $I_{L1}$        | max. leakage current after 1 minutes at $U_R$     |
| $\tan \delta$   | max. dissipation factor at 100 Hz                 |
| $Z$             | max. impedance at 100 kHz                         |

**ORDERING EXAMPLE**

Electrolytic capacitor 140 series

220  $\mu$ F/25 V;  $\pm 20\%$

Nominal case size:  $\varnothing 10 \times 16$  mm; Form TFA

Ordering Code: MAL214036221E3

Former 12NC: 2222 140 36221

**Note**

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

| ELECTRICAL DATA AND ORDERING INFORMATION |                               |  |                                    |                                 |                         |   |   |                                |         |          |
|--|-------------------------------|--|------------------------------------|---------------------------------|-------------------------|---|---|--------------------------------|---------|----------|
| $U_R$<br>(V)                             | $C_R$<br>100 Hz<br>( $\mu$ F) | NOMINAL<br>CASE SIZE<br>$\varnothing D \times L$<br>(mm) | $I_R$<br>100 kHz<br>125 °C<br>(mA) | $I_{L1}$<br>1 min<br>( $\mu$ A) | $\tan \delta$<br>100 Hz | $Z$<br>100 kHz<br>+ 20 °C<br>( $\Omega$ ) | $Z$<br>100 kHz<br>- 40 °C<br>( $\Omega$ ) | ORDERING CODE<br>MAL2140 ..... |         |          |
|  |                               |  |                                    |                                 |                         |   |   | BULK PACKAGING                 |         | TAPED    |
|  |                               |  |                                    |                                 |                         |   |   | FORM CA                        | FORM CB | FORM TFA |
| 6.3                                      | 1200                          | 10 x 16  | 760                                | 79                              | 0.28                    | 0.15                                      | 1.10                                      | 53122E3                        | 63122E3 | 33122E3  |
|  | 2200                          | 10 x 20  | 850                                | 142                             | 0.28                    | 0.12                                      | 0.85                                      | 53222E3                        | 63222E3 | 33222E3  |
| 10                                       | 330                           | 10 x 12  | 480                                | 36                              | 0.20                    | 0.200                                     | 1.40                                      | 54331E3                        | 64331E3 | 34331E3  |
|  | 470                           | 10 x 16  | 760                                | 50                              | 0.20                    | 0.150                                     | 1.10                                      | 54471E3                        | 64471E3 | 34471E3  |
|  | 1000                          | 10 x 20  | 850                                | 103                             | 0.20                    | 0.120                                     | 0.85                                      | 54102E3                        | 64102E3 | 34102E3  |
|  | 2200                          | 12.5 x 25  | 1400                               | 223                             | 0.24                    | 0.050                                     | 0.40                                      | 94225E3                        | 94226E3 | 94223E3  |
|  | 2200                          | 16 x 20  | 1400                               | 223                             | 0.24                    | 0.050                                     | 0.40                                      | 54222E3                        | 64222E3 | 34222E3  |
|  | 3300                          | 16 x 25  | 1900                               | 333                             | 0.24                    | 0.034                                     | 0.25                                      | 54332E3                        | 64332E3 | 34332E3  |
| 16                                       | 4700                          | 16 x 31  | 2200                               | 473                             | 0.24                    | 0.030                                     | 0.20                                      | 54472E3                        | 64472E3 | 34472E3  |
|  | 220                           | 10 x 12  | 480                                | 38                              | 0.16                    | 0.200                                     | 1.40                                      | 55221E3                        | 65221E3 | 35221E3  |
|  | 330                           | 10 x 16  | 760                                | 56                              | 0.16                    | 0.150                                     | 1.10                                      | 55331E3                        | 65331E3 | 35331E3  |
|  | 470                           | 10 x 16  | 760                                | 78                              | 0.16                    | 0.150                                     | 1.10                                      | 55471E3                        | 65471E3 | 35471E3  |
|  | 1000                          | 12.5 x 20  | 1200                               | 163                             | 0.16                    | 0.073                                     | 0.50                                      | 55102E3                        | 65102E3 | 35102E3  |
|  | 2200                          | 16 x 25  | 1900                               | 355                             | 0.18                    | 0.034                                     | 0.25                                      | 55222E3                        | 65222E3 | 35222E3  |
|  | 3300                          | 16 x 31  | 2200                               | 531                             | 0.18                    | 0.030                                     | 0.20                                      | 55332E3                        | 65332E3 | 35332E3  |
| 25                                       | 4700                          | 18 x 31  | 2200                               | 755                             | 0.18                    | 0.030                                     | 0.20                                      | 55472E3                        | 65472E3 | -        |
|  | 220                           | 10 x 16  | 750                                | 58                              | 0.14                    | 0.150                                     | 1.10                                      | 56221E3                        | 66221E3 | 36221E3  |
|  | 330                           | 10 x 20  | 850                                | 86                              | 0.14                    | 0.120                                     | 0.85                                      | 56331E3                        | 66331E3 | 36331E3  |
|  | 470                           | 10 x 20  | 850                                | 121                             | 0.14                    | 0.120                                     | 0.85                                      | 56471E3                        | 66471E3 | 36471E3  |
|  | 1000                          | 12.5 x 25  | 1400                               | 253                             | 0.14                    | 0.050                                     | 0.40                                      | 96105E3                        | 96106E3 | 96103E3  |
|  | 1000                          | 16 x 20  | 1400                               | 253                             | 0.14                    | 0.050                                     | 0.40                                      | 56102E3                        | 66102E3 | 36102E3  |
|  | 2200                          | 16 x 31  | 2200                               | 553                             | 0.16                    | 0.030                                     | 0.20                                      | 56222E3                        | 66222E3 | 36222E3  |
| 3300                                     | 18 x 31                       | 2200   | 828                                | 0.16                            | 0.030                   | 0.20                                      | 56332E3                                   | 66332E3                        | -       |          |

| 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>L1</sub><br>1 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>MAL2140 ..... |         |          |
|  |                                  |   |   |                                  |                 |                                |                                | BULK PACKAGING                 |         | TAPED    |
|  |                                  |   |   |                                  |                 |                                |                                | FORM CA                        | FORM CB | FORM TFA |
| 35                                       | 100                              | 10 x 12                                 | 480   | 38                               | 0.12            | 0.200                          | 1.40                           | 50101E3                        | 60101E3 | 30101E3  |
|  | 220                              | 10 x 16                                 | 760   | 80                               | 0.12            | 0.150                          | 1.10                           | 50221E3                        | 60221E3 | 30221E3  |
|  | 470                              | 12.5 x 20                               | 1200  | 168                              | 0.12            | 0.073                          | 0.50                           | 50471E3                        | 60471E3 | 30471E3  |
|  | 1000                             | 16 x 25                                 | 1500  | 353                              | 0.12            | 0.034                          | 0.25                           | 50102E3                        | 60102E3 | 30102E3  |
|  | 2200                             | 18 x 31                                 | 2200  | 773                              | 0.14            | 0.030                          | 0.20                           | 50222E3                        | 60222E3 | -        |
| 50                                       | 47                               | 10 x 12                                 | 300   | 27                               | 0.10            | 0.300                          | 2.00                           | 51479E3                        | 61479E3 | 31479E3  |
|  | 100                              | 10 x 16                                 | 380   | 53                               | 0.10            | 0.200                          | 1.40                           | 51101E3                        | 61101E3 | 31101E3  |
|  | 220                              | 12.5 x 20                               | 580   | 113                              | 0.10            | 0.120                          | 0.85                           | 51221E3                        | 61221E3 | 31221E3  |
|  | 330                              | 12.5 x 20                               | 870   | 168                              | 0.10            | 0.120                          | 0.85                           | 51331E3                        | 61331E3 | 31331E3  |
|  | 470                              | 12.5 x 25                               | 1100  | 238                              | 0.10            | 0.085                          | 0.60                           | 91475E3                        | 91476E3 | 91473E3  |
|  | 470                              | 16 x 20                                 | 1100  | 238                              | 0.10            | 0.085                          | 0.60                           | 51471E3                        | 61471E3 | 31471E3  |
| 1000                                     | 16 x 31                          | 1700                                    | 503   | 0.10                             | 0.045           | 0.30                           | 51102E3                        | 61102E3                        | 31102E3 |          |
| 63                                       | 22                               | 10 x 12                                 | 380   | 17                               | 0.10            | 0.300                          | 2.00                           | 58229E3                        | 68229E3 | 38229E3  |
|  | 47                               | 10 x 12                                 | 380   | 33                               | 0.10            | 0.300                          | 2.00                           | 58479E3                        | 68479E3 | 38479E3  |
|  | 100                              | 10 x 20                                 | 650   | 66                               | 0.10            | 0.160                          | 1.10                           | 58101E3                        | 68101E3 | 38101E3  |
|  | 220                              | 16 x 20                                 | 1100  | 142                              | 0.10            | 0.085                          | 0.60                           | 58221E3                        | 68221E3 | 38221E3  |
|  | 330                              | 16 x 20                                 | 1100  | 211                              | 0.10            | 0.085                          | 0.60                           | 58331E3                        | 68331E3 | 38331E3  |
|  | 470                              | 16 x 25                                 | 1500  | 299                              | 0.10            | 0.055                          | 0.40                           | 58471E3                        | 68471E3 | 38471E3  |
|  | 1000                             | 18 x 31                                 | 1800  | 633                              | 0.10            | 0.040                          | 0.28                           | 58102E3                        | 68102E3 | -        |

| ADDITIONAL ELECTRICAL DATA         |  |  |
|------------------------------------|--|--|
| PARAMETER                          | CONDITIONS   | VALUE  |
| <b>Voltage</b>                     |  |  |
| Surge voltage                      |  | $U_s \leq 1.15 \times U_R$                         |
| Reverse voltage                    |  | $U_{rev} \leq 1 \text{ V}$                         |
| <b>Current</b>                     |  |  |
| Leakage current                    | After 1 minute at U <sub>R</sub>                                       | $I_{L1} \leq 0.01 C_R \times U_R + 3 \mu\text{A}$  |
|                                    | After 5 minutes at U <sub>R</sub>                                      | $I_{L5} \leq 0.002 C_R \times U_R + 3 \mu\text{A}$ |
| <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)**

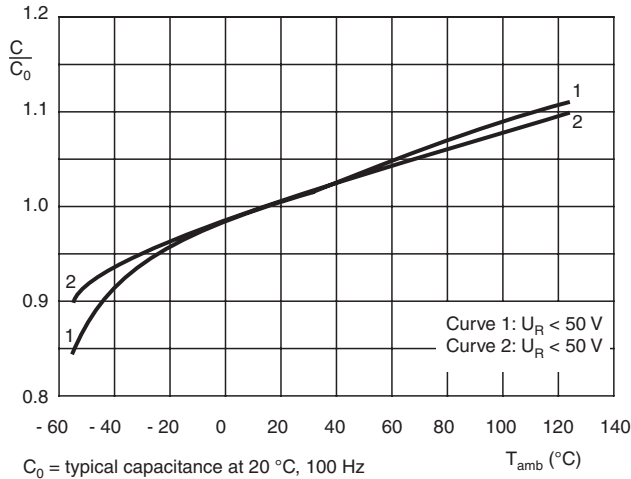


Fig.5 Typical multiplier of capacitance as a function of ambient temperature

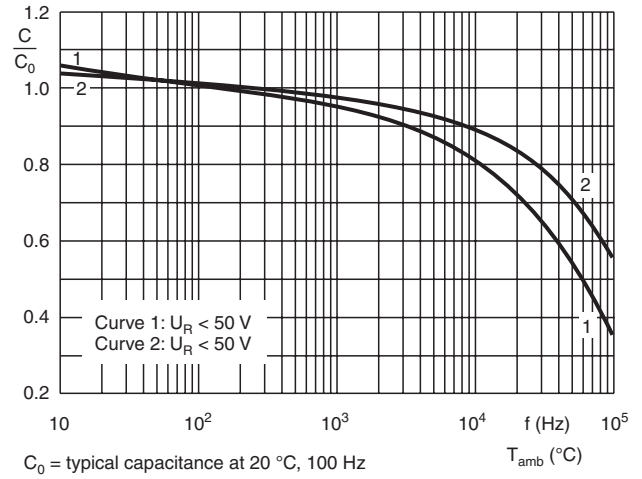


Fig.6 Typical multiplier of capacitance as a function of frequency

**EQUIVALENT SERIES RESISTANCE (ESR)**

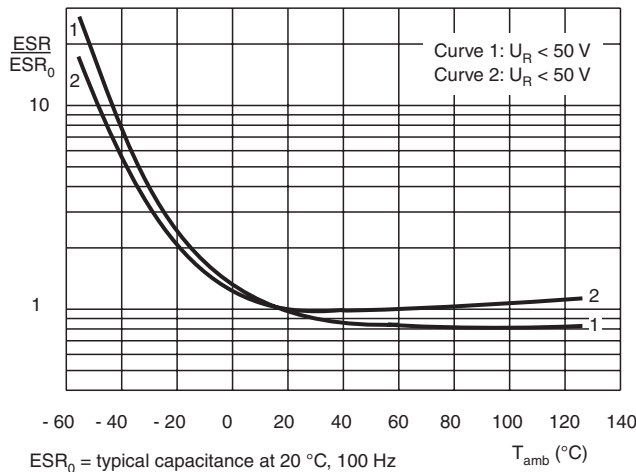


Fig.7 Typical multiplier of ESR as a function of ambient temperature

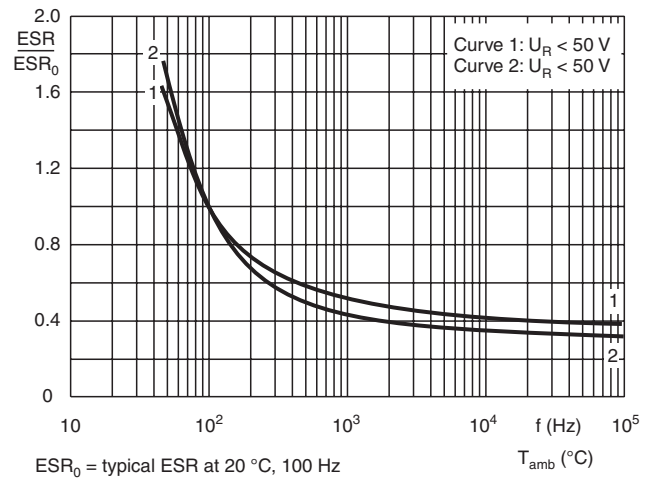


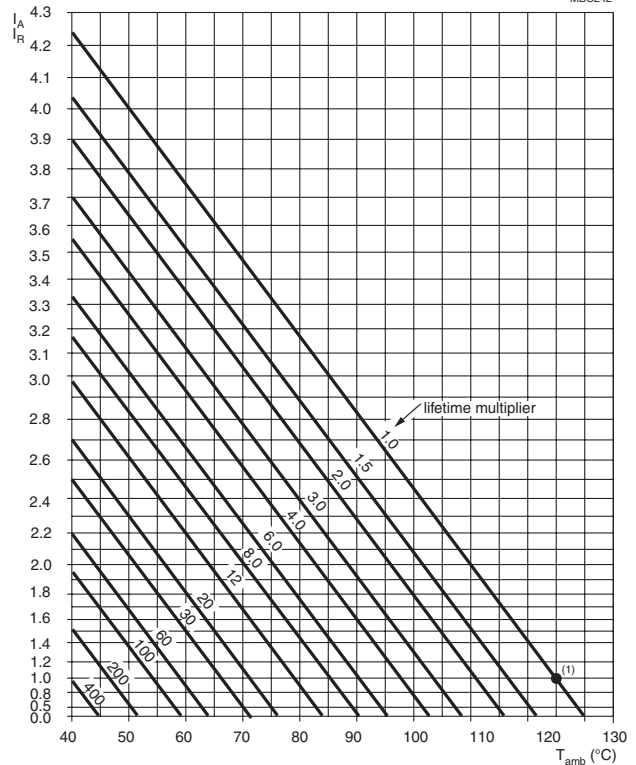
Fig.8 Typical multiplier of ESR as a function of frequency

**RIPPLE CURRENT AND USEFUL LIFE**

Table 2

| ENDURANCE AND USEFUL LIFE AS A FUNCTION OF CASE SIZE |           |                              |                           |
|--|-----------|------------------------------|---------------------------|
| NOMINAL CASE SIZE $\varnothing D \times L$ (mm)      | CASE CODE | ENDURANCE TEST AT 125 °C (h) | USEFUL LIFE AT 125 °C (h) |
| 10 x 12  | 14        | 2000                         | 2500                      |
| 10 x 16  | 15        | 2000                         | 3000                      |
| 10 x 20  | 16        | 2000                         | 3000                      |
| 12.5 x 20  | 17        | 2000                         | 3000                      |
| 12.5 x 25  | 18        | 2000                         | 3000                      |
| 16 x 20  | 19a       | 2000                         | 3000                      |
| 16 x 25  | 19        | 2000                         | 4000                      |
| 16 x 31  | 20        | 2000                         | 4000                      |
| 18 x 31  | 1831      | 2000                         | 4000                      |

MBC242



$I_A$  = actual ripple current at 100 kHz  
 $I_R$  = rated ripple current at 100 kHz, 125 °C  
 (1) Useful life at 125 °C and  $I_R$  applied: see Table 3

Fig.9 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 3

| MULTIPLIER OF RIPPLE CURRENT ( $I_R$ ) AS A FUNCTION OF FREQUENCY |                       |              |                       |
|---|-----------------------|--------------|-----------------------|
| FREQUENCY (Hz)  | $I_R$ MULTIPLIER      |              |                       |
|   | $U_R = 6.3$ to $25$ V | $U_R = 35$ V | $U_R = 50$ and $63$ V |
| 50  | 0.60                  | 0.50         | 0.35                  |
| 100   | 0.70                  | 0.65         | 0.50                  |
| 300   | 0.85                  | 0.80         | 0.65                  |
| 1000  | 0.90                  | 0.85         | 0.80                  |
| 3000  | 0.95                  | 0.90         | 0.90                  |
| 10 000  | 1.00                  | 0.95         | 0.90                  |
| 100 000   | 1.00                  | 1.00         | 1.00                  |

Table 4

| TEST PROCEDURES AND REQUIREMENTS |  |  |   |
|----------------------------------|--|--|---|
| TEST                             |  | PROCEDURE (quick reference)  | REQUIREMENTS  |
| NAME OF TEST                     | REFERENCE                                  |  |   |
| Endurance                        | IEC 60384-4/<br>EN130300<br>subclause 4.13 | $T_{amb} = 125$ °C; $U_R$ applied;<br>2000 hours   | $\Delta C/C: \pm 15$ %<br>$\tan \delta \leq 1.3$ x spec. limit<br>$Z \leq 2$ x spec. limit<br>$I_{L5} \leq$ spec. limit   |
| Useful life                      | CECC 30301<br>subclause 1.8.1              | $T_{amb} = 125$ °C; $U_R$ and $I_R$ applied;<br>for test duration see Table 3  | $\Delta C/C: \pm 30$ %<br>$\tan \delta \leq 3$ x spec. limit<br>$Z \leq 3$ x spec. limit<br>$I_{L5} \leq$ 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 | $T_{amb} = 125$ °C; no voltage applied;<br>500 hours<br><br>after test: $U_R$ to be applied for 30 minutes,<br>24 to 48 hours before measurement | $\Delta C/C: \pm 15$ %<br>$\tan \delta \leq 1.3$ x spec. limit<br>$Z \leq 2$ x spec. limit<br>$I_{L5} \leq 2$ x spec. limit   |



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