

## Aluminum Capacitors Radial, High Temperature Miniature

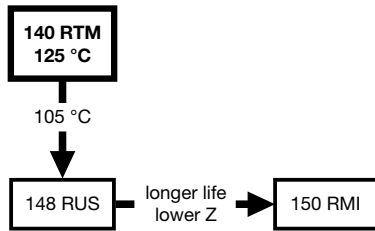


Fig. 1

### FEATURES

- Very long useful life: 2500 h to 4000 h at 125 °C
- High stability, high reliability
- AEC-Q200 qualified
- Extended temperature range up to 125 °C
- High ripple current capability
- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case with pressure relief, insulated with a blue sleeve
- Charge and discharge proof
- Material categorization: For definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


**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  $\mu\text{F}$ )
- 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 (125 °C)
- Negative terminal identification
- Series number (140)

| QUICK REFERENCE DATA                            |  |
|---|--|
| DESCRIPTION                                     | VALUE                                  |
| Nominal case sizes ( $\varnothing$ D x L in mm) | 10 x 12 to 18 x 31                     |
| Rated capacitance range, $C_R$                  | 22 $\mu\text{F}$ to 4700 $\mu\text{F}$ |
| Tolerance on $C_R$                              | $\pm 20\%$                             |
| Rated voltage range, $U_R$                      | 6.3 V to 63 V                          |
| Category temperature range                      | - 55 °C to + 125 °C                    |
| Endurance test at 125 °C                        | 2000 h                                 |
| Useful life at 125 °C                           | 2500 h to 4000 h                       |
| Useful life at 40 °C, 1.6 x $I_R$ applied       | 300 000 h                              |
| Shelf life at 0 V, 125 °C                       | 500 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) |           |           |           |           |           |         |
|  | 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   | -         | -         | -         | -       |

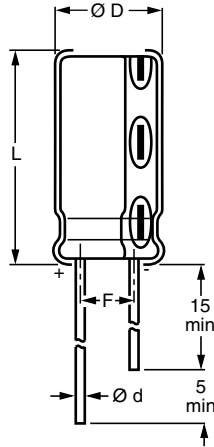
**DIMENSIONS** in millimeters **AND AVAILABLE FORMS**


Fig. 2 - Form CA: Long leads

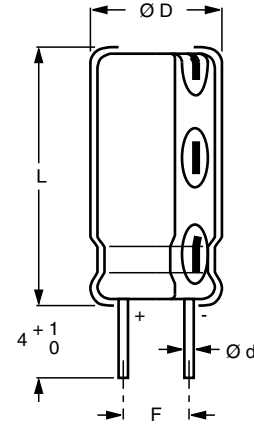


Fig. 3 - Form CB: Cut leads

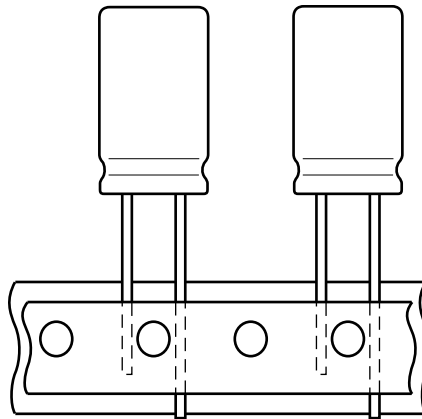


Fig. 4 - Form TFA: Taped in box (ammopack)

Table 1

| DIMENSIONS in millimeters, MASS, AND PACKAGING QUANTITIES |           |     |                     |                   |           |          |                      |         |          |
|---|-----------|-----|---------------------|-------------------|-----------|----------|----------------------|---------|----------|
| NOMINAL CASE SIZE<br>Ø D x L                              | CASE CODE | Ø d | Ø D <sub>max.</sub> | L <sub>max.</sub> | F         | MASS (g) | PACKAGING QUANTITIES |         |          |
|   |           |     |                     |                   |           |          | FORM CA              | FORM CB | FORM TFA |
| 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**

- For detailed tape dimensions please see [www.vishay.com/doc?28360](http://www.vishay.com/doc?28360)



| 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 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  $75\%$

**ORDERING EXAMPLE**

Electrolytic capacitor 140 series

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

Nominal case size:  $\varnothing 10\text{ mm} \times 16\text{ mm}$ ; form TFA

Ordering code: MAL214036221E3

Former 12NC: 2222 140 36221

**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) | $I_{L1}$<br>1 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>MAL2140 ..... |         |          |
|--------------|--------------------------------------|--|------------------------------------|--|-------------------------|---|---|--------------------------------|---------|----------|
|              |                                      |  |                                    |  |                         |   |   | BULK PACKAGING                 |         | TAPED    |
|              |                                      |  |                                    |  |                         |   |   | FORM CA                        | FORM CB | FORM TFA |
| 6.3          | 1200                                 | 10 x 16  | 760                                | 79                                     | 0.28                    | 0.150                                   | 1.10                                    | 53122E3                        | 63122E3 | 33122E3  |
|              | 2200                                 | 10 x 20  | 850                                | 142                                    | 0.28                    | 0.120                                   | 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  |
| 4700         | 16 x 31                              | 2200   | 473                                | 0.24                                   | 0.030                   | 0.20                                    | 54472E3                                 | 64472E3                        | 34472E3 |          |
| 16           | 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  |
| 4700         | 18 x 31                              | 2200   | 755                                | 0.18                                   | 0.030                   | 0.20                                    | 55472E3                                 | 65472E3                        | -       |          |
| 25           | 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                        | -       |          |
| 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 min at $U_R$   | $I_{L1} \leq 0.01 C_R \times U_R + 3 \mu\text{A}$  |
|                                    | After 5 min at $U_R$   | $I_{L5} \leq 0.002 C_R \times U_R + 3 \mu\text{A}$ |
| <b>Inductance</b>                  |  |  |
| Equivalent series inductance (ESL) | Case $\varnothing D = 10 \text{ mm}$                         | Typ. 16 nH   |
|                                    | Case $\varnothing D \geq 12.5 \text{ mm}$                    | Typ. 18 nH   |
| <b>Resistance</b>                  |  |  |
| Equivalent series resistance (ESR) | Calculated from $\tan \delta_{max.}$ and $C_R$ (see Table 2) | $ESR = \tan \delta / 2 \pi f C_R$                  |

### CAPACITANCE (C)

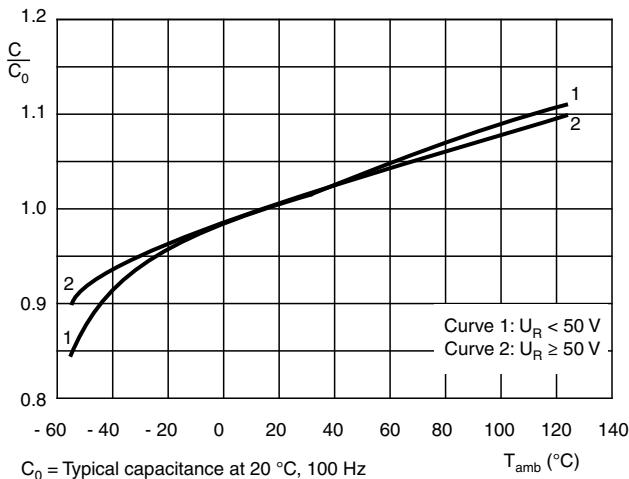


Fig. 5 - Typical multiplier of capacitance as a function of ambient temperature

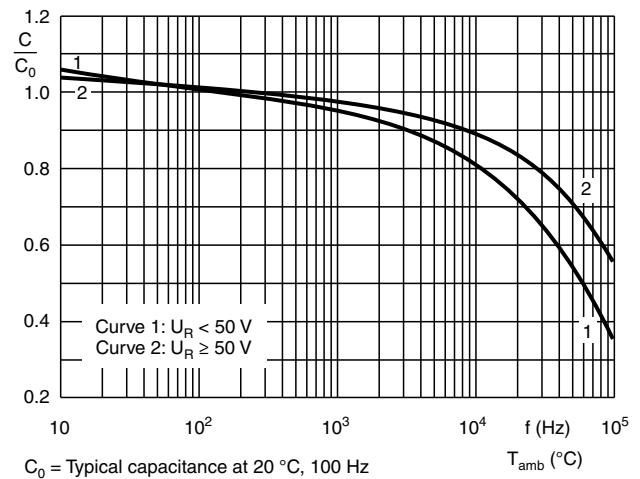


Fig. 6 - Typical multiplier of capacitance as a function of frequency

### EQUIVALENT SERIES RESISTANCE (ESR)

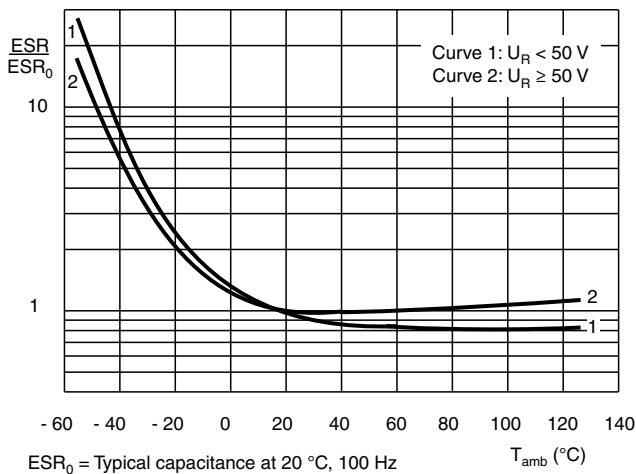


Fig. 7 - Typical multiplier of ESR as a function of ambient temperature

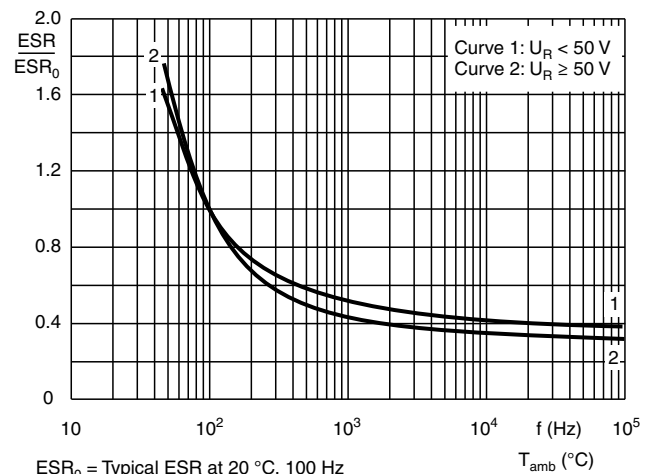


Fig. 8 - Typical multiplier of ESR as a function of frequency

**RIPPLE CURRENT AND USEFUL LIFE**

Table 2

| ENDURANCE AND USEFUL LIFE AS A FUNCTION OF CASE SIZE |           |                                    |                              |
|--|-----------|------------------------------------|------------------------------|
| NOMINAL CASE SIZE<br>Ø D x L<br>(mm)                 | CASE CODE | ENDURANCE TEST<br>AT 125 °C<br>(h) | USEFUL LIFE AT 125 °C<br>(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                         |

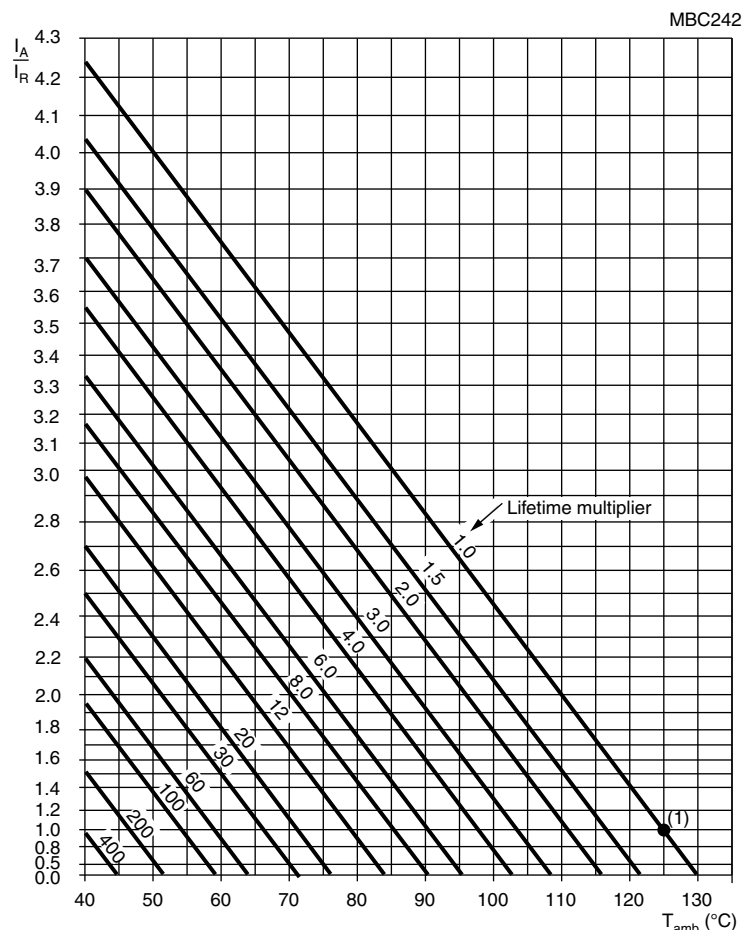


Fig. 9 - Multiplier of useful life as a function of ambient temperature and ripple current load

**Table 3**

| <b>MULTIPLIER OF RIPPLE CURRENT (<math>I_R</math>) AS A FUNCTION OF FREQUENCY</b> |  |  |  |
|---|--|--|--|
| <b>FREQUENCY (Hz)</b>   | <b><math>I_R</math> MULTIPLIER</b>                       |  |  |
|   | <b><math>U_R = 6.3 \text{ V TO } 25 \text{ V}</math></b> | <b><math>U_R = 35 \text{ V}</math></b> | <b><math>U_R = 50 \text{ V AND } 63 \text{ V}</math></b> |
| 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**

| <b>TEST PROCEDURES AND REQUIREMENTS</b> |   |   |  |
|---|---|---|--|
| <b>TEST</b>                             |   | <b>PROCEDURE (quick reference)</b>  | <b>REQUIREMENTS</b>  |
| <b>NAME OF TEST</b>                     | <b>REFERENCE</b>                            |   |  |
| Endurance                               | IEC 60384-4/<br>EN 130300<br>subclause 4.13 | $T_{amb} = 125 \text{ °C}$ ; $U_R$ applied;<br>2000 h   | $\Delta C/C: \pm 15 \%$<br>$\tan \delta \leq 1.3 \times \text{spec. limit}$<br>$Z \leq 2 \times \text{spec. limit}$<br>$I_{L5} \leq \text{spec. limit}$  |
| Useful life                             | CECC 30301<br>subclause 1.8.1               | $T_{amb} = 125 \text{ °C}$ ; $U_R$ 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>$I_{L5} \leq \text{spec. limit}$<br>no short or open circuit<br>total failure percentage: $\leq 1 \%$ |
| Shelf life                              | IEC 60384-4/<br>EN 130300<br>subclause 4.17 | $T_{amb} = 125 \text{ °C}$ ; no voltage applied;<br>500 h<br>After test: $U_R$ to be applied for 30 min,<br>24 h to 48 h before measurement | $\Delta C/C: \pm 15 \%$<br>$\tan \delta \leq 1.3 \times \text{spec. limit}$<br>$Z \leq 2 \times \text{spec. limit}$<br>$I_{L5} \leq 2 \times \text{spec. limit}$   |



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**Please note that some Vishay documentation may still make reference to RoHS Directive 2002/95/EC. We confirm that all the products identified as being compliant to Directive 2002/95/EC conform to Directive 2011/65/EU.**

**Vishay Intertechnology, Inc. hereby certifies that all its products that are identified as Halogen-Free follow Halogen-Free requirements as per JEDEC JS709A standards. Please note that some Vishay documentation may still make reference to the IEC 61249-2-21 definition. We confirm that all the products identified as being compliant to IEC 61249-2-21 conform to JEDEC JS709A standards.**



## Стандарт Электрон Связь

Мы молодая и активно развивающаяся компания в области поставок электронных компонентов. Мы поставляем электронные компоненты отечественного и импортного производства напрямую от производителей и с крупнейших складов мира.

Благодаря сотрудничеству с мировыми поставщиками мы осуществляем комплексные и плановые поставки широчайшего спектра электронных компонентов.

Собственная эффективная логистика и склад в обеспечивает надежную поставку продукции в точно указанные сроки по всей России.

Мы осуществляем техническую поддержку нашим клиентам и предпродажную проверку качества продукции. На все поставляемые продукты мы предоставляем гарантию .

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Минимальные сроки поставки, гибкие цены, неограниченный ассортимент и индивидуальный подход к клиентам являются основой для выстраивания долгосрочного и эффективного сотрудничества с предприятиями радиоэлектронной промышленности, предприятиями ВПК и научно-исследовательскими институтами России.

С нами вы становитесь еще успешнее!

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