

## Aluminum Electrolytic Capacitors SMD (Chip), High Temperature

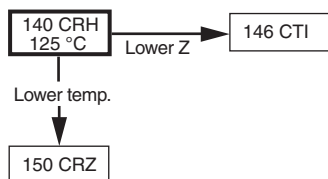


Fig. 1



### FEATURES

- Extended useful life: up to 6000 h at 125 °C for MAL214099...E3 parts
- Parts for advanced high temperature reflow soldering according to JEDEC® J-STD-020 available
- Vibration proof, 4-pin version and 6-pin version
- AEC-Q200 qualified
- Polarized aluminum electrolytic capacitors, non-solid electrolyte, self healing
- SMD-version with base plate, lead (Pb)-free reflow solderable
- Charge and discharge proof, no peak current limitation
- High reliability
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)

### APPLICATIONS

- SMD technology, for high temperature reflow soldering
- Industrial and professional applications
- Automotive, general industrial, telecom
- Smoothing, filtering, buffering

### MARKING

- Rated capacitance (in  $\mu\text{F}$ )
- Rated voltage (in V)
- Date code, in accordance with IEC 60062
- Black mark or “-” sign indicating the cathode (the anode is identified by beveled edges)
- Code indicating group number (H)

### PACKAGING

Supplied in blister tape on reel

| QUICK REFERENCE DATA                        |                                        |
|---------------------------------------------|----------------------------------------|
| DESCRIPTION                                 | VALUE                                  |
| Nominal case sizes<br>(L x W x H in mm)     | 8 x 8 x 10<br>to 18 x 18 x 21          |
| Rated capacitance range, $C_R$              | 10 $\mu\text{F}$ 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                    | 1000 h to 5000 h                       |
| Useful life at 125 °C                       | 1500 h to 6000 h                       |
| Useful life at 40 °C<br>1.8 x $I_R$ applied | 150 000 h to 500 000 h                 |
| Shelf life at 0 V, 125 °C                   | 1000 h                                 |
| Based on sectional specification            | IEC 60384-18 / CECC 32300              |
| Climatic category IEC 60068                 | 55 / 125 / 56                          |

**SELECTION CHART FOR  $C_R$ ,  $U_R$ , AND RELEVANT NOMINAL CASE SIZES (L x W x H in mm)**

| $C_R$<br>( $\mu F$ ) | $U_R$ (V)    |                  |                  |                  |                  |                  |                  |
|----------------------|--------------|------------------|------------------|------------------|------------------|------------------|------------------|
|                      | 6.3          | 10               | 16               | 25               | 35               | 50               | 63               |
| 10                   | →            | →                | →                | →                | →                | →                | 8 x 8 x 10       |
| 22                   | →            | →                | →                | →                | →                | →                | 8 x 8 x 10       |
| 33                   | →            | →                | →                | →                | →                | →                | 8 x 8 x 10       |
| 47                   | →            | →                | →                | →                | →                | 8 x 8 x 10       | 10 x 10 x 10     |
| 68                   | →            | →                | →                | →                | 8 x 8 x 10       | 10 x 10 x 10     | 10 x 10 x 14     |
| 100                  | →            | →                | →                | 8 x 8 x 10       | 10 x 10 x 10     | 10 x 10 x 14     | 12.5 x 12.5 x 13 |
| 150                  | →            | →                | 8 x 8 x 10       | →                | 10 x 10 x 14     | -                | -                |
| 220                  | →            | 8 x 8 x 10       | →                | 10 x 10 x 10     | 12.5 x 12.5 x 13 | 12.5 x 12.5 x 13 | 12.5 x 12.5 x 16 |
| 330                  | 8 x 8 x 10   | 10 x 10 x 10     | 10 x 10 x 14     | 12.5 x 12.5 x 13 | 12.5 x 12.5 x 13 | 12.5 x 12.5 x 16 | 16 x 16 x 16     |
|                      |              |                  |                  |                  |                  |                  | 16 x 16 x 21     |
|                      |              |                  |                  |                  |                  |                  | 18 x 18 x 16     |
| 470                  | 10 x 10 x 10 | 10 x 10 x 14     | 12.5 x 12.5 x 13 | 12.5 x 12.5 x 16 | 12.5 x 12.5 x 16 | 16 x 16 x 16     | 16 x 16 x 21     |
|                      |              |                  |                  |                  |                  |                  | 18 x 18 x 16     |
|                      |              |                  |                  |                  |                  |                  | 18 x 18 x 21     |
| 680                  | 10 x 10 x 14 | 12.5 x 12.5 x 13 | 12.5 x 12.5 x 16 | →                | 16 x 16 x 16     | 16 x 16 x 21     | 18 x 18 x 21     |
|                      |              |                  |                  |                  |                  | 18 x 18 x 16     |                  |
| 820                  | →            | →                | →                | →                | 16 x 16 x 21     | 18 x 18 x 16     | -                |
|                      |              |                  |                  |                  |                  | 18 x 18 x 21     | -                |
| 1000                 | →            | 12.5 x 12.5 x 16 | 16 x 16 x 16     | 16 x 16 x 16     | 18 x 18 x 16     | 18 x 18 x 21     | -                |
|                      |              |                  | 16 x 16 x 21     | 16 x 16 x 21     |                  |                  | -                |
| 1200                 | →            | →                | →                | →                | 18 x 18 x 21     | -                | -                |
| 1500                 | →            | →                | 16 x 16 x 16     | 16 x 16 x 21     | 18 x 18 x 21     | -                | -                |
|                      |              |                  | 18 x 18 x 16     | 18 x 18 x 16     | -                | -                | -                |
| 2200                 | →            | 16 x 16 x 16     | 16 x 16 x 21     | 18 x 18 x 21     | -                | -                | -                |
|                      |              |                  | 18 x 18 x 21     | -                | -                | -                | -                |
| 3300                 | →            | 16 x 16 x 21     | 18 x 18 x 21     | -                | -                | -                | -                |
|                      |              | 18 x 18 x 16     | -                | -                | -                | -                | -                |
| 4700                 | →            | 18 x 18 x 21     | -                | -                | -                | -                | -                |

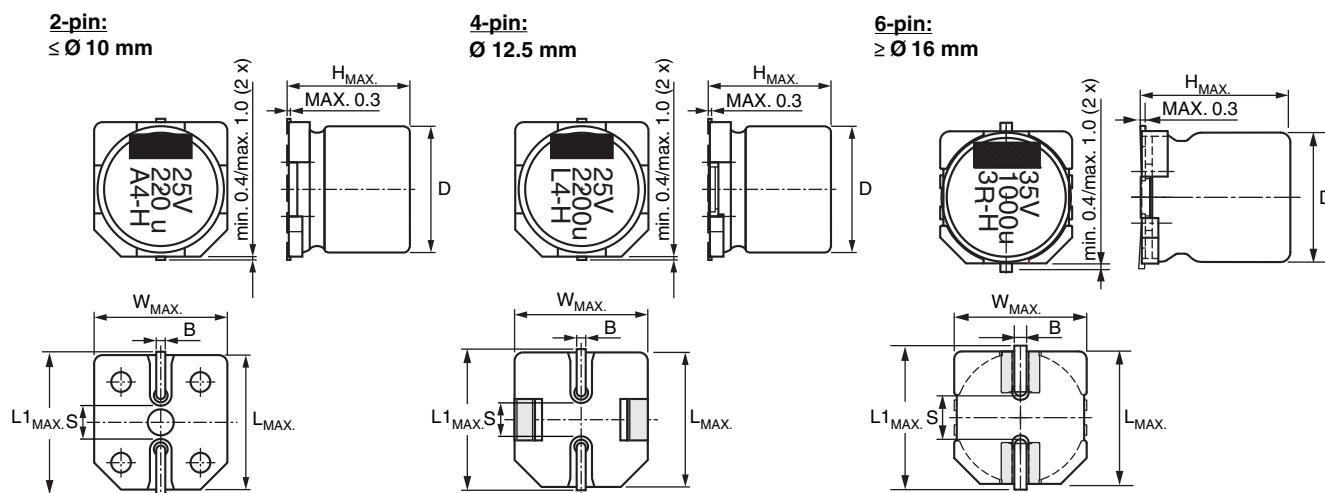


Fig. 2 - Dimensional outline



Table 1

| <b>DIMENSIONS</b> in millimeters <b>AND MASS</b> |              |                   |                   |                   |      |                   |     |                    |             |
|--------------------------------------------------|--------------|-------------------|-------------------|-------------------|------|-------------------|-----|--------------------|-------------|
| NOMINAL<br>CASE SIZE<br>L x W x H                | CASE<br>CODE | L <sub>MAX.</sub> | W <sub>MAX.</sub> | H <sub>MAX.</sub> | Ø D  | B <sub>MAX.</sub> | S   | L <sub>1MAX.</sub> | MASS<br>(g) |
| 8 x 8 x 10                                       | 0810         | 8.5               | 8.5               | 10.5              | 8.0  | 1.0               | 2.2 | 10.2               | ≈ 1.0       |
| 10 x 10 x 10                                     | 1010         | 10.5              | 10.5              | 10.5              | 10.0 | 1.0               | 3.5 | 12.1               | ≈ 1.3       |
| 10 x 10 x 14                                     | 1014         | 10.5              | 10.5              | 14.3              | 10.0 | 1.0               | 3.5 | 12.1               | ≈ 1.5       |
| 12.5 x 12.5 x 13                                 | 1213         | 12.9              | 12.9              | 14.0              | 12.5 | 1.3               | 3.6 | 14.9               | ≈ 2.6       |
| 12.5 x 12.5 x 16                                 | 1216         | 12.9              | 12.9              | 16.5              | 12.5 | 1.3               | 3.6 | 14.9               | ≈ 2.8       |
| 16 x 16 x 16                                     | 1616         | 16.6              | 16.6              | 17.5              | 16.0 | 1.3               | 6.5 | 18.6               | ≈ 5.5       |
| 16 x 16 x 21                                     | 1621         | 16.6              | 16.6              | 22.0              | 16.0 | 1.3               | 6.5 | 18.6               | ≈ 6.0       |
| 18 x 18 x 16                                     | 1816         | 19.0              | 19.0              | 17.5              | 18.0 | 1.3               | 6.5 | 21.0               | ≈ 8.0       |
| 18 x 18 x 21                                     | 1821         | 19.0              | 19.0              | 22.0              | 18.0 | 1.3               | 6.5 | 21.0               | ≈ 8.3       |

Table 2

| <b>TAPE AND REEL DIMENSIONS</b> in millimeters, <b>PACKAGING QUANTITIES</b> |              |                         |                 |                                     |               |                                   |
|-----------------------------------------------------------------------------|--------------|-------------------------|-----------------|-------------------------------------|---------------|-----------------------------------|
| NOMINAL<br>CASE SIZE<br>L x W x H                                           | CASE<br>CODE | PITCH<br>P <sub>1</sub> | TAPE WIDTH<br>W | TAPE<br>THICKNESS<br>T <sub>2</sub> | REEL DIAMETER | PACKAGING<br>QUANTITY<br>PER REEL |
| 8 x 8 x 10                                                                  | 0810         | 16                      | 24              | 11.6                                | 380           | 500                               |
| 10 x 10 x 10                                                                | 1010         | 16                      | 24              | 11.6                                | 380           | 500                               |
| 10 x 10 x 14                                                                | 1014         | 16                      | 24              | 15.4                                | 330           | 250                               |
| 12.5 x 12.5 x 13                                                            | 1213         | 20                      | 24              | 16.2                                | 380           | 250                               |
| 12.5 x 12.5 x 16                                                            | 1216         | 24                      | 32              | 18.5                                | 380           | 200                               |
| 16 x 16 x 16                                                                | 1616         | 28                      | 44              | 18.9                                | 380           | 150                               |
| 16 x 16 x 21                                                                | 1621         | 28                      | 44              | 23.4                                | 380           | 100                               |
| 18 x 18 x 16                                                                | 1816         | 32                      | 44              | 18.9                                | 380           | 125                               |
| 18 x 18 x 21                                                                | 1821         | 32                      | 44              | 23.4                                | 380           | 100                               |

**Note**

- For detailed tape dimensions please refer to packaging information: [www.vishay.com/doc?28359](http://www.vishay.com/doc?28359)

## MOUNTING

The capacitors are designed for automatic placement on to printed-circuit boards.

Optimum dimensions of soldering pads depend amongst others on soldering method, mounting accuracy, print layout and / or adjacent components.

For recommended soldering pad dimensions, refer to Fig. 3 and Table 3.

## SOLDERING

Soldering conditions are defined by the curve, temperature versus time, where the temperature is that measured on the component during processing.

For maximum conditions refer to Fig. 4 or Fig. 5.

Any temperature versus time curve which does not exceed the specified maximum curves may be applied.

As a general principle, temperature and duration shall be the **minimum** necessary required to ensure good soldering connections. However, the specified maximum curves should never be exceeded.

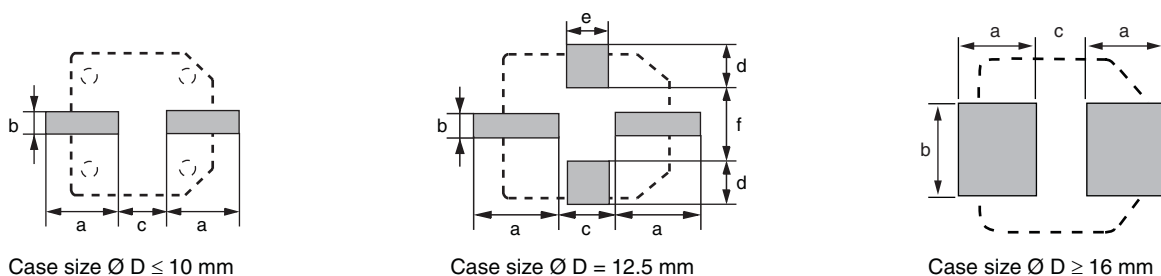


Fig. 3 - Recommended soldering pad dimensions

Table 3

| RECOMMENDED SOLDERING PAD DIMENSIONS in millimeters |     |     |     |     |     |     |
|-----------------------------------------------------|-----|-----|-----|-----|-----|-----|
| CASE CODE                                           | a   | b   | c   | d   | e   | f   |
| 0810                                                | 4.4 | 2.5 | 3.0 | -   | -   | -   |
| 1010                                                | 4.4 | 2.5 | 4.0 | -   | -   | -   |
| 1014                                                | 4.4 | 2.5 | 4.0 | -   | -   | -   |
| 1213                                                | 6.3 | 2.5 | 4.0 | 4.2 | 5.0 | 5.6 |
| 1216                                                | 6.3 | 2.5 | 4.0 | 4.2 | 5.0 | 5.6 |
| 1616                                                | 7.8 | 9.6 | 4.7 | -   | -   | -   |
| 1621                                                | 7.8 | 9.6 | 4.7 | -   | -   | -   |
| 1816                                                | 8.8 | 9.6 | 4.7 | -   | -   | -   |
| 1821                                                | 8.8 | 9.6 | 4.7 | -   | -   | -   |

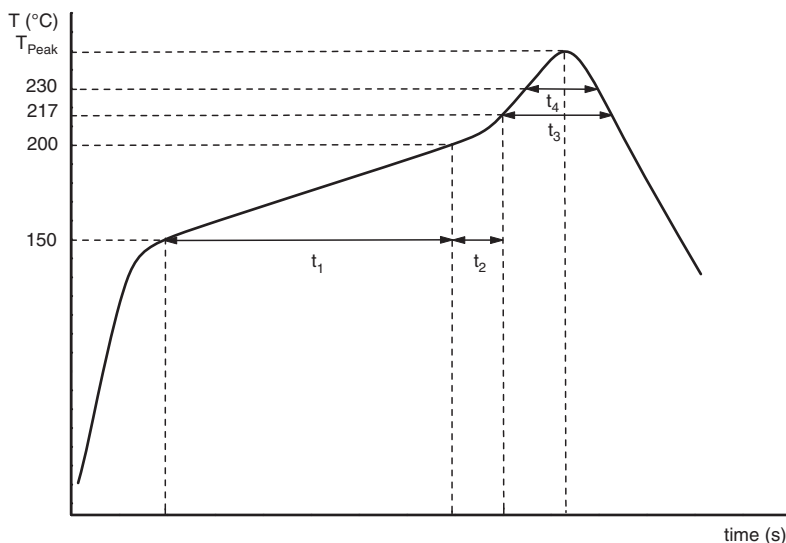
**STANDARD SOLDERING PROFILE FOR LEAD (Pb)-FREE REFLOW PROCESS**


Fig. 4 - Maximum temperature load during reflow soldering

**Table 4**

| <b>REFLOW SOLDERING CONDITIONS</b> for MAL214097xxxE3 |                                   |                                   |
|-------------------------------------------------------|-----------------------------------|-----------------------------------|
| <b>PROFILE FEATURES</b>                               | <b>CASE CODE<br/>0810 TO 1014</b> | <b>CASE CODE<br/>1213 TO 1216</b> |
| Max. time from 25 °C to $T_{Peak}$                    | 240 s                             | 200 s                             |
| Max. ramp-up rate to 150 °C                           | 3 K/s                             | 3 K/s                             |
| Max. time from 150 °C to 200 °C ( $t_1$ )             | 150 s                             | 120 s                             |
| Ramp up rate from 200 °C to $T_{Peak}$                | 0.5 K/s to 3 K/s                  | 0.5 K/s to 3 K/s                  |
| Max. time from 200 °C to 217 °C ( $t_2$ )             | 60 s                              | 60 s                              |
| Max. time above $T_{Liquidus}$ (217 °C) ( $t_3$ )     | 90 s                              | 60 s                              |
| Max. time above 230 °C ( $t_4$ )                      | 40 s                              | 30 s                              |
| Peak temperature $T_{Peak}$                           | 250 °C                            | 240 °C                            |
| Max. time above $T_{Peak}$ minus 5 °C                 | 5 s                               | 10 s                              |
| Max. ramp-down rate from $T_{Liquidus}$               | 3 K/s to 6 K/s                    | 3 K/s to 6 K/s                    |

**Notes**

- Temperature measuring point on top of the case and on terminals
- Max. 2 runs with pause of min. 30 min in between

# **ADVANCED SOLDERING PROFILE FOR LEAD (Pb)-FREE REFLOW PROCESS ACCORDING TO JEDEC J-STD-020**

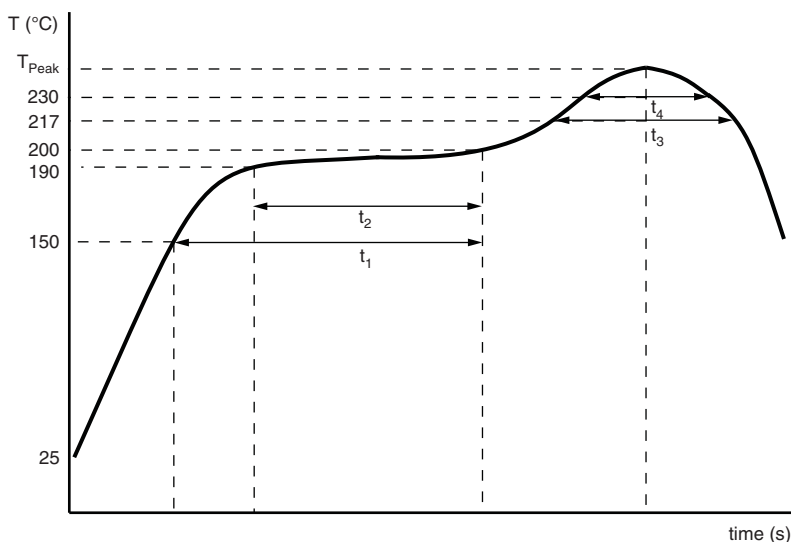


Fig. 5 - Maximum temperature load during reflow soldering

Table 5

| <b>REFLOW SOLDERING CONDITIONS for MAL214099xxxE3</b> |                           |                                   |                                   |
|-------------------------------------------------------|---------------------------|-----------------------------------|-----------------------------------|
| <b>PROFILE FEATURES</b>                               | <b>CASE CODE<br/>1010</b> | <b>CASE CODE<br/>1213 TO 1216</b> | <b>CASE CODE<br/>1616 TO 1821</b> |
| Max. time from 25 °C to $T_{Peak}$                    | 300 s                     | 300 s                             | 300 s                             |
| Max. ramp-up rate to 150 °C                           | 3 K/s                     | 3 K/s                             | 3 K/s                             |
| Max. time from 150 °C to 200 °C ( $t_1$ )             | 150 s                     | 150 s                             | 150 s                             |
| Max. time from 190 °C to 200 °C ( $t_2$ )             | 110 s                     | 110 s                             | 110 s                             |
| Ramp up rate from 200 °C to $T_{Peak}$                | 0.5 K/s to 3 K/s          | 0.5 K/s to 3 K/s                  | 0.5 K/s to 3 K/s                  |
| Max. time above $T_{Liquidus}$ (217 °C) ( $t_3$ )     | 90 s                      | 90 s                              | 90 s                              |
| Max. time above 230 °C ( $t_4$ )                      | 70 s                      | 65 s                              | 60 s                              |
| Peak temperature $T_{Peak}$                           | 260 °C                    | 250 °C                            | 245 °C                            |
| Max. time above $T_{Peak}$ minus 5 °C                 | 40 s                      | 30 s                              | 30 s                              |
| Ramp-down rate from $T_{Liquidus}$                    | 3 K/s to 6 K/s            | 3 K/s to 6 K/s                    | 3 K/s to 6 K/s                    |

## **Notes**

- Temperature measuring point on top of the case and on terminals
- Max. 2 runs with pause of min. 30 min in between



| ELECTRICAL DATA |                                                   |
|-----------------|---------------------------------------------------|
| SYMBOL          | DESCRIPTION                                       |
| $C_R$           | Rated capacitance at 100 Hz, tolerance $\pm 20\%$ |
| $I_R$           | Rated RMS ripple current at 100 kHz, 125 °C       |
| $I_{L2}$        | Max. leakage current after 2 min at $U_R$         |
| $\tan \delta$   | Max. dissipation factor at 100 Hz                 |
| Z               | Max. impedance at 100 kHz                         |

**Note**

- Unless otherwise specified, all electrical values in Table 6 apply at  $T_{amb} = 20\text{ °C}$ ,  $P = 86\text{ kPa}$  to  $106\text{ kPa}$ ,  $RH = 45\%$  to  $75\%$

Table 6

| ELECTRICAL DATA AND ORDERING INFORMATION |                            |                                           |                                    |                                        |                         |                                       |                             |                                               |                                               |
|------------------------------------------|----------------------------|-------------------------------------------|------------------------------------|----------------------------------------|-------------------------|---------------------------------------|-----------------------------|-----------------------------------------------|-----------------------------------------------|
| $U_R$<br>(V)                             | $C_R$<br>( $\mu\text{F}$ ) | NOMINAL<br>CASE SIZE<br>L x W x H<br>(mm) | $I_R$<br>100 kHz<br>125 °C<br>(mA) | $I_{L2}$<br>2 min<br>( $\mu\text{A}$ ) | $\tan \delta$<br>100 Hz | Z<br>100 kHz<br>20 °C<br>( $\Omega$ ) | LIFE<br>CODE <sup>(3)</sup> | ORDERING<br>CODE <sup>(1)</sup><br>MAL2140... | ORDERING<br>CODE <sup>(2)</sup><br>MAL2140... |
| 6.3                                      | 330                        | 8 x 8 x 10                                | 180                                | 21                                     | 0.30                    | 0.40                                  | L1                          | 97303E3                                       | -                                             |
|                                          | 470                        | 10 x 10 x 10                              | 300                                | 30                                     | 0.30                    | 0.25                                  | L1                          | 97301E3                                       | -                                             |
|                                          | 470                        | 10 x 10 x 10                              | 300                                | 30                                     | 0.30                    | 0.25                                  | L1                          | -                                             | 99301E3                                       |
|                                          | 680                        | 10 x 10 x 14                              | 430                                | 43                                     | 0.30                    | 0.20                                  | L1                          | 97302E3                                       | -                                             |
| 10                                       | 220                        | 8 x 8 x 10                                | 180                                | 22                                     | 0.26                    | 0.40                                  | L1                          | 97403E3                                       | -                                             |
|                                          | 330                        | 10 x 10 x 10                              | 300                                | 33                                     | 0.26                    | 0.25                                  | L1                          | 97401E3                                       | -                                             |
|                                          | 330                        | 10 x 10 x 10                              | 300                                | 33                                     | 0.26                    | 0.25                                  | L1                          | -                                             | 99401E3                                       |
|                                          | 470                        | 10 x 10 x 14                              | 430                                | 47                                     | 0.26                    | 0.20                                  | L1                          | 97402E3                                       | -                                             |
|                                          | 680                        | 12.5 x 12.5 x 13                          | 750                                | 68                                     | 0.22                    | 0.12                                  | L2                          | 97411E3                                       | -                                             |
|                                          | 680                        | 12.5 x 12.5 x 13                          | 750                                | 68                                     | 0.22                    | 0.12                                  | L3                          | -                                             | 99411E3                                       |
|                                          | 1000                       | 12.5 x 12.5 x 16                          | 900                                | 100                                    | 0.22                    | 0.09                                  | L2                          | 97412E3                                       | -                                             |
|                                          | 1000                       | 12.5 x 12.5 x 16                          | 900                                | 100                                    | 0.22                    | 0.09                                  | L4                          | -                                             | 99412E3                                       |
|                                          | 2200                       | 16 x 16 x 16                              | 1000                               | 220                                    | 0.24                    | 0.08                                  | L5                          | -                                             | 99413E3                                       |
|                                          | 3300                       | 16 x 16 x 21                              | 1200                               | 330                                    | 0.24                    | 0.06                                  | L5                          | -                                             | 99414E3                                       |
|                                          | 3300                       | 18 x 18 x 16                              | 1200                               | 330                                    | 0.26                    | 0.08                                  | L5                          | -                                             | 99415E3                                       |
| 16                                       | 4700                       | 18 x 18 x 21                              | 1550                               | 470                                    | 0.28                    | 0.06                                  | L5                          | -                                             | 99416E3                                       |
|                                          | 150                        | 8 x 8 x 10                                | 180                                | 24                                     | 0.22                    | 0.40                                  | L1                          | 97502E3                                       | -                                             |
|                                          | 330                        | 10 x 10 x 14                              | 430                                | 53                                     | 0.22                    | 0.20                                  | L1                          | 97501E3                                       | -                                             |
|                                          | 470                        | 12.5 x 12.5 x 13                          | 750                                | 75                                     | 0.18                    | 0.12                                  | L2                          | 97511E3                                       | -                                             |
|                                          | 470                        | 12.5 x 12.5 x 13                          | 750                                | 75                                     | 0.18                    | 0.12                                  | L3                          | -                                             | 99511E3                                       |
|                                          | 680                        | 12.5 x 12.5 x 16                          | 900                                | 108                                    | 0.18                    | 0.09                                  | L2                          | 97512E3                                       | -                                             |
|                                          | 680                        | 12.5 x 12.5 x 16                          | 900                                | 108                                    | 0.18                    | 0.09                                  | L4                          | -                                             | 99512E3                                       |
|                                          | 1000                       | 16 x 16 x 16                              | 1100                               | 160                                    | 0.18                    | 0.08                                  | L5                          | -                                             | 99513E3                                       |
|                                          | 1000                       | 16 x 16 x 21                              | 1200                               | 160                                    | 0.18                    | 0.06                                  | L5                          | -                                             | 99514E3                                       |
|                                          | 1500                       | 16 x 16 x 16                              | 1100                               | 240                                    | 0.18                    | 0.08                                  | L5                          | -                                             | 99515E3                                       |
|                                          | 1500                       | 18 x 18 x 16                              | 1200                               | 240                                    | 0.18                    | 0.08                                  | L5                          | -                                             | 99516E3                                       |
|                                          | 2200                       | 16 x 16 x 21                              | 1200                               | 352                                    | 0.20                    | 0.06                                  | L5                          | -                                             | 99517E3                                       |
|                                          | 2200                       | 18 x 18 x 21                              | 1550                               | 352                                    | 0.20                    | 0.06                                  | L5                          | -                                             | 99518E3                                       |
| 25                                       | 3300                       | 18 x 18 x 21                              | 1550                               | 528                                    | 0.22                    | 0.06                                  | L5                          | -                                             | 99519E3                                       |
|                                          | 100                        | 8 x 8 x 10                                | 180                                | 25                                     | 0.18                    | 0.40                                  | L1                          | 97602E3                                       | -                                             |
|                                          | 220                        | 10 x 10 x 10                              | 300                                | 55                                     | 0.18                    | 0.25                                  | L1                          | 97601E3                                       | -                                             |
|                                          | 220                        | 10 x 10 x 10                              | 300                                | 55                                     | 0.18                    | 0.25                                  | L1                          | -                                             | 99601E3                                       |
|                                          | 330                        | 12.5 x 12.5 x 13                          | 750                                | 82                                     | 0.16                    | 0.12                                  | L2                          | 97611E3                                       | -                                             |
|                                          | 330                        | 12.5 x 12.5 x 13                          | 750                                | 82                                     | 0.16                    | 0.12                                  | L3                          | -                                             | 99611E3                                       |
|                                          | 470                        | 12.5 x 12.5 x 16                          | 900                                | 117                                    | 0.16                    | 0.09                                  | L2                          | 97612E3                                       | -                                             |
|                                          | 470                        | 12.5 x 12.5 x 16                          | 900                                | 117                                    | 0.16                    | 0.09                                  | L4                          | -                                             | 99612E3                                       |
|                                          | 1000                       | 16 x 16 x 16                              | 1100                               | 250                                    | 0.16                    | 0.08                                  | L5                          | -                                             | 99613E3                                       |
|                                          | 1000                       | 16 x 16 x 21                              | 1200                               | 250                                    | 0.16                    | 0.06                                  | L5                          | -                                             | 99614E3                                       |
|                                          | 1500                       | 16 x 16 x 21                              | 1200                               | 375                                    | 0.16                    | 0.06                                  | L5                          | -                                             | 99615E3                                       |
|                                          | 1500                       | 18 x 18 x 16                              | 1200                               | 375                                    | 0.16                    | 0.08                                  | L5                          | -                                             | 99616E3                                       |
|                                          | 2200                       | 18 x 18 x 21                              | 1550                               | 550                                    | 0.18                    | 0.06                                  | L5                          | -                                             | 99617E3                                       |

**Notes**

- (1) Standard reflow soldering profile, see Fig. 4 and Table 4
- (2) Advanced reflow soldering profile, according to JEDEC J-STD-020, see Fig. 5 and Table 5
- (3) Determines the applicable row in the table "Endurance Test Duration and Useful Life"

**ELECTRICAL DATA AND ORDERING INFORMATION**

| $U_R$<br>(V) | $C_R$<br>( $\mu$ F) | NOMINAL<br>CASE SIZE<br>L x W x H<br>(mm) | $I_R$<br>100 kHz<br>125 °C<br>(mA) | $I_{L2}$<br>2 min<br>( $\mu$ A) | $\tan \delta$<br>100 Hz | Z<br>100 kHz<br>20 °C<br>( $\Omega$ ) | LIFE<br>CODE <sup>(3)</sup> | ORDERING<br>CODE <sup>(1)</sup><br>MAL2140... | ORDERING<br>CODE <sup>(2)</sup><br>MAL2140... |
|--------------|---------------------|-------------------------------------------|------------------------------------|---------------------------------|-------------------------|---------------------------------------|-----------------------------|-----------------------------------------------|-----------------------------------------------|
| 35           | 68                  | 8 x 8 x 10                                | 180                                | 24                              | 0.14                    | 0.40                                  | L1                          | 97003E3                                       | -                                             |
|              | 100                 | 10 x 10 x 10                              | 255                                | 35                              | 0.14                    | 0.25                                  | L1                          | 97001E3                                       | -                                             |
|              | 100                 | 10 x 10 x 10                              | 255                                | 35                              | 0.14                    | 0.25                                  | L1                          | -                                             | 99001E3                                       |
|              | 150                 | 10 x 10 x 14                              | 317                                | 53                              | 0.14                    | 0.20                                  | L1                          | 97002E3                                       | -                                             |
|              | 220                 | 12.5 x 12.5 x 13                          | 750                                | 77                              | 0.14                    | 0.12                                  | L2                          | 97011E3                                       | -                                             |
|              | 220                 | 12.5 x 12.5 x 13                          | 750                                | 77                              | 0.14                    | 0.12                                  | L3                          | -                                             | 99011E3                                       |
|              | 330                 | 12.5 x 12.5 x 13                          | 750                                | 115                             | 0.14                    | 0.12                                  | L2                          | 97012E3                                       | -                                             |
|              | 330                 | 12.5 x 12.5 x 13                          | 750                                | 115                             | 0.14                    | 0.12                                  | L3                          | -                                             | 99012E3                                       |
|              | 470                 | 12.5 x 12.5 x 16                          | 900                                | 164                             | 0.14                    | 0.09                                  | L2                          | 97013E3                                       | -                                             |
|              | 470                 | 12.5 x 12.5 x 16                          | 900                                | 164                             | 0.14                    | 0.09                                  | L4                          | -                                             | 99013E3                                       |
|              | 680                 | 16 x 16 x 16                              | 1100                               | 238                             | 0.14                    | 0.08                                  | L5                          | -                                             | 99014E3                                       |
|              | 820                 | 16 x 16 x 21                              | 1200                               | 287                             | 0.14                    | 0.06                                  | L5                          | -                                             | 99015E3                                       |
|              | 1000                | 18 x 18 x 16                              | 1200                               | 350                             | 0.14                    | 0.08                                  | L5                          | -                                             | 99016E3                                       |
|              | 1200                | 18 x 18 x 21                              | 1550                               | 420                             | 0.14                    | 0.06                                  | L5                          | -                                             | 99017E3                                       |
|              | 1500                | 18 x 18 x 21                              | 1550                               | 525                             | 0.14                    | 0.06                                  | L5                          | -                                             | 99018E3                                       |
| 50           | 47                  | 8 x 8 x 10                                | 145                                | 24                              | 0.14                    | 0.70                                  | L1                          | 97103E3                                       | -                                             |
|              | 68                  | 10 x 10 x 10                              | 205                                | 34                              | 0.14                    | 0.50                                  | L1                          | 97101E3                                       | -                                             |
|              | 68                  | 10 x 10 x 10                              | 205                                | 34                              | 0.14                    | 0.50                                  | L1                          | -                                             | 99101E3                                       |
|              | 100                 | 10 x 10 x 14                              | 255                                | 50                              | 0.14                    | 0.40                                  | L1                          | 97102E3                                       | -                                             |
|              | 220                 | 12.5 x 12.5 x 13                          | 750                                | 110                             | 0.12                    | 0.23                                  | L2                          | 97111E3                                       | -                                             |
|              | 220                 | 12.5 x 12.5 x 13                          | 750                                | 110                             | 0.12                    | 0.23                                  | L3                          | -                                             | 99111E3                                       |
|              | 330                 | 12.5 x 12.5 x 16                          | 900                                | 165                             | 0.12                    | 0.18                                  | L2                          | 97112E3                                       | -                                             |
|              | 330                 | 12.5 x 12.5 x 16                          | 900                                | 165                             | 0.12                    | 0.18                                  | L4                          | -                                             | 99112E3                                       |
|              | 470                 | 16 x 16 x 16                              | 900                                | 235                             | 0.12                    | 0.15                                  | L5                          | -                                             | 99113E3                                       |
|              | 680                 | 16 x 16 x 21                              | 1000                               | 340                             | 0.12                    | 0.13                                  | L5                          | -                                             | 99114E3                                       |
|              | 680                 | 18 x 18 x 16                              | 1000                               | 340                             | 0.12                    | 0.15                                  | L5                          | -                                             | 99115E3                                       |
|              | 820                 | 18 x 18 x 16                              | 1000                               | 410                             | 0.12                    | 0.15                                  | L5                          | -                                             | 99116E3                                       |
|              | 820                 | 18 x 18 x 21                              | 1050                               | 410                             | 0.12                    | 0.13                                  | L5                          | -                                             | 99117E3                                       |
|              | 1000                | 18 x 18 x 21                              | 1050                               | 500                             | 0.12                    | 0.13                                  | L5                          | -                                             | 99118E3                                       |
| 63           | 10                  | 8 x 8 x 10                                | 145                                | 6.3                             | 0.12                    | 0.70                                  | L1                          | 97805E3                                       | -                                             |
|              | 22                  | 8 x 8 x 10                                | 145                                | 14                              | 0.12                    | 0.70                                  | L1                          | 97803E3                                       | -                                             |
|              | 33                  | 8 x 8 x 10                                | 145                                | 21                              | 0.12                    | 0.70                                  | L1                          | 97804E3                                       | -                                             |
|              | 47                  | 10 x 10 x 10                              | 205                                | 30                              | 0.12                    | 0.50                                  | L1                          | 97801E3                                       | -                                             |
|              | 47                  | 10 x 10 x 10                              | 205                                | 30                              | 0.12                    | 0.50                                  | L1                          | -                                             | 99801E3                                       |
|              | 68                  | 10 x 10 x 14                              | 255                                | 43                              | 0.12                    | 0.40                                  | L1                          | 97802E3                                       | -                                             |
|              | 100                 | 12.5 x 12.5 x 13                          | 500                                | 63                              | 0.10                    | 0.25                                  | L2                          | 97811E3                                       | -                                             |
|              | 100                 | 12.5 x 12.5 x 13                          | 500                                | 63                              | 0.10                    | 0.25                                  | L3                          | -                                             | 99811E3                                       |
|              | 220                 | 12.5 x 12.5 x 16                          | 600                                | 138                             | 0.10                    | 0.20                                  | L2                          | 97812E3                                       | -                                             |
|              | 220                 | 12.5 x 12.5 x 16                          | 600                                | 138                             | 0.10                    | 0.20                                  | L4                          | -                                             | 99812E3                                       |
|              | 330                 | 16 x 16 x 16                              | 700                                | 208                             | 0.10                    | 0.18                                  | L5                          | -                                             | 99813E3                                       |
|              | 330                 | 16 x 16 x 21                              | 750                                | 208                             | 0.10                    | 0.15                                  | L5                          | -                                             | 99814E3                                       |
|              | 330                 | 18 x 18 x 16                              | 750                                | 208                             | 0.10                    | 0.18                                  | L5                          | -                                             | 99815E3                                       |
|              | 470                 | 16 x 16 x 21                              | 750                                | 296                             | 0.10                    | 0.15                                  | L5                          | -                                             | 99816E3                                       |
|              | 470                 | 18 x 18 x 16                              | 750                                | 296                             | 0.10                    | 0.18                                  | L5                          | -                                             | 99817E3                                       |
|              | 470                 | 18 x 18 x 21                              | 900                                | 296                             | 0.10                    | 0.15                                  | L5                          | -                                             | 99818E3                                       |
|              | 680                 | 18 x 18 x 21                              | 900                                | 428                             | 0.10                    | 0.15                                  | L5                          | -                                             | 99819E3                                       |

**Notes**

(1) Standard reflow soldering profile, see Fig. 4 and Table 4

(2) Advanced reflow soldering profile, according to JEDEC J-STD-020, see Fig. 5 and Table 5

(3) Determines the applicable row in the table "Endurance Test Duration and Useful Life"

Table 7

| ADDITIONAL ELECTRICAL DATA                   |                                                              |                                          |
|----------------------------------------------|--------------------------------------------------------------|------------------------------------------|
| PARAMETER                                    | CONDITIONS                                                   | VALUE                                    |
| <b>Voltage</b>                               |                                                              |                                          |
| Surge voltage for short periods              | IEC 60384-18, subclause 4.14                                 | $U_s \leq 1.15 \times U_R$               |
| Reverse voltage for short periods            | IEC 60384-18, subclause 4.16                                 | $U_{rev} \leq 1 \text{ V}$               |
| <b>Current</b>                               |                                                              |                                          |
| Leakage current                              | After 2 min at $U_R$                                         | $I_{L2} \leq 0.01 \times C_R \times U_R$ |
| <b>Inductance</b>                            |                                                              |                                          |
| Equivalent series inductance (ESL)           | $\varnothing D = 8 \text{ mm}$                               | Typ. 6 nH                                |
|                                              | $\varnothing D = 10 \text{ mm}$                              | Typ. 8 nH                                |
|                                              | $\varnothing D \geq 12.5 \text{ mm}$                         | Typ. 11 nH                               |
| <b>Resistance</b>                            |                                                              |                                          |
| Equivalent series resistance (ESR) at 100 Hz | Calculated from $\tan \delta_{max.}$ and $C_R$ (see Table 6) | $ESR = \tan \delta / 2\pi f C_R$         |

## CAPACITANCE (C)

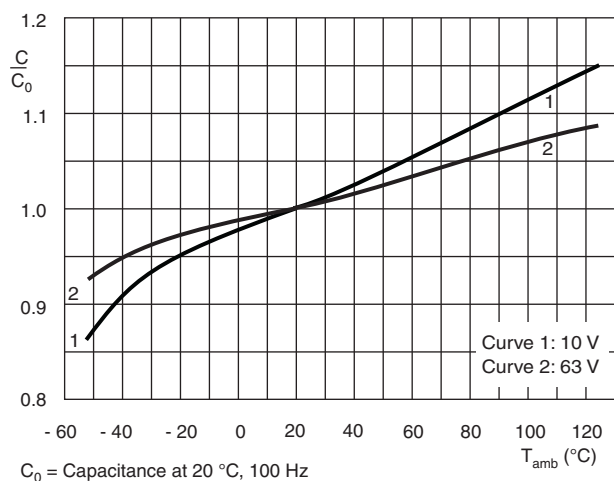
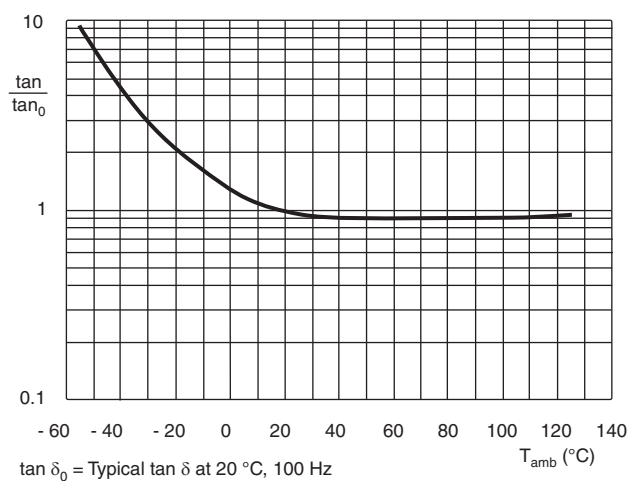


Fig. 6 - Typical multiplier of capacitance as a function of ambient temperature

## DISSIPATION FACTOR ( $\tan \delta$ )


Fig. 7 - Typical multiplier of dissipation factor ( $\tan \delta$ ) as a function of ambient temperature

## EQUIVALENT SERIES RESISTANCE (ESR)

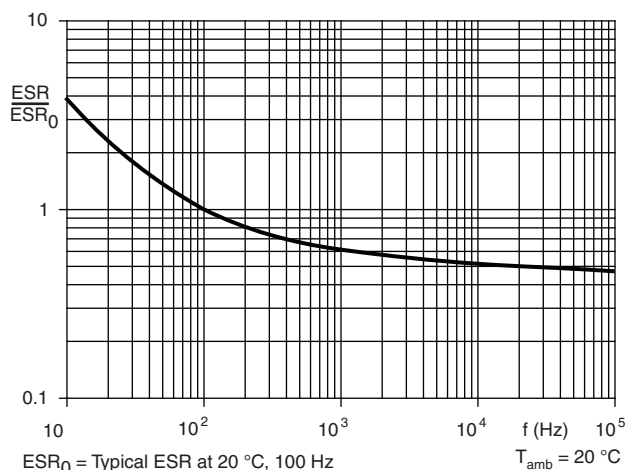


Fig. 8 - Typical multiplier of ESR as a function of frequency

## IMPEDANCE (Z)

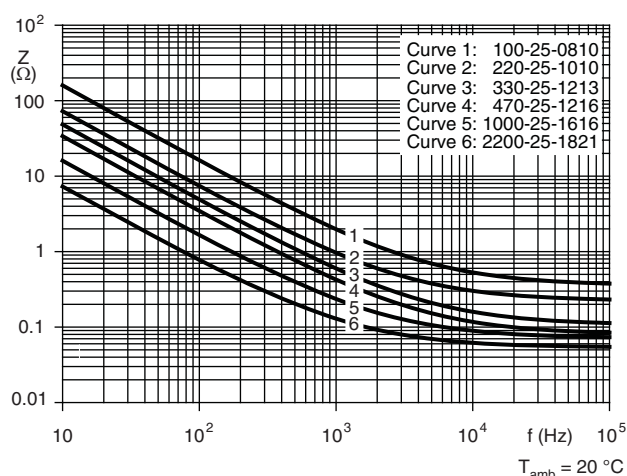


Fig. 9 - Typical impedance as a function of frequency

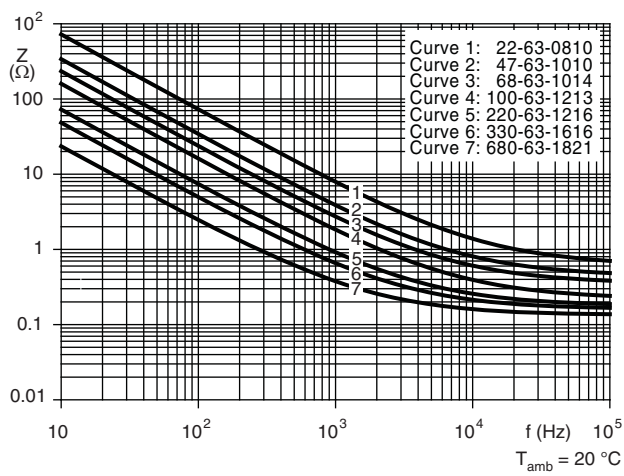


Fig. 10 - Typical impedance as a function of frequency

## RIPPLE CURRENT AND USEFUL LIFE

Table 8

| ENDURANCE TEST DURATION AND USEFUL LIFE |                         |                           |                                                      |
|-----------------------------------------|-------------------------|---------------------------|------------------------------------------------------|
| LIFE CODE                               | ENDURANCE AT 125 °C (h) | USEFUL LIFE AT 125 °C (h) | USEFUL LIFE AT 40°C 1.8 x I <sub>R</sub> APPLIED (h) |
| L1                                      | 1000                    | 1500                      | 150 000                                              |
| L2                                      | 2000                    | 3000                      | 300 000                                              |
| L3                                      | 3000                    | 3500                      | 350 000                                              |
| L4                                      | 4000                    | 5000                      | 400 000                                              |
| L5                                      | 5000                    | 6000                      | 500 000                                              |

### Note

- Multiplier of useful life code: MBC242

MBC242

$I_A$  = Actual ripple current at 100 kHz  
 $I_R$  = Rated ripple current at 100 kHz, 125 °C  
<sup>(1)</sup> Useful life at 125 °C and  $I_R$  applied; see Table 8

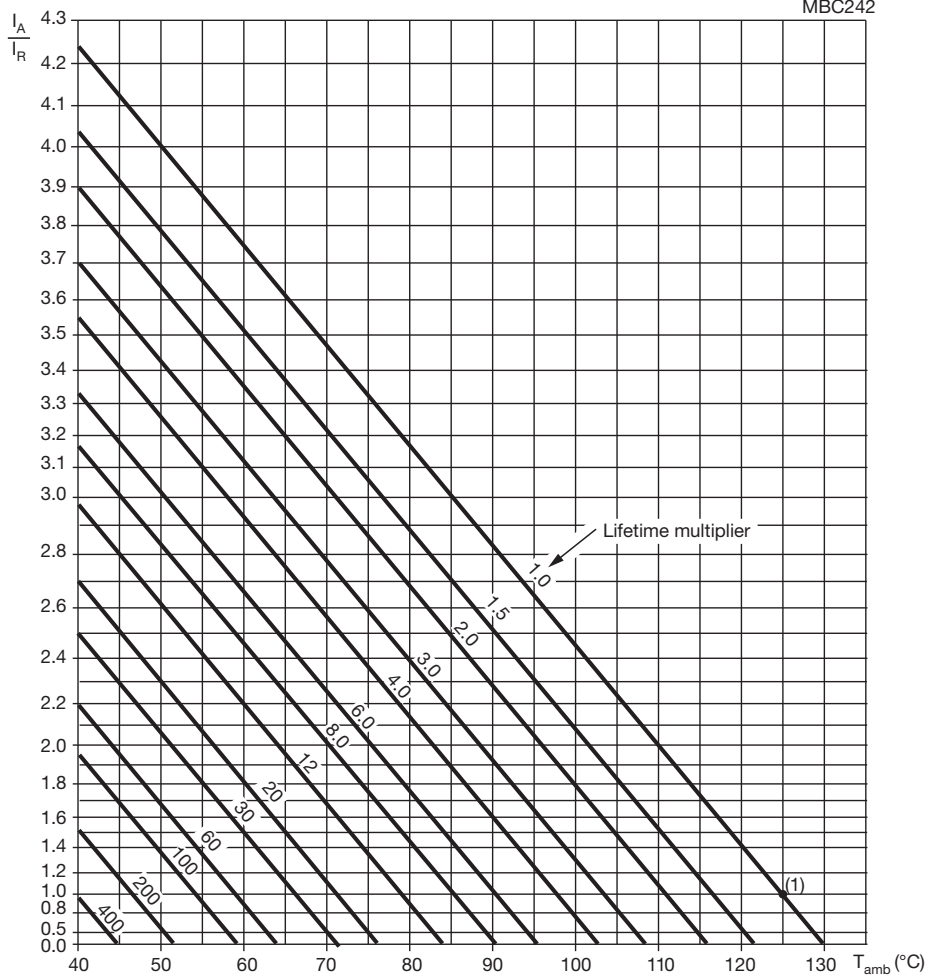


Fig. 11 - Multiplier of useful life as a function of ambient temperature and ripple current load

Table 9

| MULTIPLIER OF RIPPLE CURRENT ( $I_R$ ) AS A FUNCTION OF FREQUENCY |                  |      |      |      |      |        |        |         |
|-------------------------------------------------------------------|------------------|------|------|------|------|--------|--------|---------|
| $U_R$<br>(V)                                                      | FREQUENCY (Hz)   |      |      |      |      |        |        |         |
|                                                                   | 50               | 100  | 300  | 1000 | 3000 | 10 000 | 30 000 | 100 000 |
|                                                                   | $I_R$ MULTIPLIER |      |      |      |      |        |        |         |
| 6.3                                                               | 0.60             | 0.70 | 0.80 | 0.85 | 0.90 | 0.95   | 0.97   | 1.00    |
| 10                                                                | 0.60             | 0.70 | 0.80 | 0.85 | 0.90 | 0.95   | 0.97   | 1.00    |
| 16                                                                | 0.60             | 0.70 | 0.80 | 0.85 | 0.90 | 0.95   | 0.97   | 1.00    |
| 25                                                                | 0.60             | 0.70 | 0.80 | 0.85 | 0.90 | 0.95   | 0.97   | 1.00    |
| 35                                                                | 0.45             | 0.60 | 0.75 | 0.85 | 0.90 | 0.95   | 0.97   | 1.00    |
| 50                                                                | 0.45             | 0.60 | 0.75 | 0.85 | 0.90 | 0.95   | 0.97   | 1.00    |
| 63                                                                | 0.40             | 0.55 | 0.70 | 0.85 | 0.90 | 0.95   | 0.97   | 1.00    |



Table 10

| TEST PROCEDURES AND REQUIREMENTS               |                                                 |                                                                                                                                                                   |                                                                                                                                                                                            |
|------------------------------------------------|-------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TEST                                           |                                                 | PROCEDURE<br>(quick reference)                                                                                                                                    | REQUIREMENTS                                                                                                                                                                               |
| NAME OF TEST                                   | REFERENCE                                       |                                                                                                                                                                   |                                                                                                                                                                                            |
| Mounting                                       | IEC 60384-18,<br>subclause 4.3                  | Shall be performed prior to tests mentioned below;<br>reflow soldering;<br>for maximum temperature load refer to chapter "Mounting"                               | $\Delta C/C: \pm 5 \%$<br>$\tan \delta \leq \text{spec. limit}$<br>$I_{L2} \leq \text{spec. limit}$                                                                                        |
| Endurance                                      | IEC 60384-18 /<br>CECC 32300,<br>subclause 4.15 | $T_{\text{amb}} = 125 \text{ }^{\circ}\text{C}$ ; $U_R$ applied;<br>for test duration see Table 8                                                                 | $U_R = 6.3 \text{ V}$ ; $\Delta C/C: \pm 25 \%$<br>$U_R \geq 10 \text{ V}$ ; $\Delta C/C: \pm 20 \%$<br>$\tan \delta \leq 2 \times \text{spec. limit}$<br>$I_{L2} \leq \text{spec. limit}$ |
| Useful life                                    | CECC 30301,<br>subclause 1.8.1                  | $T_{\text{amb}} = 125 \text{ }^{\circ}\text{C}$ ; $U_R$ and $I_R$ applied;<br>for test duration see Table 8                                                       | $\Delta C/C: \pm 30 \%$<br>$\tan \delta \leq 3 \times \text{spec. limit}$<br>$I_{L2} \leq \text{spec. limit}$<br>no short or open circuit<br>total failure percentage: $\leq 1 \%$         |
| Shelf life<br>(storage at high<br>temperature) | IEC 60384-18 /<br>CECC 32300,<br>subclause 4.17 | $T_{\text{amb}} = 125 \text{ }^{\circ}\text{C}$ ; no voltage applied;<br>1000 h<br>after test: $U_R$ to be applied for 30 min,<br>24 h to 48 h before measurement | For requirements<br>see "Endurance test" above                                                                                                                                             |
| Reverse voltage                                | IEC 60384-18 /<br>CECC 32300,<br>subclause 4.16 | $T_{\text{amb}} = 125 \text{ }^{\circ}\text{C}$ :<br>125 h at $U = -0.5 \text{ V}$ ,<br>followed by 125 h at $U_R$                                                | $\Delta C/C: \pm 15 \%$<br>$\tan \delta \leq 1.5 \times \text{spec. limit}$<br>$I_{L2} \leq \text{spec. limit}$                                                                            |

Statements about product lifetime are based on calculations and internal testing. They should only be interpreted as estimations. Also due to external factors, the lifetime in the field application may deviate from the calculated lifetime. In general, nothing stated herein shall be construed as a guarantee of durability.



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