

# Aluminum Electrolytic Capacitors

## Radial, Enhanced High Temperature, Low Impedance, High Vibration Capability

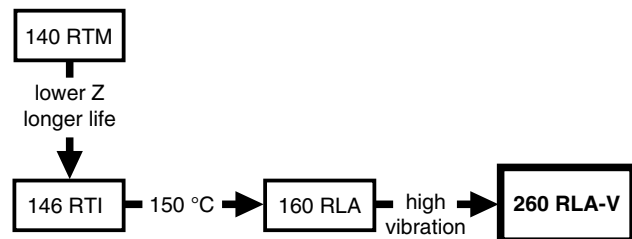
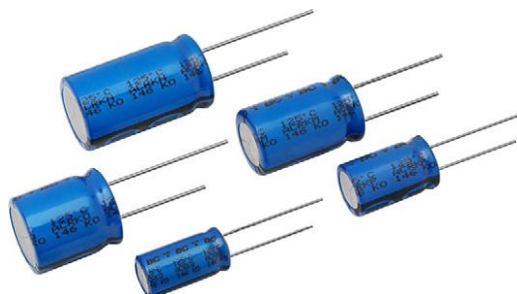


Fig. 1

| QUICK REFERENCE DATA                               |                         |
|----------------------------------------------------|-------------------------|
| DESCRIPTION                                        | VALUE                   |
| Nominal case sizes (Ø D x L in mm)                 | 16 x 25 to 18 x 35      |
| Rated capacitance range, C <sub>R</sub>            | 470 µF to 3300 µF       |
| Tolerance on C <sub>R</sub>                        | ± 20 %                  |
| Rated voltage range, U <sub>R</sub>                | 16 V to 50 V            |
| Category temperature range                         | -55 °C to +150 °C       |
| Endurance test at 150 °C                           | 1500 h                  |
| Useful life at 150 °C                              | 2000 h                  |
| Useful life at 40 °C, 1.8 x I <sub>R</sub> applied | 200 000 h               |
| Shelf life at 0 V, 150 °C                          | 1000 h                  |
| Based on sectional specification                   | IEC 60384-4 / EN 130300 |
| Climatic category IEC 60068                        | 55 / 150 / 56           |

### FEATURES

- Useful life: up to 2000 h at 150 °C
- High stability, high reliability
- Very low ESR
- AEC-Q200 qualified
- Excellent ripple current capability
- High vibration resistance up to 50 g
- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case, insulated with a blue PET sleeve
- Charge and discharge proof
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)

AUTOMOTIVE  
GRADE

**RoHS**  
COMPLIANT

### APPLICATIONS

- Power supplies (SMPS, DC/DC converters) for industrial, automotive, telecommunications and military
- Smoothing, filtering and buffering

### MARKING

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

- Rated capacitance (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for ± 20 %)
- Rated voltage (in V)
- Date code, in accordance with IEC 60062
- Code indicating factory of origin
- Logo of manufacturer
- Upper category temperature (150 °C)
- Negative terminal identification
- Series number (260)

| SELECTION CHART FOR C <sub>R</sub> , U <sub>R</sub> , AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm) |                    |         |         |         |
|-------------------------------------------------------------------------------------------------------|--------------------|---------|---------|---------|
| C <sub>R</sub><br>(µF)                                                                                | U <sub>R</sub> (V) |         |         |         |
|                                                                                                       | 16                 | 25      | 35      | 50      |
| 470                                                                                                   | →                  | 16 x 25 | 18 x 20 | -       |
| 680                                                                                                   | →                  | →       | 16 x 31 | 16 x 25 |
| 1000                                                                                                  | 16 x 25            | 16 x 31 | 18 x 35 | 18 x 31 |
| 1500                                                                                                  | 18 x 20            | 18 x 31 | -       | -       |
| 2200                                                                                                  | 18 x 25            | -       | -       | -       |
| 2700                                                                                                  | 18 x 31            | -       | -       | -       |
| 3300                                                                                                  | 18 x 35            | -       | -       | -       |

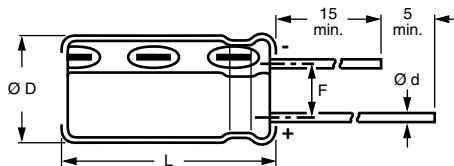
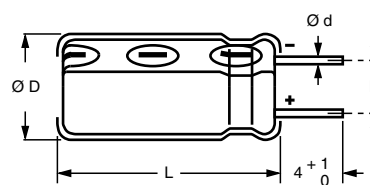
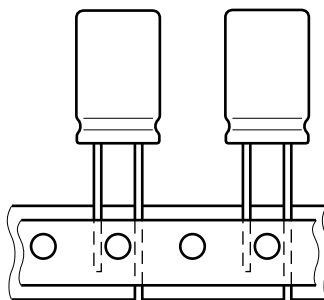
**DIMENSIONS** in millimeters **AND AVAILABLE FORMS**

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

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

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

Table 1

| <b>DIMENSIONS</b> in millimeters, <b>MASS AND PACKAGING QUANTITIES</b> |              |     |                     |                   |           |             |                      |            |             |
|------------------------------------------------------------------------|--------------|-----|---------------------|-------------------|-----------|-------------|----------------------|------------|-------------|
| NOMINAL<br>CASE SIZE<br>Ø D x L                                        | CASE<br>CODE | Ø d | Ø D <sub>max.</sub> | L <sub>max.</sub> | F         | MASS<br>(g) | PACKAGING QUANTITIES |            |             |
|                                                                        |              |     |                     |                   |           |             | FORM<br>CA           | FORM<br>CB | FORM<br>TFA |
| 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 20                                                                | 1820         | 0.8 | 18.5                | 22.0              | 7.5 ± 0.5 | ≈ 8.0       | 100                  | 100        | 250         |
| 18 x 25                                                                | 1825         | 0.8 | 18.5                | 27.0              | 7.5 ± 0.5 | ≈ 10.0      | 100                  | 100        | 250         |
| 18 x 31                                                                | 1831         | 0.8 | 18.5                | 33.5              | 7.5 ± 0.5 | ≈ 12.5      | 100                  | 100        | 250         |
| 18 x 35                                                                | 22           | 0.8 | 18.5                | 37.5              | 7.5 ± 0.5 | ≈ 14.5      | 100                  | 100        | -           |

| <b>ELECTRICAL DATA</b> |                                                       |
|------------------------|-------------------------------------------------------|
| SYMBOL                 | DESCRIPTION                                           |
| C <sub>R</sub>         | Rated capacitance at 100 Hz, tolerance ± 20 %         |
| I <sub>R</sub>         | Rated RMS ripple current at 100 kHz, 150 °C           |
| I <sub>L2</sub>        | Maximum leakage current after 2 min at U <sub>R</sub> |
| tan δ                  | Maximum dissipation factor at 100 Hz                  |
| Z                      | Maximum impedance at 100 kHz                          |

**Note**

- Unless otherwise specified, all electrical values in Table 2 apply at T<sub>amb</sub> = 20 °C, P = 86 kPa to 106 kPa, RH = 45 % to 75 %

**ORDERING EXAMPLE**

Electrolytic capacitor 260 RLA-V series

470 µF / 25 V; ± 20 %

Nominal case size: Ø 16 mm x 25 mm; Form TFA

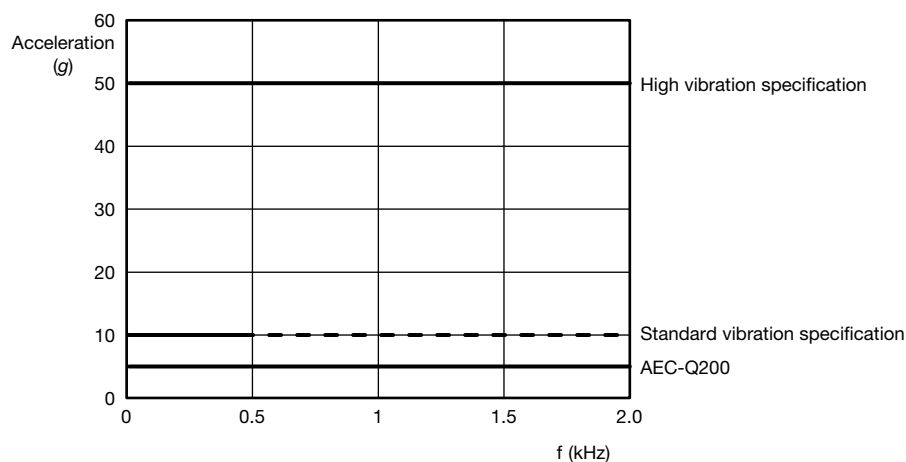
Ordering code: MAL226036471E3

**Table 2**

| ELECTRICAL DATA AND ORDERING INFORMATION |                                  |                                         |                                             |                                  |                 |                               |                               |                               |         |          |
|------------------------------------------|----------------------------------|-----------------------------------------|---------------------------------------------|----------------------------------|-----------------|-------------------------------|-------------------------------|-------------------------------|---------|----------|
| U <sub>R</sub><br>(V)                    | C <sub>R</sub><br>100 Hz<br>(μF) | NOMINAL<br>CASE SIZE<br>Ø D x L<br>(mm) | I <sub>R</sub><br>100 kHz<br>150 °C<br>(mA) | I <sub>L2</sub><br>2 min<br>(μA) | tan δ<br>100 Hz | Z<br>100 kHz<br>+20 °C<br>(Ω) | Z<br>100 kHz<br>-40 °C<br>(Ω) | ORDERING CODE<br>MAL2260..... |         |          |
|                                          |                                  |                                         |                                             |                                  |                 |                               |                               | BULK PACKAGING                |         | TAPED    |
|                                          |                                  |                                         |                                             |                                  |                 |                               |                               | FORM CA                       | FORM CB | FORM TFA |
| 16                                       | 1000                             | 16 x 25                                 | 800                                         | 163                              | 0.16            | 0.029                         | 0.174                         | 55102E3                       | 65102E3 | 35102E3  |
|                                          | 1500                             | 18 x 20                                 | 750                                         | 243                              | 0.16            | 0.035                         | 0.210                         | 55152E3                       | 65152E3 | 35152E3  |
|                                          | 2200                             | 18 x 25                                 | 1200                                        | 355                              | 0.18            | 0.028                         | 0.168                         | 55222E3                       | 65222E3 | 35222E3  |
|                                          | 2700                             | 18 x 31                                 | 1600                                        | 435                              | 0.18            | 0.025                         | 0.150                         | 55272E3                       | 65272E3 | 35272E3  |
|                                          | 3300                             | 18 x 35                                 | 2000                                        | 531                              | 0.20            | 0.023                         | 0.132                         | 55332E3                       | 65332E3 | -        |
| 25                                       | 470                              | 16 x 25                                 | 800                                         | 121                              | 0.12            | 0.029                         | 0.174                         | 56471E3                       | 66471E3 | 36471E3  |
|                                          | 1000                             | 16 x 31                                 | 1000                                        | 253                              | 0.12            | 0.027                         | 0.162                         | 56102E3                       | 66102E3 | 36102E3  |
|                                          | 1500                             | 18 x 31                                 | 1600                                        | 378                              | 0.14            | 0.025                         | 0.150                         | 56152E3                       | 66152E3 | 36152E3  |
| 35                                       | 470                              | 18 x 20                                 | 750                                         | 168                              | 0.10            | 0.035                         | 0.210                         | 50471E3                       | 60471E3 | 30471E3  |
|                                          | 680                              | 16 x 31                                 | 1000                                        | 241                              | 0.10            | 0.027                         | 0.162                         | 50681E3                       | 60681E3 | 30681E3  |
|                                          | 1000                             | 18 x 35                                 | 1200                                        | 353                              | 0.10            | 0.024                         | 0.144                         | 50102E3                       | 60102E3 | -        |
| 50                                       | 680                              | 16 x 25                                 | 700                                         | 343                              | 0.10            | 0.069                         | 0.414                         | 51681E3                       | 61681E3 | 31681E3  |
|                                          | 1000                             | 18 x 31                                 | 1000                                        | 503                              | 0.10            | 0.062                         | 0.372                         | 51102E3                       | 61102E3 | 31102E3  |

**Table 3**

| <b>EXTENDED VIBRATION SPECIFICATIONS</b> |                                                                                                                                       |                                                                                                                                      |
|------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| PARAMETER                                | PROCEDURE                                                                                                                             | REQUIREMENTS                                                                                                                         |
| Vibration specifications                 | From 10 g to 50 g                                                                                                                     | No visible damage;<br>no leakage of electrolyte;<br>marking legible<br>$\Delta C/C: \pm 5\%$ with respect to initial<br>measurements |
| Vibration frequency range                | 10 Hz to 2 kHz                                                                                                                        |                                                                                                                                      |
| Vibration profile                        | <ul style="list-style-type: none"> <li>Constant sinus sweep (1 oct./min.)</li> <li>3 directions</li> <li>8 h per direction</li> </ul> |                                                                                                                                      |


**Fig. 5 - Vibration profile**

**Table 4**

| ADDITIONAL ELECTRICAL DATA         |                                                              |                                             |
|------------------------------------|--------------------------------------------------------------|---------------------------------------------|
| PARAMETER                          | CONDITIONS                                                   | VALUE                                       |
| <b>Voltage</b>                     |                                                              |                                             |
| Surge voltage                      |                                                              | $U_s \leq 1.15 \times U_R$                  |
| Reverse voltage                    |                                                              | $U_{rev} \leq 0.5 V$                        |
| <b>Current</b>                     |                                                              |                                             |
| Leakage current                    | After 2 min at $U_R$                                         | $I_{L2} \leq 0.01 C_R \times U_R + 3 \mu A$ |
| <b>Inductance</b>                  |                                                              |                                             |
| Equivalent series inductance (ESL) | Case $\varnothing D \geq 16 mm$                              | 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)

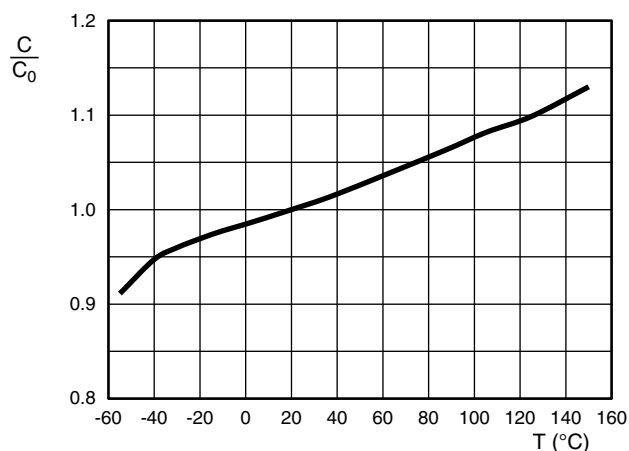


Fig. 6 - Typical multiplier of capacitance at 100 Hz as a function of temperature ( $C_0 = C$  at 20 °C)

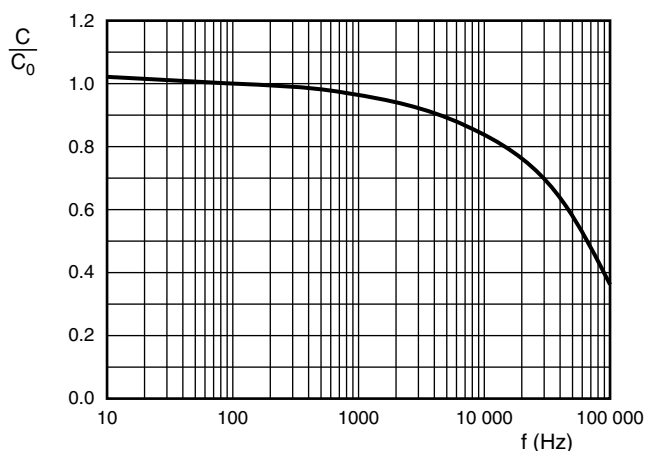


Fig. 7 - Typical multiplier of capacitance as a function of frequency at 20 °C ( $C_0 = C$  at 100 Hz)

### EQUIVALENT SERIES RESISTANCE (ESR)

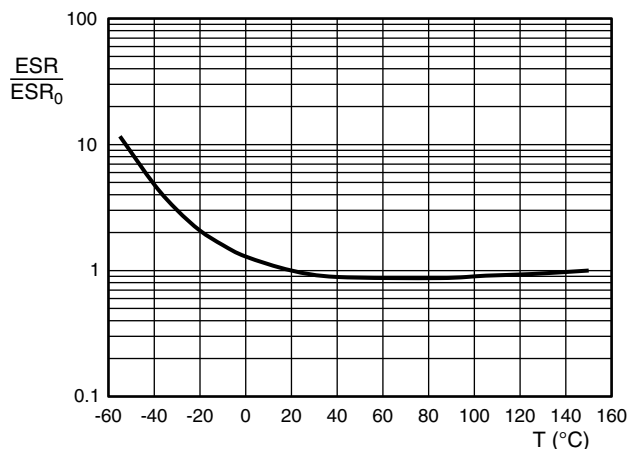


Fig. 8 - Typical multiplier of ESR at 100 Hz as a function of temperature ( $ESR_0 = ESR$  at 20 °C)

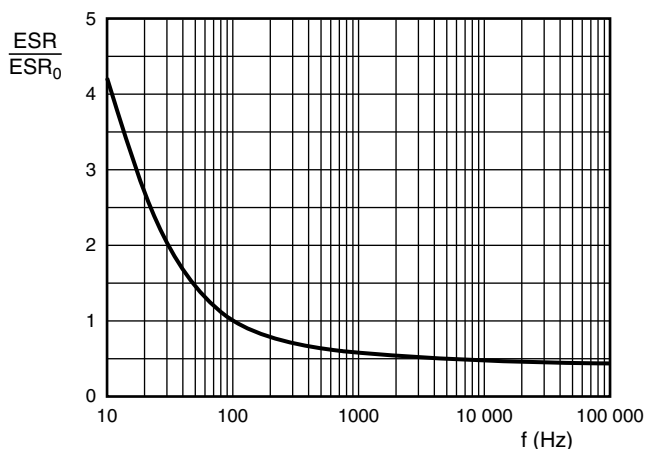


Fig. 9 - Typical multiplier of ESR at 20 °C as a function of frequency ( $ESR_0 = ESR$  at 100 Hz)

## IMPEDANCE (Z)

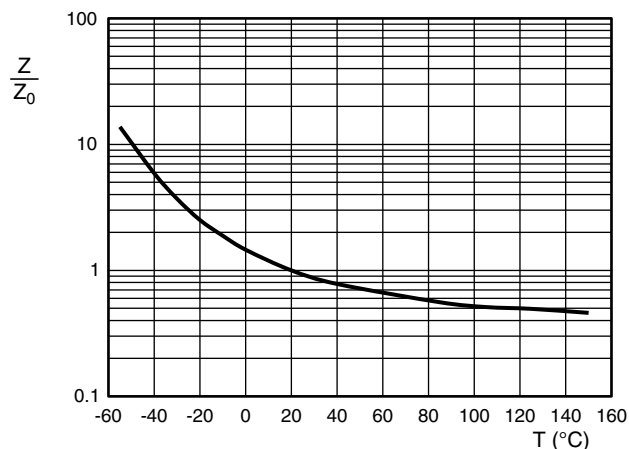


Fig. 10 - Typical multiplier of impedance at 100 kHz as a function of temperature ( $Z_0 = Z$  at 20 °C)

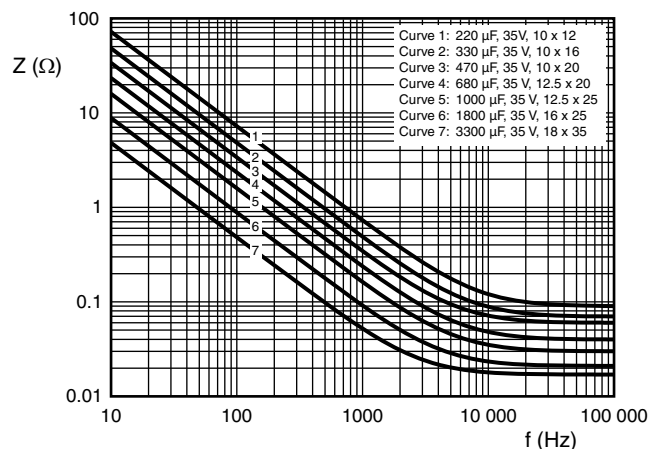


Fig. 11 - Typical impedance  $Z$  at 20 °C as a function of frequency

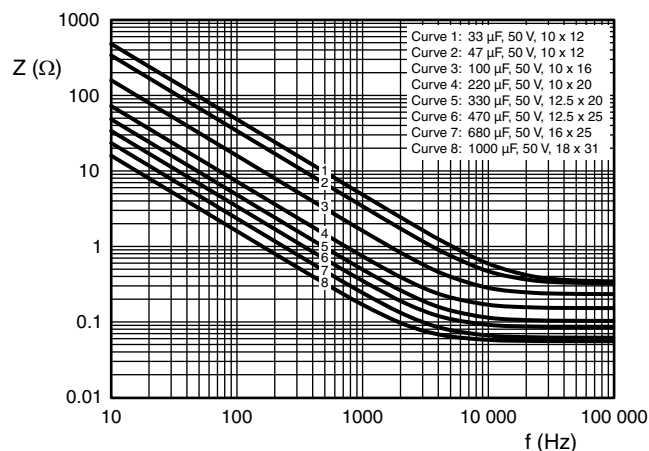


Fig. 12 - Typical impedance  $Z$  at 20 °C as a function of frequency

## RIPPLE CURRENT AND USEFUL LIFE

Table 5

| ENDURANCE TEST DURATION AND USEFUL LIFE AS A FUNCTION OF CASE SIZE |           |                               |                                 |
|--------------------------------------------------------------------|-----------|-------------------------------|---------------------------------|
| NOMINAL CASE SIZE<br>$\varnothing D \times L$<br>(mm)              | CASE CODE | ENDURANCE<br>AT 150 °C<br>(h) | USEFUL LIFE<br>AT 150 °C<br>(h) |
| 16 x 25                                                            | 19        | 1500                          | 2000                            |
| 16 x 31                                                            | 20        | 1500                          | 2000                            |
| 18 x 20                                                            | 1820      | 1500                          | 2000                            |
| 18 x 25                                                            | 1825      | 1500                          | 2000                            |
| 18 x 31                                                            | 1831      | 1500                          | 2000                            |
| 18 x 35                                                            | 22        | 1500                          | 2000                            |

### Note

- Multiplier of useful life code: MBC245

MBC245

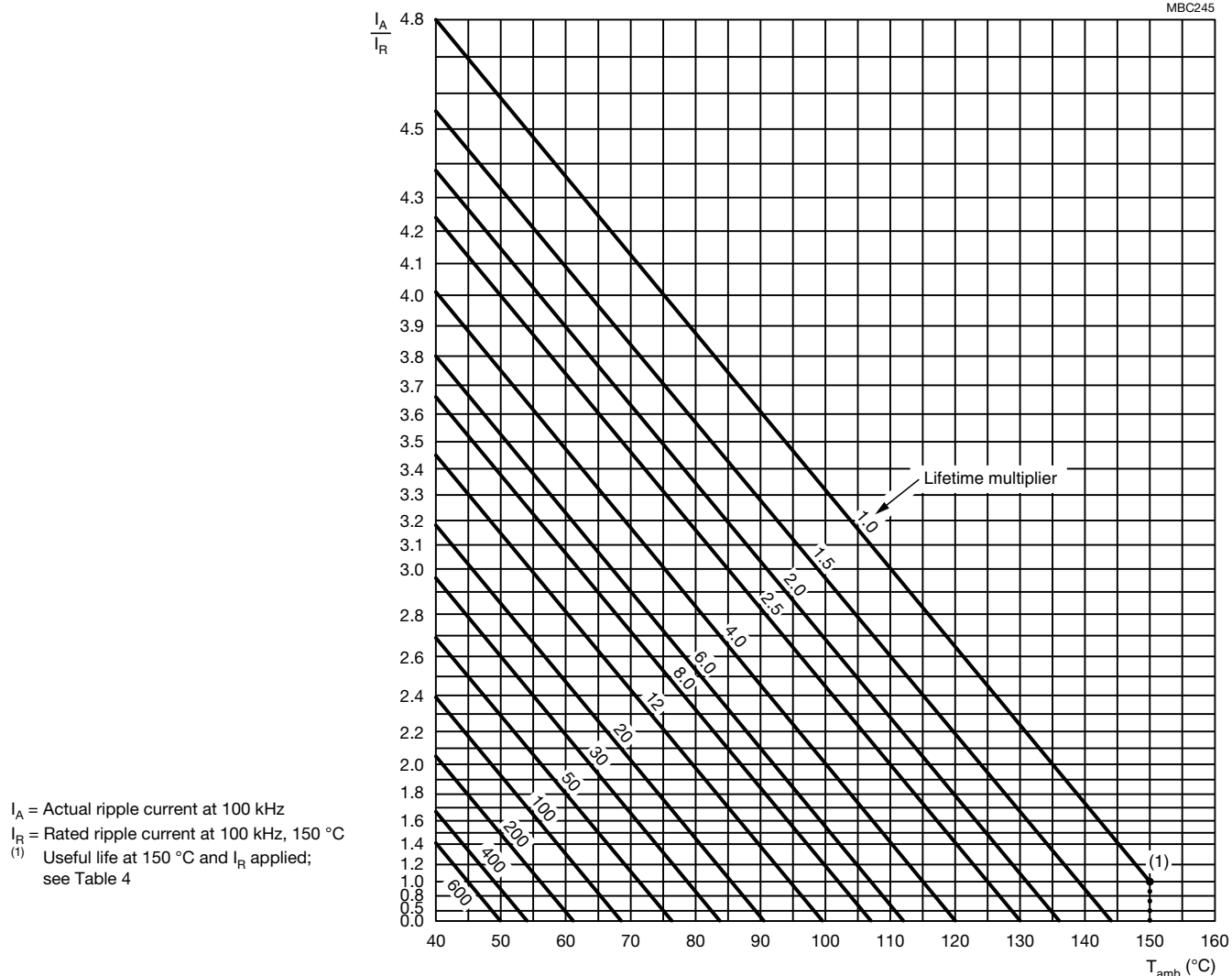


Fig. 13 - Multiplier of useful life as a function of ambient temperature and ripple current load

Table 6

| MULTIPLIER OF RIPPLE CURRENT ( $I_R$ ) AS A FUNCTION OF FREQUENCY |                  |      |      |      |      |        |         |
|-------------------------------------------------------------------|------------------|------|------|------|------|--------|---------|
| $U_R$<br>(V)                                                      | FREQUENCY (Hz)   |      |      |      |      |        |         |
|                                                                   | 50               | 100  | 300  | 1000 | 3000 | 10 000 | 100 000 |
|                                                                   | $I_R$ MULTIPLIER |      |      |      |      |        |         |
| 16                                                                | 0.60             | 0.70 | 0.85 | 0.90 | 0.95 | 1.00   | 1.00    |
| 25                                                                | 0.60             | 0.70 | 0.85 | 0.90 | 0.95 | 1.00   | 1.00    |
| 35                                                                | 0.50             | 0.65 | 0.80 | 0.85 | 0.90 | 0.95   | 1.00    |
| 50                                                                | 0.35             | 0.50 | 0.65 | 0.80 | 0.90 | 0.90   | 1.00    |



Table 7

| TEST PROCEDURES AND REQUIREMENTS |                                              |                                                                                                                                                          |                                                                                                                                                                                  |
|----------------------------------|----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TEST                             |                                              | PROCEDURE<br>(quick reference)                                                                                                                           | REQUIREMENTS                                                                                                                                                                     |
| NAME OF TEST                     | REFERENCE                                    |                                                                                                                                                          |                                                                                                                                                                                  |
| Endurance                        | IEC 60384-4 /<br>EN 130300<br>subclause 4.13 | $T_{amb} = 150\text{ }^{\circ}\text{C}$ ; $U_R$ applied;<br>for test duration see Table 3                                                                | $\Delta C/C: \pm 15\%$<br>$\tan \delta \leq 1.3 \times \text{spec. limit}$<br>$I_{L2} \leq \text{spec. limit}$                                                                   |
| Useful life                      | CECC 30301<br>subclause 1.8.1                | $T_{amb} = 150\text{ }^{\circ}\text{C}$ ; $U_R$ and $I_R$ applied;<br>for test duration see Table 3                                                      | $\Delta C/C: \pm 30\%$<br>$\tan \delta \leq 3 \times \text{spec. limit}$<br>$I_{L2} \leq \text{spec. limit}$<br>no short or open circuit<br>total failure percentage: $\leq 1\%$ |
| Shelf life                       | IEC 60384-4 /<br>EN 130300<br>subclause 4.17 | $T_{amb} = 150\text{ }^{\circ}\text{C}$ ; no voltage applied;<br>1000 h<br>after test: $U_R$ to be applied for 30 min,<br>24 h o 48 h before measurement | $\Delta C/C: \pm 15\%$<br>$\tan \delta \leq 1.3 \times \text{spec. limit}$<br>$I_{L2} \leq \text{spec. limit}$                                                                   |

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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