

Aluminum Electrolytic Capacitors

Radial Miniature, Low Impedance, High Vibration Capability

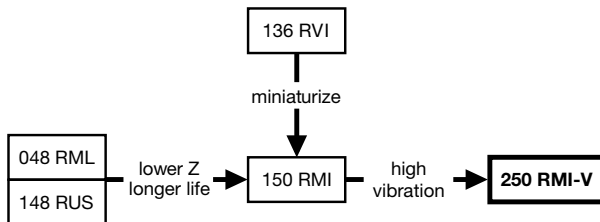
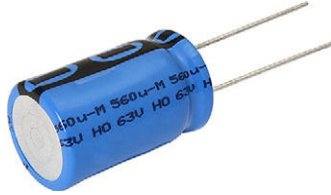


Fig. 1

| QUICK REFERENCE DATA | |
|--|------------------------|
| DESCRIPTION | VALUE |
| Nominal case sizes (Ø D x L in mm) | 16 x 20 to 18 x 40 |
| Rated capacitance range, C _R | 330 µF to 8200 µF |
| Tolerance on C _R | ± 20 % |
| Rated voltage range, U _R | 10 V to 100 V |
| Category temperature range | -55 °C to +105 °C |
| Endurance test at 105 °C | 3000 h to 7000 h |
| Useful life at 105 °C | 7000 h to 10 000 h |
| Useful life at 40 °C, 1.8 x I _R applied | 200 000 h to 500 000 h |
| Shelf life at 0 V, 105 °C | 1000 h |
| Based on sectional specification | IEC 60384-4 / EN130300 |
| Climatic category IEC 60068 | 55 / 105 / 56 |

FEATURES

- Very long useful life: 7000 h to 10 000 h at 105 °C, high stability, high reliability
- Very low impedance and low ESR in smaller case sizes than the 136 RVI series
- Excellent ripple current capability
- High vibration resistance up to 50 g
- AEC-Q200 qualified
- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case, insulated with a blue sleeve
- Charge and discharge proof
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

 AUTOMOTIVE
GRADE

RoHS
COMPLIANT

APPLICATIONS

- Power supplies (SMPS, DC/DC converters) for general industrial, EDP, audio-video, automotive, and telecommunications
- Smoothing, filtering, 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
- Name of manufacturer
- Upper category temperature (105 °C)
- Negative terminal identification
- Series number (250)

SELECTION CHART FOR C_R, U_R, AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

| C _R (µF) | U _R (V) | | | | | | |
|------------------------|--------------------|---------|---------|---------|---------|---------|---------|
| | 10 | 16 | 25 | 35 | 50 | 63 | 100 |
| 330 | - | - | - | - | - | - | 18 x 20 |
| 470 | - | - | - | - | - | 16 x 20 | - |
| 680 | - | - | - | - | - | 16 x 20 | - |
| | - | - | - | - | - | 16 x 25 | - |
| 1000 | - | - | - | - | 16 x 25 | 16 x 31 | - |
| | - | - | - | 16 x 20 | - | - | - |
| 1200 | - | - | - | - | 16 x 31 | - | - |
| 1500 | - | - | - | 16 x 20 | 16 x 31 | - | - |
| 2200 | - | - | 16 x 20 | 16 x 31 | - | 18 x 40 | - |
| 3300 | - | 16 x 20 | 16 x 31 | 18 x 31 | 18 x 40 | - | - |
| 4700 | 16 x 25 | 16 x 31 | 16 x 35 | 18 x 40 | - | - | - |
| 6800 | 16 x 31 | 16 x 35 | 18 x 40 | - | - | - | - |
| 8200 | - | 18 x 40 | - | - | - | - | - |

DIMENSIONS in millimeters **AND AVAILABLE FORMS**

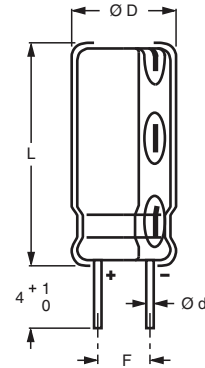
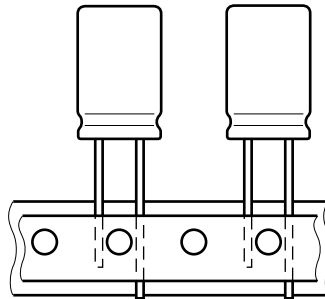
 Fig. 2 - **Form CA:** Long leads

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

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

Table 1

| DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES | | | | | | | | | |
|--|-----------|-----------------|------------------------|------------|---------------|----------------|----------------------|---------|----------|
| NOMINAL CASE SIZE $\varnothing D \times L$ | CASE CODE | $\varnothing d$ | $\varnothing D_{max.}$ | $L_{max.}$ | F | MASS (g) | PACKAGING QUANTITIES | | |
| | | | | | | | FORM CA | FORM CB | FORM TFA |
| 16 x 20 | 19a | 0.8 | 16.5 | 22.0 | 7.5 ± 0.5 | ≈ 6.0 | 250 | 250 | 250 |
| 16 x 25 | 19 | 0.8 | 16.5 | 27.0 | 7.5 ± 0.5 | ≈ 8.0 | 250 | 250 | 250 |
| 16 x 31 | 20 | 0.8 | 16.5 | 33.5 | 7.5 ± 0.5 | ≈ 9.0 | 100 | 100 | 250 |
| 16 x 35 | 21 | 0.8 | 16.5 | 37.5 | 7.5 ± 0.5 | ≈ 11.0 | 100 | 100 | - |
| 18 x 20 | 1820 | 0.8 | 18.5 | 22.0 | 7.5 ± 0.5 | ≈ 8.0 | 100 | 100 | - |
| 18 x 31 | 1831 | 0.8 | 18.5 | 33.5 | 7.5 ± 0.5 | ≈ 12.5 | 100 | 100 | - |
| 18 x 40 | 1840 | 0.8 | 18.5 | 42.5 | 7.5 ± 0.5 | ≈ 16.5 | 100 | 100 | - |



| ELECTRICAL DATA | |
|-----------------|---|
| SYMBOL | DESCRIPTION |
| C_R | Rated capacitance at 100 Hz, tolerance $\pm 20\%$ |
| I_R | Rated RMS ripple current at 100 kHz, 105 °C |
| I_{L2} | Maximum leakage current after 2 min at U_R |
| $\tan \delta$ | Maximum dissipation factor at 100 Hz |
| Z | Maximum impedance at 100 kHz |

Note

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

Table 2

| ELECTRICAL DATA AND ORDERING INFORMATION | | | | | | | | | | |
|--|--------------------------------------|--|------------------------------------|--|-------------------------|--|--|-------------------------------|---------|----------|
| U_R (V) | C_R 100 Hz (μF) | NOMINAL CASE SIZE $\varnothing D \times L$ (mm) | I_R 100 kHz 105 °C (mA) | I_{L2} 2 min (μA) | $\tan \delta$ 100 Hz | Z 100 kHz +20 °C (Ω) | Z 100 kHz -40 °C (Ω) | ORDERING CODE MAL2250..... | | |
| | | | | | | | | BULK PACKAGING | | TAPED |
| | | | | | | | | FORM CA | FORM CB | FORM TFA |
| 10 | 4700 | 16 x 25 | 2390 | 473 | 0.23 | 0.022 | 0.150 | 54472E3 | 64472E3 | 34472E3 |
| | 6800 | 16 x 31 | 2890 | 683 | 0.25 | 0.019 | 0.130 | 54682E3 | 64682E3 | 34682E3 |
| 16 | 3300 | 16 x 20 | 1840 | 531 | 0.20 | 0.028 | 0.200 | 55332E3 | 65332E3 | 35332E3 |
| | 4700 | 16 x 31 | 2890 | 755 | 0.22 | 0.019 | 0.130 | 55472E3 | 65472E3 | 35472E3 |
| | 6800 | 16 x 35 | 3100 | 1091 | 0.24 | 0.018 | 0.130 | 55682E3 | 65682E3 | - |
| | 8200 | 18 x 40 | 3500 | 1315 | 0.28 | 0.018 | 0.130 | 55822E3 | 65822E3 | - |
| 25 | 2200 | 16 x 20 | 1840 | 553 | 0.16 | 0.028 | 0.200 | 56222E3 | 66222E3 | 36222E3 |
| | 3300 | 16 x 31 | 2890 | 828 | 0.16 | 0.019 | 0.130 | 56332E3 | 66332E3 | 36332E3 |
| | 4700 | 16 x 35 | 3100 | 1178 | 0.18 | 0.018 | 0.130 | 56472E3 | 66472E3 | - |
| | 6800 | 18 x 40 | 3500 | 1703 | 0.22 | 0.018 | 0.130 | 56682E3 | 66682E3 | - |
| 35 | 1000 | 16 x 20 | 1840 | 353 | 0.12 | 0.028 | 0.200 | 90105E3 | 90106E3 | 90103E3 |
| | 1500 | 16 x 20 | 1840 | 528 | 0.12 | 0.028 | 0.200 | 50152E3 | 60152E3 | 30152E3 |
| | 2200 | 16 x 31 | 2890 | 773 | 0.14 | 0.019 | 0.130 | 50222E3 | 60222E3 | 30222E3 |
| | 3300 | 18 x 31 | 3000 | 1155 | 0.16 | 0.019 | 0.130 | 50332E3 | 60332E3 | - |
| | 4700 | 18 x 40 | 3300 | 1648 | 0.18 | 0.018 | 0.130 | 50472E3 | 60472E3 | - |
| 50 | 1000 | 16 x 25 | 1800 | 503 | 0.10 | 0.034 | 0.240 | 51102E3 | 61102E3 | 31102E3 |
| | 1200 | 16 x 31 | 2200 | 603 | 0.10 | 0.027 | 0.190 | 51122E3 | 61122E3 | 31122E3 |
| | 1500 | 16 x 31 | 2200 | 753 | 0.10 | 0.027 | 0.190 | 51152E3 | 61152E3 | 31152E3 |
| | 3300 | 18 x 40 | 3200 | 1653 | 0.14 | 0.024 | 0.168 | 51332E3 | 61332E3 | - |
| 63 | 470 | 16 x 20 | 1100 | 299 | 0.10 | 0.074 | 0.520 | 98475E3 | 98476E3 | 98473E3 |
| | 680 | 16 x 20 | 1100 | 431 | 0.10 | 0.074 | 0.520 | 58681E3 | 68681E3 | 38681E3 |
| | 680 | 16 x 25 | 1500 | 431 | 0.10 | 0.054 | 0.380 | 98685E3 | 98686E3 | 98683E3 |
| | 1000 | 16 x 31 | 1900 | 633 | 0.10 | 0.042 | 0.295 | 58102E3 | 68102E3 | 38102E3 |
| | 2200 | 18 x 40 | 3100 | 1389 | 0.12 | 0.033 | 0.231 | 58222E3 | 68222E3 | - |
| 100 | 330 | 18 x 20 | 1700 | 330 | 0.07 | 0.074 | 2.0 | 90183E3 | 90185E3 | - |

Table 3

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

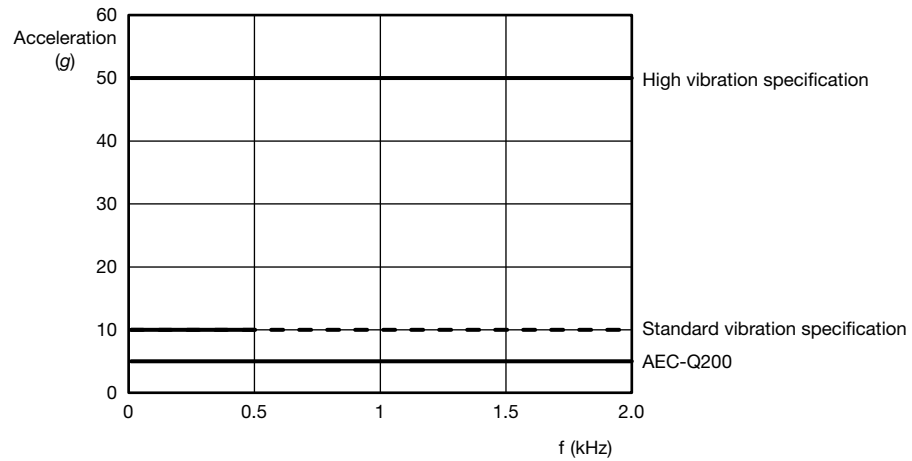
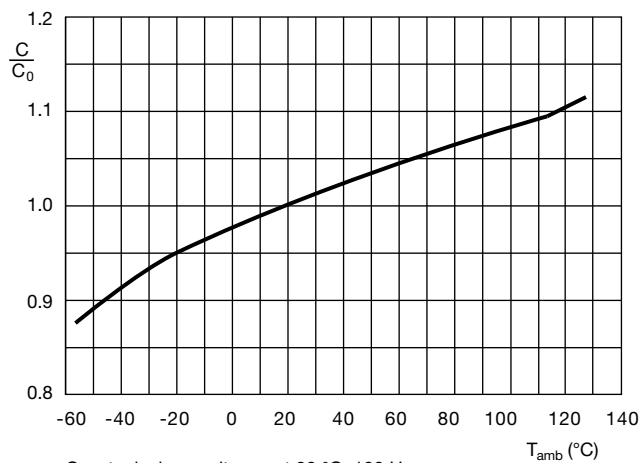


Fig. 5 - Vibration profile

Table 4

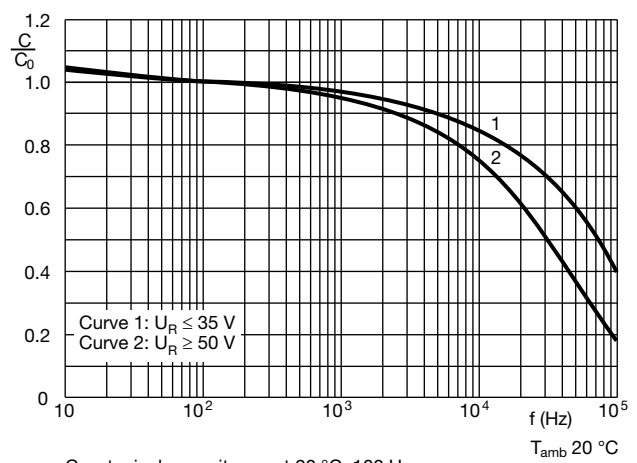
| ADDITIONAL ELECTRICAL DATA | | |
|------------------------------------|---|---|
| PARAMETER | CONDITIONS | VALUE |
| Voltage | | |
| Surge voltage | | $U_S \leq 1.15 \times U_R$ |
| Reverse voltage | | $U_{rev} \leq 1 V$ |
| Current | | |
| Leakage current | After 2 min at U_R | $I_{L2} \leq 0.01 C_R \times U_R + 3 \mu A$ |
| Inductance | | |
| Equivalent series inductance (ESL) | Case $\varnothing D \geq 16 \text{ mm}$ | Typ. 18 nH |
| Resistance | | |
| 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)



C_0 = typical capacitance at 20 °C, 100 Hz

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



C_0 = typical capacitance at 20 °C, 100 Hz

Fig. 7 - Typical multiplier of capacitance as a function of frequency

EQUIVALENT SERIES RESISTANCE (ESR)

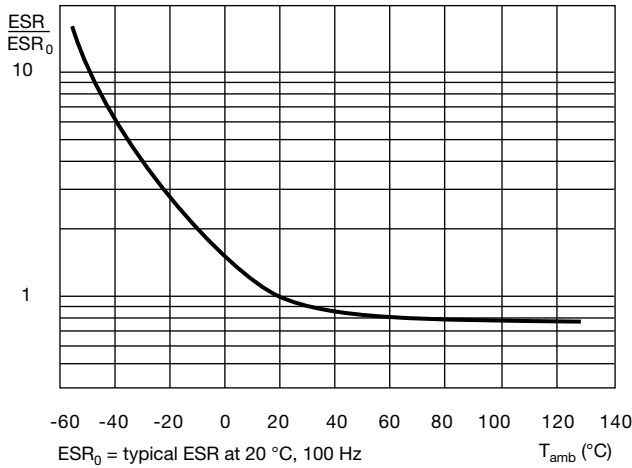


Fig. 8 - Typical multiplier of ESR as a function of ambient temperature

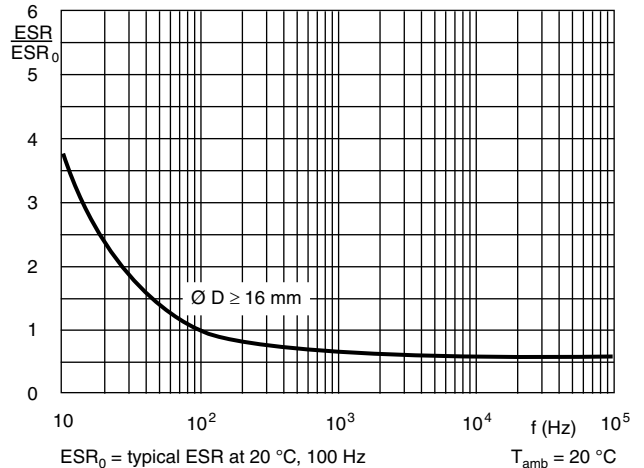


Fig. 9 - Typical multiplier of ESR as a function of frequency

IMPEDANCE (Z)

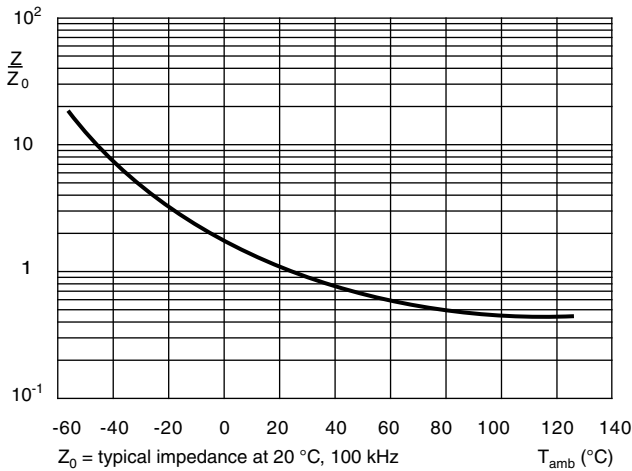


Fig. 10 - Typical multiplier of impedance as a function of ambient temperature

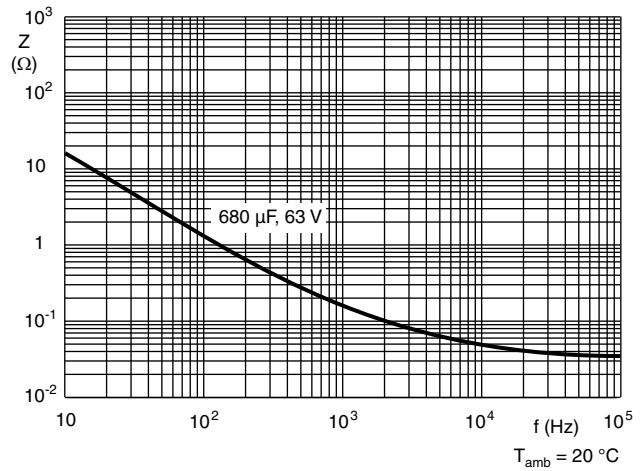


Fig. 11 - Typical impedance as a function of frequency

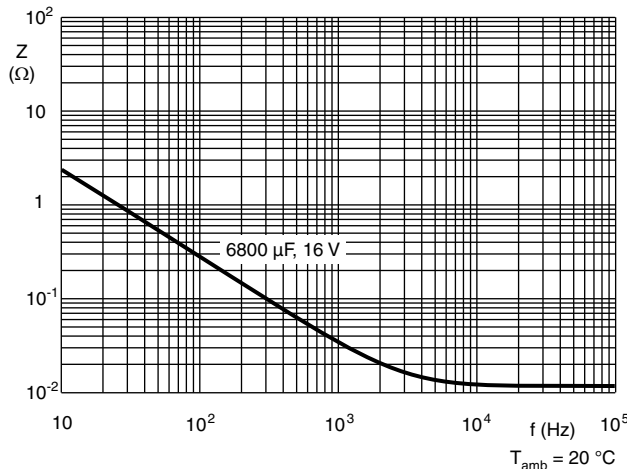


Fig. 12 - Typical impedance as a function of frequency

RIPPLE CURRENT AND USEFUL LIFE

Table 5

| ENDURANCE TEST DURATION AND USEFUL LIFE AS A FUNCTION OF CASE SIZE | | | |
|--|-----------|-------------------------------|---------------------------------|
| NOMINAL CASE SIZE Ø D x L (mm) | CASE CODE | ENDURANCE AT 105 °C (h) | USEFUL LIFE AT 105 °C (h) |
| 16 x 20 | 19a | 3000 | 7000 |
| 16 x 25 | 19 | 5000 | 10 000 |
| 16 x 31 | 20 | 5000 | 10 000 |
| 16 x 35 | 21 | 5000 | 10 000 |
| 18 x 20 | 1820 | 3000 | 7000 |
| 18 x 31 | 1831 | 6000 | 10 000 |
| 18 x 40 | 1840 | 8000 | 10 000 |

Note

- Multiplier of useful life code: CCC206

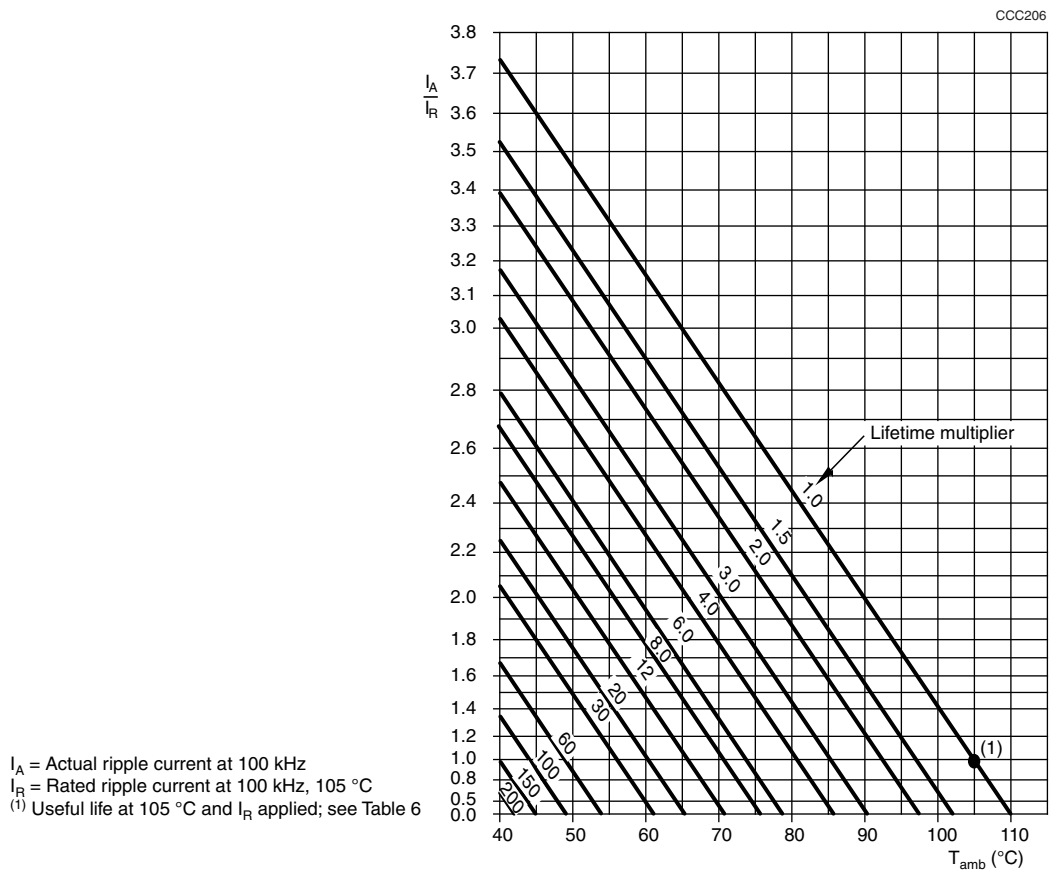


Fig. 13 - Multiplier of useful life as a function of ambient temperature and ripple current load



Table 6

| MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY | | | | | | |
|---|------|------|------|--------|--------|---------|
| FREQUENCY (Hz) | | | | | | |
| 100 | 300 | 1000 | 3000 | 10 000 | 30 000 | 100 000 |
| I_R MULTIPLIER | | | | | | |
| 0.76 | 0.85 | 0.91 | 0.94 | 0.96 | 0.98 | 1.00 |

Table 7

| TEST PROCEDURES AND REQUIREMENTS | | | |
|---|---------------------------------------|---|--|
| TEST | | PROCEDURE (quick reference) | REQUIREMENTS |
| NAME OF TEST | REFERENCE | | |
| Endurance | IEC 60384-4 / EN130300 subclause 4.13 | $T_{amb} = 105\text{ }^\circ\text{C}$; U_R applied; for test duration see Table 3 | $\Delta C/C: \pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$ |
| Useful life | CECC 30301 subclause 1.8.1 | $T_{amb} = 105\text{ }^\circ\text{C}$; U_R and I_R applied; for test duration see Table 3 | $\Delta C/C: \pm 30\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\%$ |
| Shelf life (storage at high temperature) | IEC 60384-4 / EN130300 subclause 4.17 | $T_{amb} = 105\text{ }^\circ\text{C}$; no voltage applied; 1000 h after test: U_R to be applied for 30 min., 24 h to 48 h before measurement | $\Delta C/C: \pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$ |

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