

Aluminum Electrolytic Capacitors SMD (Chip) Long Life Vertical

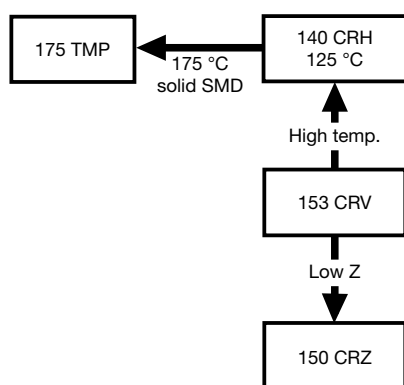


Fig. 1


**RoHS
COMPLIANT**

FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte, self healing
- SMD-version with base plate, vertical construction requiring minimum board space, lead (Pb)-free reflow solderable
- High CV per unit volume
- Long useful life: 2000 h to 3000 h at 105 °C
- Charge and discharge proof, no peak current limitation
- Supplied in blister tape on reel
- ATTENTION: for maximum safe soldering conditions refer to Fig. 5
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

APPLICATIONS

- SMD technology, in compliance with RoHS
- Coupling, decoupling, smoothing, filtering, buffering, timing
- Telecommunications, general industrial, EDP, automotive, portable and lightweight equipment

MARKING

- Rated capacitance (in μF)
- Rated voltage (in V)
- Date code
- Black mark or “-” sign indicating the cathode (the anode is identified by bevelled edges)

PACKAGING

Supplied in blister tape on reel

| QUICK REFERENCE DATA | |
|---|--|
| DESCRIPTION | VALUE |
| Nominal case sizes (L x W x H in mm) | 4.0 x 4.0 x 5.3 to 10 x 10 x 14 |
| Rated capacitance range, C_R | 0.47 μF to 1000 μF |
| Tolerance on C_R | $\pm 20\%$ |
| Rated voltage range, U_R | 6.3 V to 100 V |
| Category temperature range | -55 °C to +105 °C |
| Endurance test at 105 °C: | |
| Case sizes 4.0 x 4.0 x 5.3 to 6.3 x 6.3 x 5.3 | 1000 h |
| Case sizes 8.0 x 8.0 x 6.5 to 10 x 10 x 14 | 2000 h |
| Useful life at 105 °C: | |
| Case sizes 4.0 x 4.0 x 5.3 to 6.3 x 6.3 x 5.3 | 2000 h |
| Case sizes 8.0 x 8.0 x 6.5 to 10 x 10 x 14 | 3000 h |
| Useful life at 40 °C; 1.3 x I_R applied: | |
| Case sizes 4.0 x 4.0 x 5.3 to 6.3 x 6.3 x 5.3 | 200 000 h |
| Case sizes 8.0 x 8.0 x 6.5 to 10 x 10 x 14 | 300 000 h |
| Shelf life at 0 V, 105 °C | 1000 h |
| Based on sectional specification | IEC 60384-18 / CECC 32300 |
| Climatic category IEC 60068 | 55 / 105 / 56 |

| SELECTION CHART FOR C_R, U_R, AND RELEVANT NOMINAL CASE SIZES (L x W x H in mm) | | | | | | | | |
|--|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|--------------|--------------|
| C_R (μF) | U_R (V) | | | | | | | |
| | 6.3 | 10 | 16 | 25 | 35 | 50 | 63 | 100 |
| 0.47 | - | - | - | - | - | 4.0 x 4.0 x 5.3 | - | - |
| 1.0 | - | - | - | - | - | 4.0 x 4.0 x 5.3 | - | - |
| 2.2 | - | - | - | - | - | 4.0 x 4.0 x 5.3 | - | - |
| 3.3 | - | - | - | - | - | 4.0 x 4.0 x 5.3 | - | - |
| 4.7 | - | - | - | - | 4.0 x 4.0 x 5.3 | 5.0 x 5.0 x 5.3 | - | - |
| 10 | - | - | 4.0 x 4.0 x 5.3 | - | 5.0 x 5.0 x 5.3 | 6.3 x 6.3 x 5.3 | - | - |
| 22 | 4.0 x 4.0 x 5.3 | - | 5.0 x 5.0 x 5.3 | - | 6.3 x 6.3 x 5.3 | 8.0 x 8.0 x 6.5 | - | - |
| 33 | - | 5.0 x 5.0 x 5.3 | - | 6.3 x 6.3 x 5.3 | 8.0 x 8.0 x 6.5 | 8.0 x 8.0 x 10 | - | 10 x 10 x 14 |
| 47 | 5.0 x 5.0 x 5.3 | - | 6.3 x 6.3 x 5.3 | 8.0 x 8.0 x 6.5 | - | 8.0 x 8.0 x 10 | - | - |
| 100 | 6.3 x 6.3 x 5.3 | - | 8.0 x 8.0 x 6.5 | 8.0 x 8.0 x 10 | - | 10 x 10 x 10 | 10 x 10 x 14 | - |
| | - | - | - | - | - | - | - | - |
| 220 | - | 8.0 x 8.0 x 10 | 10 x 10 x 10 | - | - | - | - | - |
| 330 | 8.0 x 8.0 x 10 | 10 x 10 x 10 | - | 10 x 10 x 14 | - | - | - | - |
| 470 | 10 x 10 x 10 | - | 10 x 10 x 14 | - | - | - | - | - |
| 680 | - | 10 x 10 x 14 | - | - | - | - | - | - |
| 1000 | 10 x 10 x 14 | - | - | - | - | - | - | - |

Table 1

| TAPE AND REEL DIMENSIONS in millimeters AND PACKAGING QUANTITIES | | | | | |
|---|----------------|-------------------|-------------------------|------------------|-----------------------------------|
| CASE CODE | PITCH P_1 | TAPE WIDTH W | TAPE THICKNESS T_2 | REEL DIAMETER | PACKAGING QUANTITY PER REEL |
| 0405 | 8 | 12 | 5.8 | 380 | 2000 |
| 0505 | 12 | 12 | 5.8 | 380 | 1000 |
| 0605 | 12 | 16 | 5.8 | 380 | 1000 |
| 0807 | 12 | 16 | 6.8 | 380 | 1000 |
| 0810 | 16 | 24 | 11.3 | 380 | 500 |
| 1010 | 16 | 24 | 11.3 | 380 | 500 |
| 1014 | 16 | 24 | 14.8 | 330 | 250 |

Note

- Detailed tape dimensions see section "PACKAGING"

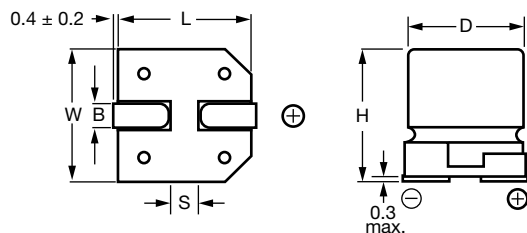


Fig. 2 - Dimensional outline

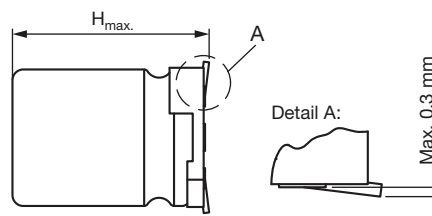


Fig. 3 - Coplanarity of pins

Table 2

| DIMENSIONS in millimeters AND MASS | | | | | | | | |
|---|-----------|------------|------------|------------|-----------------|------------|-----|-------------|
| NOMINAL CASE SIZE L x W x H | CASE CODE | $L_{max.}$ | $W_{max.}$ | $H_{max.}$ | $\varnothing D$ | $B_{max.}$ | S | MASS (g) |
| 4.0 x 4.0 x 5.3 | 0405 | 4.5 | 4.5 | 5.5 | 4.0 | 0.8 | 1.0 | ≈ 0.13 |
| 5.0 x 5.0 x 5.3 | 0505 | 5.5 | 5.5 | 5.5 | 5.0 | 0.8 | 1.4 | ≈ 0.20 |
| 6.3 x 6.3 x 5.3 | 0605 | 6.8 | 6.8 | 5.5 | 6.3 | 0.8 | 2.0 | ≈ 0.30 |
| 8.0 x 8.0 x 6.5 | 0807 | 8.6 | 8.6 | 6.8 | 8.0 | 0.8 | 2.3 | ≈ 0.50 |
| 8.0 x 8.0 x 10 | 0810 | 8.6 | 8.6 | 10.5 | 8.0 | 1.1 | 3.1 | ≈ 1.00 |
| 10 x 10 x 10 | 1010 | 10.6 | 10.6 | 10.5 | 10.0 | 1.1 | 4.7 | ≈ 1.30 |
| 10 x 10 x 14 | 1014 | 10.6 | 10.6 | 14.3 | 10.0 | 1.2 | 4.5 | ≈ 1.50 |

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. 4 and Table 3.

SOLDERING

Soldering conditions are defined by the curve, temperature versus time, where the temperature is that measured on the soldering pad and on top of the case during processing.

For maximum conditions refer to Fig. 5 and Table 4.

Maximum 2 runs with pause of minimum 30 min between.

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.

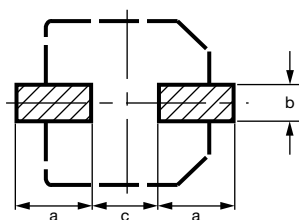


Fig. 4 - Recommended soldering pad dimensions

Table 3

| RECOMMENDED SOLDERING PAD DIMENSIONS in millimeters | | | |
|---|-----|-----|-----|
| CASE CODE | a | b | c |
| 0405 | 2.6 | 1.6 | 1.0 |
| 0505 | 3.0 | 1.6 | 1.4 |
| 0605 | 3.5 | 1.6 | 1.9 |
| 0807 | 4.0 | 1.6 | 2.1 |
| 0810 | 3.5 | 2.5 | 3.0 |
| 1010 | 4.0 | 2.5 | 4.0 |
| 1014 | 4.3 | 2.5 | 4.0 |

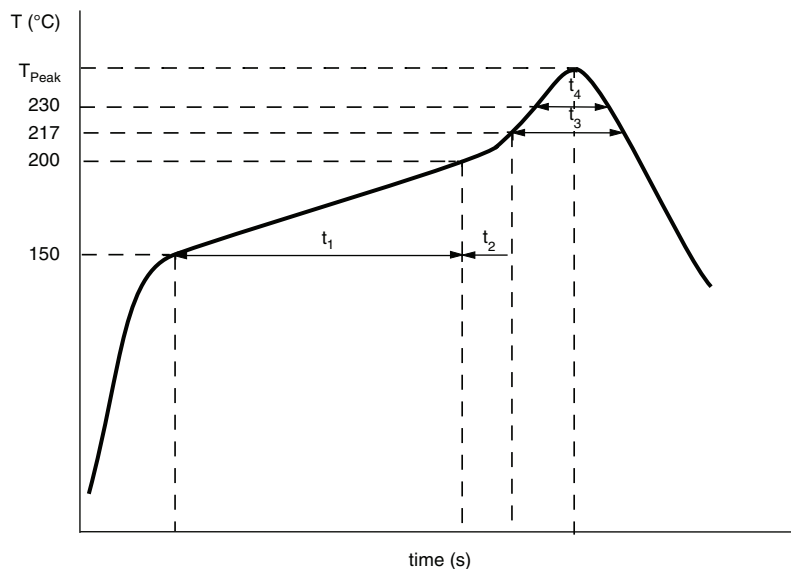


Fig. 5 - Maximum temperature load during reflow soldering measured on capacitors soldering pad and top of the case

Table 4

| REFLOW SOLDERING CONDITIONS | | | | |
|--|---------------------------|---------------------------|--------------------------|-------------------------|
| PROFILE FEATURES | CASE CODE 0405 TO 0605 | CASE CODE 0807 TO 1010 | CASE CODE 1014 ≤ 63 V | CASE CODE 1014 100 V |
| Max. time from 25 °C to T_{peak} | 240 s | 240 s | 300 s | 270 s |
| Max. ramp-up rate to 150 °C | 3 K/s | 3 K/s | 3 K/s | 3 K/s |
| Max. time from 150 °C to 200 °C (t_1) | 120 s | 120 s | 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 | 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) | 20 s | 20 s | 60 s | 60 s |
| Max. time above $T_{Liquidus}$ (217 °C), (t_3) | 60 s | 60 s | 90 s | 60 s |
| Max. time above 230 °C (t_4) | 30 s | 20 s | 40 s | 30 s |
| Peak temperature T_{peak} | 250 °C | 240 °C | 250 °C | 240 °C |
| Max. time above T_{peak} minus 5 °C | 5 s | 5 s | 5 s | 10 s |
| Max. ramp-down rate from $T_{Liquidus}$ | 6 K/s | 6 K/s | 6 K/s | 6 K/s |

Note

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

| ELECTRICAL DATA | |
|-----------------|---|
| SYMBOL | DESCRIPTION |
| C_R | Rated capacitance at 100 Hz or 120 Hz, tolerance $\pm 20\%$ |
| I_R | Rated RMS ripple current at 100 Hz or 120 Hz, 105 °C |
| I_{L2} | Max. leakage current after 2 min at U_R |
| $\tan \delta$ | Max. dissipation factor at 100 Hz or 120 Hz |
| ESR | Equivalent series resistance at 100 kHz |

Note

- Unless otherwise specified, all electrical values in Table 5 apply at $T_{amb} = 20\text{ °C}$, $P = 86\text{ kPa}$ to 106 kPa , $RH = 45\%$ to 75% .

Table 5

| ELECTRICAL DATA AND ORDERING INFORMATION | | | | | | | |
|--|----------------------------|--|-------------------------|--|-------------------------|--------------------------------|-------------------------------|
| U_R (V) | C_R (μF) | NOMINAL CASE SIZE L x W x H (mm) | I_R 105 °C (mA) | I_{L2} 2 min (μA) | $\tan \delta$ 100 Hz | ESR 100 kHz (Ω) | ORDERING CODE MAL2153..... |
| 6.3 | 22 | 4.0 x 4.0 x 5.3 | 21 | 3.0 | 0.30 | 8 | 73229E3 |
| | 47 | 5.0 x 5.0 x 5.3 | 36 | 3.0 | 0.30 | 4 | 73479E3 |
| | 100 | 6.3 x 6.3 x 5.3 | 61 | 6.3 | 0.30 | 2 | 73101E3 |
| | 330 | 8.0 x 8.0 x 10 | 180 | 21 | 0.30 | 0.5 | 73331E3 |
| | 470 | 10 x 10 x 10 | 320 | 30 | 0.30 | 0.3 | 73471E3 |
| | 1000 | 10 x 10 x 14 | 400 | 63 | 0.24 | 0.24 | 73102E3 |
| 10 | 33 | 5.0 x 5.0 x 5.3 | 31 | 3.3 | 0.26 | 4 | 74339E3 |
| | 220 | 8.0 x 8.0 x 10 | 180 | 22 | 0.26 | 0.5 | 74221E3 |
| | 330 | 10 x 10 x 10 | 320 | 33 | 0.26 | 0.3 | 74331E3 |
| | 680 | 10 x 10 x 14 | 380 | 68 | 0.19 | 0.24 | 74681E3 |
| 16 | 10 | 4.0 x 4.0 x 5.3 | 16 | 3.0 | 0.22 | 8 | 75109E3 |
| | 22 | 5.0 x 5.0 x 5.3 | 28 | 3.5 | 0.22 | 4 | 75229E3 |
| | 47 | 6.3 x 6.3 x 5.3 | 47 | 7.5 | 0.22 | 2.2 | 75479E3 |
| | 100 | 8.0 x 8.0 x 6.5 | 110 | 16 | 0.22 | 1.2 | 75101E3 |
| | 220 | 10 x 10 x 10 | 320 | 35 | 0.22 | 0.3 | 75221E3 |
| | 470 | 10 x 10 x 14 | 370 | 75 | 0.16 | 0.25 | 75471E3 |
| 25 | 33 | 6.3 x 6.3 x 5.3 | 44 | 8.3 | 0.16 | 2.2 | 76339E3 |
| | 47 | 8.0 x 8.0 x 6.5 | 110 | 12 | 0.16 | 1.2 | 76479E3 |
| | 100 | 8.0 x 8.0 x 10 | 180 | 22 | 0.16 | 0.5 | 76101E3 |
| | 330 | 10 x 10 x 14 | 300 | 83 | 0.14 | 0.27 | 76331E3 |
| 35 | 4.7 | 4.0 x 4.0 x 5.3 | 14 | 3.0 | 0.13 | 8 | 70478E3 |
| | 10 | 5.0 x 5.0 x 5.3 | 23 | 3.5 | 0.13 | 4 | 70109E3 |
| | 22 | 6.3 x 6.3 x 5.3 | 50 | 7.7 | 0.13 | 2.2 | 70229E3 |
| | 33 | 8.0 x 8.0 x 6.5 | 110 | 12 | 0.13 | 1.2 | 70339E3 |
| 50 | 0.47 | 4.0 x 4.0 x 5.3 | 5 | 3.0 | 0.12 | 12 | 71477E3 |
| | 1.0 | 4.0 x 4.0 x 5.3 | 7 | 3.0 | 0.12 | 12 | 71108E3 |
| | 2.2 | 4.0 x 4.0 x 5.3 | 10 | 3.0 | 0.12 | 12 | 71228E3 |
| | 3.3 | 4.0 x 4.0 x 5.3 | 12 | 3.0 | 0.12 | 12 | 71338E3 |
| | 4.7 | 5.0 x 5.0 x 5.3 | 17 | 3.0 | 0.12 | 6 | 71478E3 |
| | 10 | 6.3 x 6.3 x 5.3 | 26 | 5.0 | 0.12 | 3 | 71109E3 |
| | 22 | 8.0 x 8.0 x 6.5 | 110 | 11 | 0.12 | 1.2 | 71229E3 |
| | 33 | 8.0 x 8.0 x 10 | 180 | 17 | 0.12 | 0.5 | 71339E3 |
| | 47 | 8.0 x 8.0 x 10 | 180 | 24 | 0.12 | 0.5 | 71479E3 |
| | 100 | 10 x 10 x 10 | 320 | 50 | 0.12 | 0.3 | 71101E3 |
| 63 | 100 | 10 x 10 x 14 | 240 | 63 | 0.09 | 0.34 | 78101E3 |
| 100 | 33 | 10 x 10 x 14 | 170 | 33 | 0.07 | 1.3 | 79339E3 |

ORDERING EXAMPLE

Electrolytic capacitor 153 CRV series

100 μF / 25 V; $\pm 20\%$

Nominal case size: 8 mm x 8 mm x 10 mm; taped on reel

Ordering code: MAL215376101E3

Former 12NC: 2222 153 76101

| ADDITIONAL ELECTRICAL DATA | | |
|------------------------------------|------------------------------|--|
| PARAMETER | CONDITIONS | VALUE |
| Voltage | | |
| Surge voltage | IEC 60384-18, subclause 4.14 | $U_s \leq 1.15 \times U_R$ |
| Reverse voltage | IEC 60384-18, subclause 4.16 | $U_{rev} \leq 1 \text{ V}$ |
| Current | | |
| Leakage current | After 2 min at U_R | $I_{L2} \leq 0.01 \times C_R \times U_R$ or $3 \mu\text{A}$, whichever is greater |
| Inductance | | |
| Equivalent series inductance (ESL) | Case codes 0405 to 0605 | Typ. 10 nH |
| | Case codes 0807 to 1014 | Typ. 15 nH |

CAPACITANCE (C)



Fig. 6 - Typical multiplier of capacitance at 100 Hz or 120 Hz as a function of ambient temperature

EQUIVALENT SERIES RESISTANCE (ESR)



Fig. 7 - Typical ESR as a function of frequency at 20 °C

DISSIPATION FACTOR ($\tan \delta$)



Fig. 8 - Typical dissipation factor ($\tan \delta$) at 100 Hz or 120 Hz as a function of ambient temperature

IMPEDANCE (Z)



Fig. 9 - Typical impedance as a function of frequency at 20 °C

RIPPLE CURRENT AND USEFUL LIFE

Table 6

| ENDURANCE TEST DURATION AND USEFUL LIFE | | | | |
|---|-------------------------------|---------------------------------|--|-----------------------------------|
| NOMINAL CASE SIZE Ø D x L (mm) | ENDURANCE AT 105 °C (h) | USEFUL LIFE AT 105 °C (h) | USEFUL LIFE AT 40 °C 1.3 x I _R APPLIED (h) | MULTIPLIER OF USEFUL LIFE CODE |
| 4.0 x 4.0 x 5.3 | 1000 | 2000 | 200 000 | CCC206r |
| 5.0 x 5.0 x 5.3 | 1000 | 2000 | 200 000 | CCC206r |
| 6.3 x 6.3 x 5.3 | 1000 | 2000 | 200 000 | CCC206r |
| 8.0 x 8.0 x 6.5 | 2000 | 3000 | 300 000 | CCC206r |
| 8.0 x 8.0 x 10 | 2000 | 3000 | 300 000 | CCC206r |
| 10 x 10 x 10 | 2000 | 3000 | 300 000 | CCC206r |
| 10 x 10 x 14 | 2000 | 3000 | 300 000 | CCC206 |

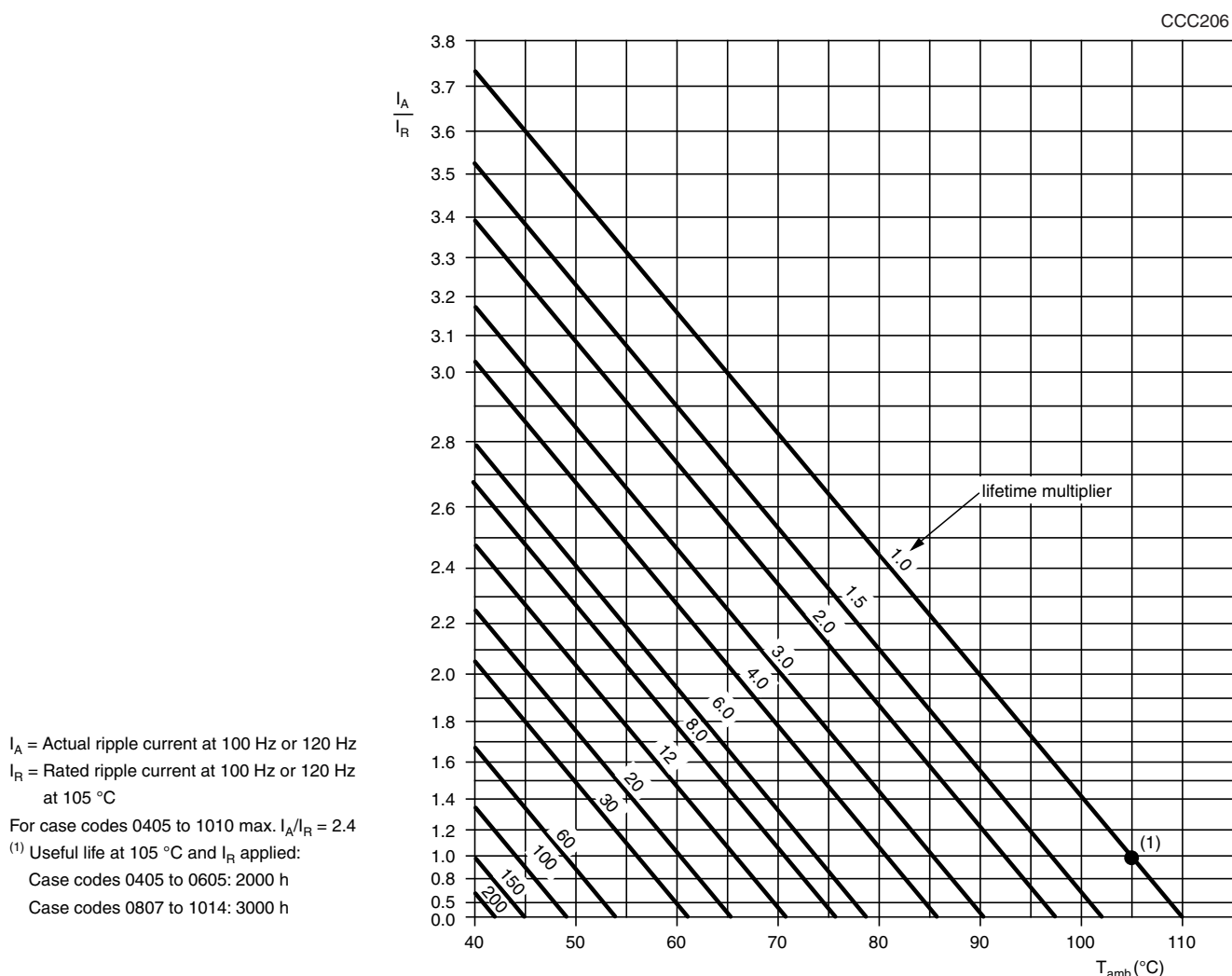


Fig. 10 - Multiplier of useful life as a function of ambient temperature and ripple current load

Table 7

| MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY | | | | | | |
|---|------------------|------|------|------|------|----------------|
| U_R (V) | FREQUENCY (Hz) | | | | | |
| | 50 | 100 | 300 | 1000 | 3000 | $\geq 10\ 000$ |
| | I_R MULTIPLIER | | | | | |
| 6.3 | 0.80 | 1.00 | 1.10 | 1.15 | 1.20 | 1.25 |
| 10 | 0.80 | 1.00 | 1.10 | 1.15 | 1.20 | 1.25 |
| 16 | 0.80 | 1.00 | 1.10 | 1.15 | 1.20 | 1.25 |
| 25 | 0.80 | 1.00 | 1.15 | 1.25 | 1.35 | 1.40 |
| 35 | 0.80 | 1.00 | 1.15 | 1.25 | 1.35 | 1.40 |
| 50 | 0.80 | 1.00 | 1.20 | 1.35 | 1.45 | 1.50 |
| 63 | 0.80 | 1.00 | 1.20 | 1.35 | 1.45 | 1.50 |
| 100 | 0.80 | 1.00 | 1.20 | 1.35 | 1.45 | 1.50 |

Table 8

| TEST PROCEDURES AND REQUIREMENTS | | | |
|--|---|---|--|
| TEST | | PROCEDURE (quick reference) | REQUIREMENTS |
| NAME OF TEST | REFERENCE | | |
| Mounting | IEC 60384-18, subclause 4.3 | Shall be performed prior to tests mentioned below; reflow soldering; for maximum temperature load refer to chapter "Mounting" | $\Delta C/C: \pm 10\ \%$ $\tan \delta \leq \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$ |
| Endurance | IEC 60384-18 / CECC 32300, subclause 4.15 | $T_{amb} = 105\ ^\circ\text{C}$; U_R applied; 1000 h, case codes 0405 to 0605 2000 h, case codes 0807 to 1014 | $\Delta C/C: \pm 20\ \%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$ |
| Useful life | CECC 30301, subclause 1.8.1 | $T_{amb} = 105\ ^\circ\text{C}$; U_R and I_R applied; 2000 h, case codes 0405 to 0605 3000 h, case codes 0807 to 1014 | $\Delta C/C: \pm 50\ \%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $I_{L2} \leq \text{spec. limit}$ no short or open circuit total failure percentage: $\leq 1\ \%$ |
| Shelf life (storage at high temperature) | IEC 60384-18 / CECC 32300, subclause 4.17 | $T_{amb} = 105\ ^\circ\text{C}$; no voltage applied; 1000 h After test: U_R to be applied for 30 min, 24 h to 48 h before measurement | For requirements see "Endurance test" above |

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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