



Aluminum Capacitors Radial Long-Life, High Voltage

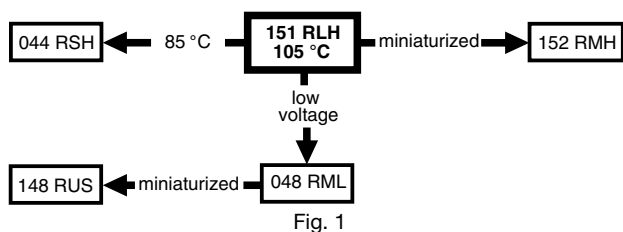


Fig. 1



RoHS
COMPLIANT

FEATURES

- Long useful life: 3000 h to 4000 h at 105 °C
- High rated voltage, up to 450 V
- Charge and discharge proof
- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case, insulated with a blue sleeve
- Pressure relief
- Material categorization: For definitions of compliance please see www.vishay.com/doc?99912

APPLICATIONS

- Professional applications
- Lighting, monitors, consumer electronics, general industrial
- Filtering of high voltages in power supplies

MARKING

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

- Rated capacitance value (in μF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for $\pm 20\%$)
- Rated voltage (in V)
- Date code, in accordance with IEC 60062
- Code indicating factory of origin
- Name of manufacturer
- Upper category temperature (105 °C)
- Negative terminal identification
- Series number (151)

| QUICK REFERENCE DATA | |
|---|--|
| DESCRIPTION | VALUE |
| Nominal case sizes (\varnothing D x L in mm) | 10 x 12 to 18 x 35 |
| Rated capacitance range, C_R | 2.2 μF to 220 μF |
| Tolerance on C_R | $\pm 20\%$ |
| Rated voltage range, U_R | 160 V to 450 V |
| Category temperature range | -40 °C to +105 °C |
| Endurance test at 105 °C | 2000 h |
| Useful life at 105 °C: Case \varnothing D = 10 mm and 12.5 mm Case \varnothing D = 16 mm and 18 mm | 3000 h 4000 h |
| Useful life at 40 °C, 1.6 x I_R applied: Case \varnothing D = 10 mm and 12.5 mm Case \varnothing D = 16 mm and 18 mm | 200 000 h 260 000 h |
| Shelf life at 0 V, 105 °C | 500 h |
| Based on sectional specification | IEC 60384-4/EN130300 |
| Climatic category IEC 60068 | 40/105/56 |

| SELECTION CHART FOR C_R , U_R , AND RELEVANT NOMINAL CASE SIZES (\varnothing D x L in mm) | | | | | | |
|--|-----------|-----------|-----------|-----------|-----------|-----------|
| C_R (μF) | U_R (V) | | | | | |
| | 160 | 200 | 250 | 350 | 400 | 450 |
| 2.2 | - | - | - | - | 10 x 12 | 10 x 16 |
| 3.3 | - | - | - | 10 x 12 | 10 x 16 | 10 x 20 |
| 4.7 | - | 10 x 12 | 10 x 12 | 10 x 16 | 10 x 20 | 12.5 x 20 |
| 10 | 10 x 16 | 10 x 16 | 10 x 20 | 12.5 x 20 | 12.5 x 20 | 16 x 20 |
| 22 | 10 x 20 | 10 x 20 | 12.5 x 25 | 12.5 x 25 | 16 x 25 | 16 x 31 |
| | - | - | 16 x 20 | 16 x 20 | 18 x 20 | 18 x 25 |
| 33 | 12.5 x 20 | 12.5 x 20 | 12.5 x 25 | 16 x 25 | 16 x 31 | 18 x 35 |
| | - | - | 16 x 20 | - | 18 x 25 | - |
| 47 | 12.5 x 25 | 12.5 x 25 | 16 x 25 | 16 x 35 | 18 x 31 | - |
| | 16 x 20 | 16 x 20 | 18 x 20 | 18 x 31 | - | - |
| 100 | 16 x 25 | 16 x 31 | 16 x 31 | - | - | - |
| | 18 x 20 | 18 x 25 | 18 x 25 | - | - | - |
| 220 | 18 x 35 | - | - | - | - | - |



DIMENSIONS in millimeters **AND AVAILABLE FORMS**

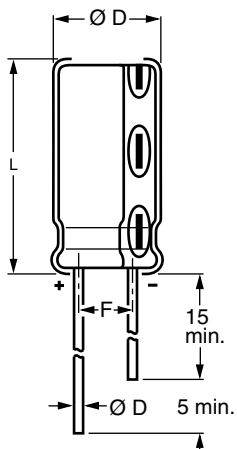


Fig. 2 - Form CA: Long leads

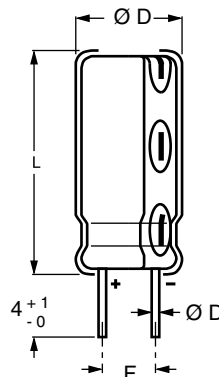


Fig. 3 - Form CB: Cut leads

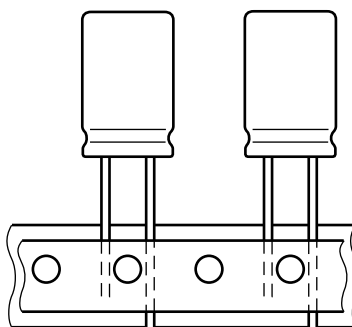


Fig. 4 - Form TFA: Taped in box (ammopack)

Table 1

| DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES | | | | | | | | | |
|--|-----------|-----|---------------------|-------------------|-----------|----------|------------------------------|---------|----------|
| NOMINAL CASE SIZE Ø D x L | CASE CODE | Ø d | Ø D _{max.} | L _{max.} | F | MASS (g) | PACKAGING QUANTITIES PER BOX | | |
| | | | | | | | FORM CA | FORM CB | FORM TFA |
| 10 x 12 | 14 | 0.6 | 10.5 | 13.5 | 5.0 ± 0.5 | ≈ 1.6 | 1000 | 500 | 800 |
| 10 x 16 | 15 | 0.6 | 10.5 | 17.5 | 5.0 ± 0.5 | ≈ 1.9 | 500 | 500 | 800 |
| 10 x 20 | 16 | 0.6 | 10.5 | 22.0 | 5.0 ± 0.5 | ≈ 2.2 | 500 | 500 | 800 |
| 12.5 x 20 | 17 | 0.6 | 13.0 | 22.0 | 5.0 ± 0.5 | ≈ 4.0 | 500 | 500 | 500 |
| 12.5 x 25 | 18 | 0.6 | 13.0 | 27.0 | 5.0 ± 0.5 | ≈ 5.0 | 250 | 250 | 500 |
| 16 x 20 | 19 a | 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 25 | 1825 | 0.8 | 18.5 | 27.0 | 7.5 ± 0.5 | ≈ 10.0 | 100 | 100 | - |
| 18 x 31 | 1831 | 0.8 | 18.5 | 33.5 | 7.5 ± 0.5 | ≈ 12.5 | 100 | 100 | - |
| 18 x 35 | 22 | 0.8 | 18.5 | 37.5 | 7.5 ± 0.5 | ≈ 14.5 | 100 | 100 | - |



| ELECTRICAL DATA | |
|-----------------|---|
| SYMBOL | DESCRIPTION |
| C_R | Rated capacitance at 100 Hz, tolerance $\pm 20\%$ |
| I_R | Rated RMS ripple current at 100 Hz, 105 °C |
| I_{L1} | Max. leakage current after 1 min at U_R |
| $\tan \delta$ | Max. dissipation factor at 100 Hz |
| Z | Max. impedance at 10 kHz |

ORDERING EXAMPLE

Electrolytic capacitor 151 series
 4.7 μ F/400 V; $\pm 20\%$
 Nominal case size: \varnothing 10 mm x 20 mm; Form TFA
 Ordering code: MAL215136478E3
 Former 12NC: 2222 151 36478

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 (μ F) | NOMINAL CASE SIZE \varnothing D x L (mm) | I_R 100 Hz 105 °C (mA) | I_{L1} 1 min (μ A) | $\tan \delta$ 100 Hz | Z 10 kHz (Ω) | ORDERING CODE MAL2151..... | | |
| | | | | | | | BULK PACKAGING | | TAPED |
| | | | | | | | FORM CA | FORM CB | FORM TFA |
| 160 | 10 | 10 x 16 | 95 | 118 | 0.12 | 6.3 | 51109E3 | 61109E3 | 31109E3 |
| | 22 | 10 x 20 | 145 | 176 | 0.12 | 3.2 | 51229E3 | 61229E3 | 31229E3 |
| | 33 | 12.5 x 20 | 190 | 228 | 0.12 | 2.3 | 51339E3 | 61339E3 | 31339E3 |
| | 47 | 12.5 x 25 | 280 | 296 | 0.12 | 1.7 | 51479E3 | 61479E3 | 31479E3 |
| | 47 | 16 x 20 | 280 | 296 | 0.12 | 1.7 | 91475E3 | 91476E3 | 91473E3 |
| | 100 | 16 x 25 | 380 | 550 | 0.12 | 1.1 | 51101E3 | 61101E3 | 31101E3 |
| | 100 | 18 x 20 | 380 | 550 | 0.12 | 1.1 | 91105E3 | 91106E3 | - |
| | 220 | 18 x 35 | 630 | 1126 | 0.12 | 0.8 | 51221E3 | 61221E3 | - |
| 200 | 4.7 | 10 x 12 | 60 | 96 | 0.12 | 13.0 | 52478E3 | 62478E3 | 32478E3 |
| | 10 | 10 x 16 | 95 | 130 | 0.12 | 6.3 | 52109E3 | 62109E3 | 32109E3 |
| | 22 | 10 x 20 | 145 | 202 | 0.12 | 3.2 | 52229E3 | 62229E3 | 32229E3 |
| | 33 | 12.5 x 20 | 190 | 268 | 0.12 | 2.3 | 52339E3 | 62339E3 | 32339E3 |
| | 47 | 12.5 x 25 | 280 | 352 | 0.12 | 1.7 | 52479E3 | 62479E3 | 32479E3 |
| | 47 | 16 x 20 | 280 | 352 | 0.12 | 1.7 | 92475E3 | 92476E3 | 92473E3 |
| | 100 | 16 x 31 | 410 | 670 | 0.12 | 1.1 | 52101E3 | 62101E3 | 32101E3 |
| | 100 | 18 x 25 | 410 | 670 | 0.12 | 1.1 | 92105E3 | 92106E3 | - |
| 250 | 4.7 | 10 x 12 | 60 | 105 | 0.12 | 13.0 | 53478E3 | 63478E3 | 33478E3 |
| | 10 | 10 x 20 | 105 | 145 | 0.12 | 6.3 | 53109E3 | 63109E3 | 33109E3 |
| | 22 | 12.5 x 25 | 180 | 235 | 0.12 | 3.2 | 53229E3 | 63229E3 | 33229E3 |
| | 22 | 16 x 20 | 180 | 235 | 0.12 | 3.2 | 93225E3 | 93226E3 | 93223E3 |
| | 33 | 12.5 x 25 | 250 | 318 | 0.12 | 2.3 | 53339E3 | 63339E3 | 33339E3 |
| | 33 | 16 x 20 | 250 | 318 | 0.12 | 2.3 | 93335E3 | 93336E3 | 93333E3 |
| | 47 | 16 x 25 | 300 | 423 | 0.12 | 1.7 | 53479E3 | 63479E3 | 33479E3 |
| | 47 | 18 x 20 | 300 | 423 | 0.12 | 1.7 | 93475E3 | 93476E3 | - |
| | 100 | 16 x 31 | 410 | 820 | 0.12 | 1.1 | 53101E3 | 63101E3 | 33101E3 |
| | 100 | 18 x 25 | 410 | 820 | 0.12 | 1.1 | 93105E3 | 93106E3 | - |
| 350 | 3.3 | 10 x 12 | 50 | 105 | 0.15 | 22.0 | 55338E3 | 65338E3 | 35338E3 |
| | 4.7 | 10 x 16 | 65 | 119 | 0.15 | 16.0 | 55478E3 | 65478E3 | 35478E3 |
| | 10 | 12.5 x 20 | 120 | 175 | 0.15 | 7.6 | 55109E3 | 65109E3 | 35109E3 |
| | 22 | 12.5 x 25 | 180 | 301 | 0.15 | 3.8 | 55229E3 | 65229E3 | 35229E3 |
| | 22 | 16 x 20 | 180 | 301 | 0.15 | 3.8 | 95225E3 | 95226E3 | 95223E3 |
| | 33 | 16 x 25 | 210 | 417 | 0.15 | 2.6 | 55339E3 | 65339E3 | 35339E3 |
| | 47 | 16 x 35 | 300 | 564 | 0.15 | 2.0 | 55479E3 | 65479E3 | - |
| | 47 | 18 x 31 | 300 | 564 | 0.15 | 2.0 | 95475E3 | 95476E3 | - |



| ELECTRICAL DATA AND ORDERING INFORMATION | | | | | | | | | |
|--|----------------------------------|---|--|----------------------------------|-----------------|--------------------|-------------------------------|---------|----------|
| U _R (V) | C _R 100 Hz (μF) | NOMINAL CASE SIZE Ø D x L (mm) | I _R 100 Hz 105 °C (mA) | I _{L1} 1 min (μA) | tan δ 100 Hz | Z 10 kHz (Ω) | ORDERING CODE MAL2151..... | | |
| | | | | | | | BULK PACKAGING | | TAPED |
| | | | | | | | FORM CA | FORM CB | FORM TFA |
| 400 | 2.2 | 10 x 12 | 40 | 93 | 0.15 | 33.0 | 56228E3 | 66228E3 | 36228E3 |
| | 3.3 | 10 x 16 | 50 | 110 | 0.15 | 22.0 | 56338E3 | 66338E3 | 36338E3 |
| | 4.7 | 10 x 20 | 70 | 126 | 0.15 | 16.0 | 56478E3 | 66478E3 | 36478E3 |
| | 10 | 12.5 x 20 | 120 | 190 | 0.15 | 7.6 | 56109E3 | 66109E3 | 36109E3 |
| | 22 | 16 x 25 | 200 | 334 | 0.15 | 3.8 | 56229E3 | 66229E3 | 36229E3 |
| | 22 | 18 x 20 | 200 | 334 | 0.15 | 3.8 | 96225E3 | 96226E3 | - |
| | 33 | 16 x 31 | 245 | 466 | 0.15 | 2.6 | 56339E3 | 66339E3 | 36339E3 |
| | 33 | 18 x 25 | 245 | 466 | 0.15 | 2.6 | 96335E3 | 96336E3 | - |
| 450 | 47 | 18 x 31 | 300 | 634 | 0.15 | 2.0 | 56479E3 | 66479E3 | - |
| | 2.2 | 10 x 16 | 45 | 99 | 0.2 | 43.0 | 57228E3 | 67228E3 | 37228E3 |
| | 3.3 | 10 x 20 | 65 | 115 | 0.2 | 29.0 | 57338E3 | 67338E3 | 37338E3 |
| | 4.7 | 12.5 x 20 | 80 | 133 | 0.2 | 20.0 | 57478E3 | 67478E3 | 37478E3 |
| | 10 | 16 x 20 | 140 | 205 | 0.2 | 10.0 | 57109E3 | 67109E3 | 37109E3 |
| | 22 | 16 x 31 | 220 | 367 | 0.2 | 4.6 | 57229E3 | 67229E3 | 37229E3 |
| | 22 | 18 x 25 | 220 | 367 | 0.2 | 4.6 | 97225E3 | 97226E3 | - |
| | 33 | 18 x 35 | 280 | 516 | 0.2 | 3.4 | 57339E3 | 67339E3 | - |

| ADDITIONAL ELECTRICAL DATA | | |
|------------------------------------|--|---|
| PARAMETER | CONDITIONS | VALUE |
| Voltage | | |
| Surge voltage | IEC 60384-4, subclause 4.14: U _R = 160 V to 250 V U _R = 350 V to 400 V | U _s ≤ 1.15 x U _R U _s ≤ 1.10 x U _R |
| Reverse voltage | IEC 60384-4, subclause 4.15 | U _{rev} ≤ 1 V |
| Current | | |
| Leakage current | After 1 min at U _R : CV ≤ 1000 μC CV > 1000 μC | I _{L1} ≤ 0.06 C _R x U _R + 40 μA I _{L1} ≤ 0.03 C _R x U _R + 70 μA |
| | After 5 min at U _R : CV ≤ 1000 μC CV > 1000 μC | I _{L5} ≤ 0.03 C _R x U _R + 15 μA I _{L5} ≤ 0.015 C _R x U _R + 30 μA |
| Inductance | | |
| Equivalent series inductance (ESL) | Case Ø D = 10 mm | Typ. 16 nH |
| | Case Ø D ≥ 12.5 mm | Typ. 18 nH |
| Resistance | | |
| Equivalent series resistance (ESR) | Calculated from tan δ _{max} and C _R (see Table 2) | ESR = tan δ/2 πf C _R |



RIPPLE CURRENT AND USEFUL LIFE

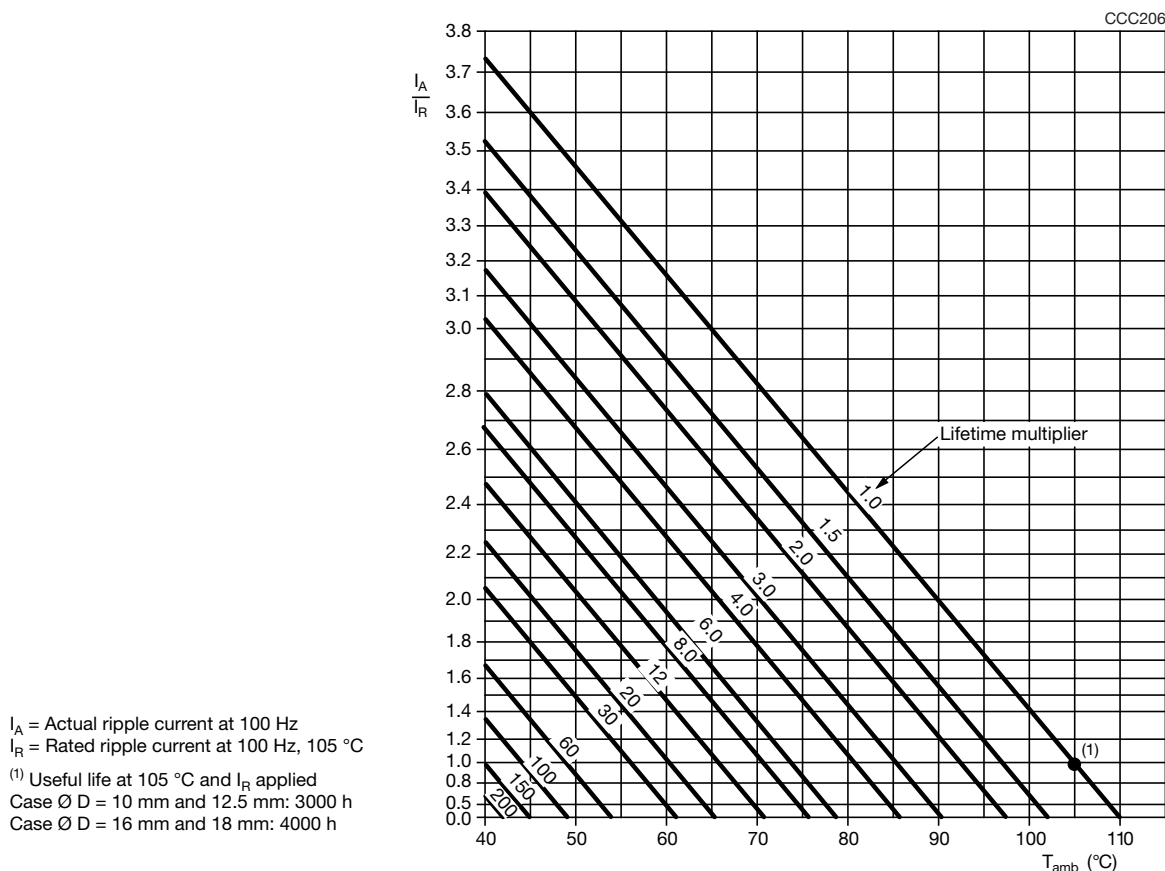


Fig. 5 - Multiplier of useful life as a function of ambient temperature and ripple current load

Table 3

| MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY | |
|---|------------------|
| FREQUENCY (Hz) | I_R MULTIPLIER |
| 50 | 0.75 |
| 100 | 1.00 |
| 300 | 1.20 |
| 1000 | 1.35 |
| 3000 | 1.45 |
| $\geq 10\ 000$ | 1.50 |



Table 4

| TEST PROCEDURES AND REQUIREMENTS | | | |
|--|--|---|--|
| TEST | | PROCEDURE (quick reference) | REQUIREMENTS |
| NAME OF TEST | REFERENCE | | |
| Endurance | IEC 60384-4/ EN130300 subclause 4.15 | $T_{amb} = 105\text{ }^{\circ}\text{C}$; U_R applied; 2000 h | $\Delta C/C: \pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ |
| Useful life | CECC 30301 subclause 1.8.1 | $T_{amb} = 105\text{ }^{\circ}\text{C}$; U_R and I_R applied; Case $\varnothing D = 10\text{ mm}$ and 12.5 mm : 3000 h; Case $\varnothing D = 16\text{ mm}$ and 18 mm : 4000 h | $\Delta C/C: \pm 50\%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ 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; 500 h After test: U_R to be applied for 30 min, 24 h to 48 h before measurement | $\Delta C/C: \pm 20\%$ $\tan \delta \leq 2 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq 2 \times \text{spec. limit}$ |



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