

Aluminum Electrolytic Capacitors, Power High Ripple for Traction, Screw Terminals



LINKS TO ADDITIONAL RESOURCES



3D Models

| QUICK REFERENCE DATA | |
|---|-------------------------------------|
| DESCRIPTION | VALUE |
| Nominal case size (Ø D x L in mm) | 76 x 146 to 76 x 220 ⁽¹⁾ |
| Rated capacitance range (E6 series), C _R | 6000 µF ⁽¹⁾ |
| Tolerance on C _R | -10 % / +30 % |
| Rated voltage range, U _R | 250 V to 450 V ⁽¹⁾ |
| Category temperature range | -40 °C to +85 °C |
| Endurance test at 85 °C | 2000 h |
| Useful life at 85 °C | > 10 000 h |
| Useful life at 70 °C | > 40 000 h |
| Useful life at 40 °C, 1.4 x I _R applied | > 400 000 h |
| Shelf life at 0 V, 85 °C | 500 h |
| Based on sectional specification | IEC 60384-4 / EN 130300 |
| Climatic category IEC 60068 | 40 / 085 / 056 |

Note
⁽¹⁾ Other values available on request

| SELECTION CHART FOR C _R , U _R , AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm) | | | | | |
|---|--------------------|----------|----------|----------|----------|
| C _R (µF) | U _R (V) | | | | |
| | 250 | 300 | 350 | 400 | 450 |
| 6000 | 76 x 146 | 76 x 220 | 76 x 220 | 76 x 220 | 76 x 220 |

Note

- Other values available on request

FEATURES

- Long useful life: > 10 000 h at +85 °C
- Available in case sizes up to Ø 90 mm x 220 mm
- Low ESR
- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Large types, cylindrical aluminum case, insulated with a blue sleeve
- Pressure relief in the sealing
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912


**RoHS
COMPLIANT**

APPLICATIONS

- Traction (metro / subway, light rail, streetcars / tram)
- Heavy duty applications
- Various industrial applications

MARKING

The capacitors are marked with the following information:

- Rated capacitance (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (Q for -10 % / +30 %)
- Rated voltage (in V)
- Date code
- Name of manufacturer
- Code for factory of origin
- “-” sign to identify the negative terminal, visible from the top and side of the capacitor
- Code number
- Climatic category in accordance with IEC 60068

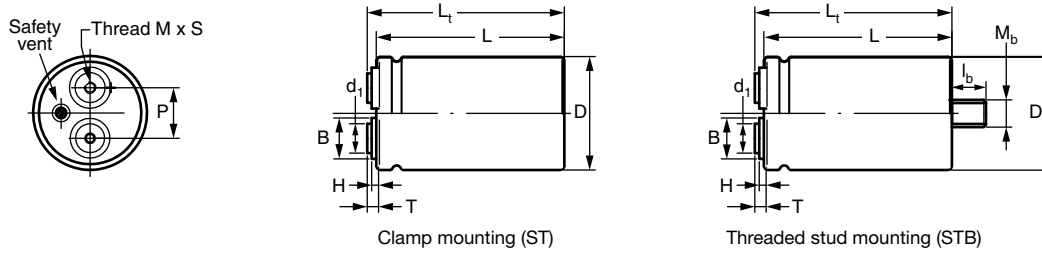
DIMENSIONS in millimeters AND AVAILABLE FORMS


Fig. 1A - High current M5 and M6-13 mm disc: Screw Terminal (ST) and Screw Terminal Bolt nut (STB)
For details refer to Table 1

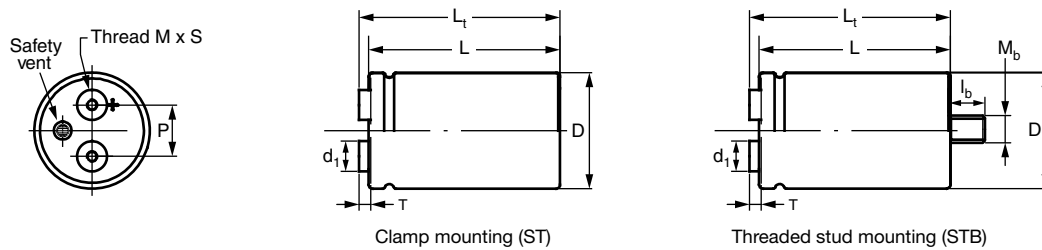


Fig. 1B - High current M6-18 mm disc and 1/4-28 UNF disc: Screw Terminal (ST) and Screw Terminal Bolt nut (STB)
For details refer to Table 1

Note

- Maximum permissible torque which may be applied to the termination screws: 2 Nm for M5; 2.5 Nm for M6 and 1/4-28 UNF. For accessories refer to document "Mounting Accessories", see www.vishay.com/doc?28348
The capacitors are delivered with screws and washers

Table 1

| DIMENSIONS in millimeters, MASS, AND PACKAGING QUANTITIES | | | | | | | | | | | | | | |
|--|---------|-----------|-------------|-----------|-------------|-------------|-------------|-------------|---------------|------------|-----------|-------|---------------|----------|
| DESIGN | DRAWING | $L \pm 1$ | $L_t \pm 1$ | $D \pm 1$ | $P \pm 0.3$ | $T \pm 0.2$ | $H \pm 0.3$ | $B \pm 0.3$ | $d_1 \pm 0.1$ | M | $S \pm 1$ | M_b | $l_b \pm 0.1$ | MASS (g) |
| 76 x 146 M5-13 mm | 1A | 145.8 | 150.2 | 76.4 | 31.8 | 5.5 | 3.5 | 18.3 | 13.0 | M5 | 9.5 | M12 | 16 | 1000 |
| 76 x 146 M6-13 mm | 1A | 145.8 | 150.2 | 76.4 | 31.8 | 5.5 | 3.5 | 18.3 | 13.0 | M6 | 9.5 | M12 | 16 | 1000 |
| 76 x 146 M6-18 mm | 1B | 145.8 | 153.0 | 76.4 | 31.8 | 8.3 | n/a | n/a | 17.3 | M6 | 10.0 | M12 | 16 | 1000 |
| 76 x 146 1/4-28 UNF | 1B | 145.8 | 153.0 | 76.4 | 31.8 | 8.3 | n/a | n/a | 17.3 | 1/4-28 UNF | 10.0 | M12 | 16 | 1000 |
| 76 x 220 M5-13 mm | 1A | 219.8 | 224.2 | 76.4 | 31.8 | 5.5 | 3.5 | 18.3 | 13.0 | M5 | 9.5 | M12 | 16 | 1500 |
| 76 x 220 M6-13 mm | 1A | 219.8 | 224.2 | 76.4 | 31.8 | 5.5 | 3.5 | 18.3 | 13.0 | M6 | 9.5 | M12 | 16 | 1500 |
| 76 x 220 M6-18 mm | 1B | 219.8 | 227.0 | 76.4 | 31.8 | 8.3 | n/a | n/a | 17.3 | M6 | 10.0 | M12 | 16 | 1500 |
| 76 x 220 1/4-28 UNF | 1B | 219.8 | 227.0 | 76.4 | 31.8 | 8.3 | n/a | n/a | 17.3 | 1/4-28 UNF | 10.0 | M12 | 16 | 1500 |

| DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES | | |
|---|--------------------------------------|-----------------------------------|
| DESIGN | PACKAGING QUANTITIES (units per box) | CARDBOX DIMENSIONS L x W x H (mm) |
| 76 x 146 | 12 | 377 x 375 x 168 |
| 76 x 220 | 12 | 377 x 375 x 242 |

Note

- For STB version holds:
H cardboard box: +10 mm



| ELECTRICAL DATA | |
|-----------------|--|
| SYMBOL | DESCRIPTION |
| C _R | Rated capacitance at 100 Hz, tolerance -10 % / +30 % |
| I _R | Rated RMS ripple current at 100 Hz, 85 °C |
| I _{L5} | Max. leakage current after 5 min at U _R |
| ESR | Max. equivalent series resistance at 100 Hz |
| Z | Max. impedance at 20 kHz |

Note

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

Table 2

| ELECTRICAL DATA AND ORDERING INFORMATION | | | | | | | | | | |
|--|----------------------------------|------------------------------|--|---------------------------------|-------------|------|-----------|------|------------------------------|-------------------------|
| U _R (V) | C _R 100 Hz (µF) | CASE SIZE Ø D x L (mm) | I _R 100 Hz 85 °C (A) | I _L 5 min (mA) | ESR (mΩ) | | Z (mΩ) | | ORDERING CODE ⁽¹⁾ | |
| | | | | | MAX. | TYP. | MAX. | TYP. | ST | STB |
| 250 | 6000 | 76 x 146 | 18.35 | 3.0 | 17.6 | 9.7 | 11.5 | 6.9 | MAL21101 <u>3</u> 602E3 | MAL21102 <u>3</u> 602E3 |
| | | | | | | | | | MAL21103 <u>3</u> 602E3 | MAL21104 <u>3</u> 602E3 |
| | | | | | | | | | MAL21105 <u>3</u> 602E3 | MAL21106 <u>3</u> 602E3 |
| | | | | | | | | | MAL21107 <u>3</u> 602E3 | MAL21108 <u>3</u> 602E3 |
| 300 | 6000 | 76 x 220 | 18.35 | 3.6 | 25.3 | 13.9 | 20.0 | 12.0 | MAL21101 <u>0</u> 602E3 | MAL21102 <u>0</u> 602E3 |
| | | | | | | | | | MAL21103 <u>0</u> 602E3 | MAL21104 <u>0</u> 602E3 |
| | | | | | | | | | MAL21105 <u>0</u> 602E3 | MAL21106 <u>0</u> 602E3 |
| | | | | | | | | | MAL21107 <u>0</u> 602E3 | MAL21108 <u>0</u> 602E3 |
| 350 | 6000 | 76 x 220 | 18.49 | 4.2 | 24.0 | 13.2 | 18.6 | 11.2 | MAL21101 <u>5</u> 602E3 | MAL21102 <u>5</u> 602E3 |
| | | | | | | | | | MAL21103 <u>5</u> 602E3 | MAL21104 <u>5</u> 602E3 |
| | | | | | | | | | MAL21105 <u>5</u> 602E3 | MAL21106 <u>5</u> 602E3 |
| | | | | | | | | | MAL21107 <u>5</u> 602E3 | MAL21108 <u>5</u> 602E3 |
| 400 | 6000 | 76 x 220 | 18.45 | 4.8 | 23.8 | 13.1 | 18.6 | 11.2 | MAL21101 <u>6</u> 602E3 | MAL21102 <u>6</u> 602E3 |
| | | | | | | | | | MAL21103 <u>6</u> 602E3 | MAL21104 <u>6</u> 602E3 |
| | | | | | | | | | MAL21105 <u>6</u> 602E3 | MAL21106 <u>6</u> 602E3 |
| | | | | | | | | | MAL21107 <u>6</u> 602E3 | MAL21108 <u>6</u> 602E3 |
| 450 | 6000 | 76 x 220 | 19.76 | 5.4 | 19.1 | 10.5 | 13.6 | 8.2 | MAL21101 <u>7</u> 602E3 | MAL21102 <u>7</u> 602E3 |
| | | | | | | | | | MAL21103 <u>7</u> 602E3 | MAL21104 <u>7</u> 602E3 |
| | | | | | | | | | MAL21105 <u>7</u> 602E3 | MAL21106 <u>7</u> 602E3 |
| | | | | | | | | | MAL21107 <u>7</u> 602E3 | MAL21108 <u>7</u> 602E3 |

Note

- (1) Underlined 8th digit determines form: for details see “Part Number Explanation” table

| PART NUMBER EXPLANATION (Example: 350 V, 6000 µF, M6-13 mm disc) | | | | | | |
|--|-------------|--|---|---------------|------------------------------------|--|
| 1 2 3 4 | 5 6 7 | 8 | 9 | 10 11 12 | 13 14 | |
| MAL2 | 110 | 3 | 5 | 602 | E3 | |
| PREFIX | SERIES NAME | FORM | VOLTAGE | CAPACITANCE | Lead (Pb)-free (RoHS-compliant) | |
| | | <ul style="list-style-type: none"> 1 = high current M5-13 mm disc (ST) 2 = high current M5-13 mm disc, with mounting bolt (STB) 3 = high current M6-13 mm disc (ST) 4 = high current M6-13 mm disc, with mounting bolt (STB) 5 = high current M6-18 mm disc (ST) 6 = high current M6-18 mm disc, with mounting bolt (STB) 7 = US tread 1/4-28 UNF (ST) 8 = US tread 1/4-28 UNF, with mounting bolt (STB) | <ul style="list-style-type: none"> 3 = 250 V 0 = 300 V 5 = 350 V 6 = 400 V 7 = 450 V | 602 = 6000 µF | | |

Note

- Other values or designs are available on request. For more information, please visit the “Product Coding” page: www.vishay.com/doc?28394



| ADDITIONAL ELECTRICAL DATA | | |
|------------------------------------|----------------------|------------------------------------|
| PARAMETER | CONDITIONS | VALUE |
| Voltage | | |
| Surge voltage | | $U_S = 1.1 \times U_R$ |
| Reverse voltage | | $U_{rev} \leq 1 \text{ V}$ |
| Current | | |
| Leakage current | After 1 min at U_R | $I_{L1} \leq 0.006 C_R \times U_R$ |
| | After 5 min at U_R | $I_{L5} \leq 0.002 C_R \times U_R$ |
| Inductance | | |
| Equivalent series inductance (ESL) | | Typ. 20 nH ⁽¹⁾ |

Note

⁽¹⁾ Low ESL designs available on request

RIPPLE CURRENT AND USEFUL LIFE

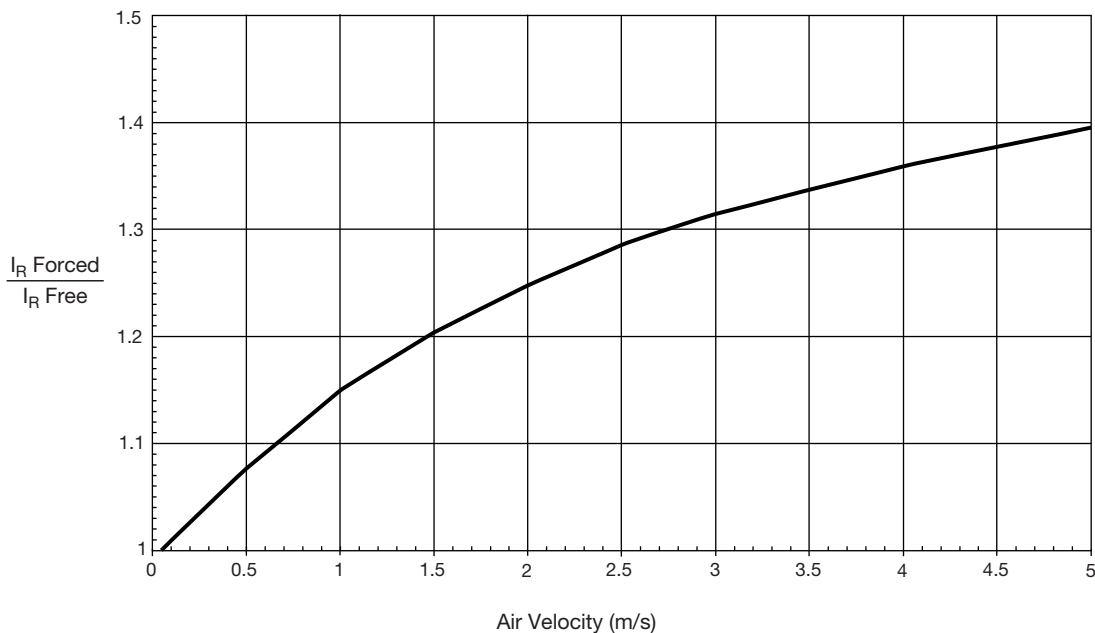


Fig. 2 - Multiplier of ripple current (I_R) as a function of air flow

| MAXIMUM RIPPLE CURRENT | | | |
|-----------------------------------|-----------|-----------------------------------|-------|
| PARAMETER | CONDITION | MAXIMUM RIPPLE CURRENT MULTIPLIER | VALUE |
| Ambient temperature (T_{amb}) | 70 °C | From nomogram; see Fig. 3 | 1.6 |
| Operating frequency (f) | 400 Hz | From frequency; see Table 3 | 1.3 |
| Air flow | 2 m/s | From air flow; see Fig. 2 | 1.25 |

Note

- Calculation example for 110 series. maximum ripple current multiplier = 1.6 x 1.3 x 1.25 = 2.6

Table 3

| ENDURANCE TEST DURATION AND USEFUL LIFE | |
|---|--------------------------------|
| ENDURANCE AT 85 °C (h) | USEFUL LIFE AT 85 °C (h) |
| 2000 | > 10 000 |

Note

- Multiplier of useful life code: CCC205-05

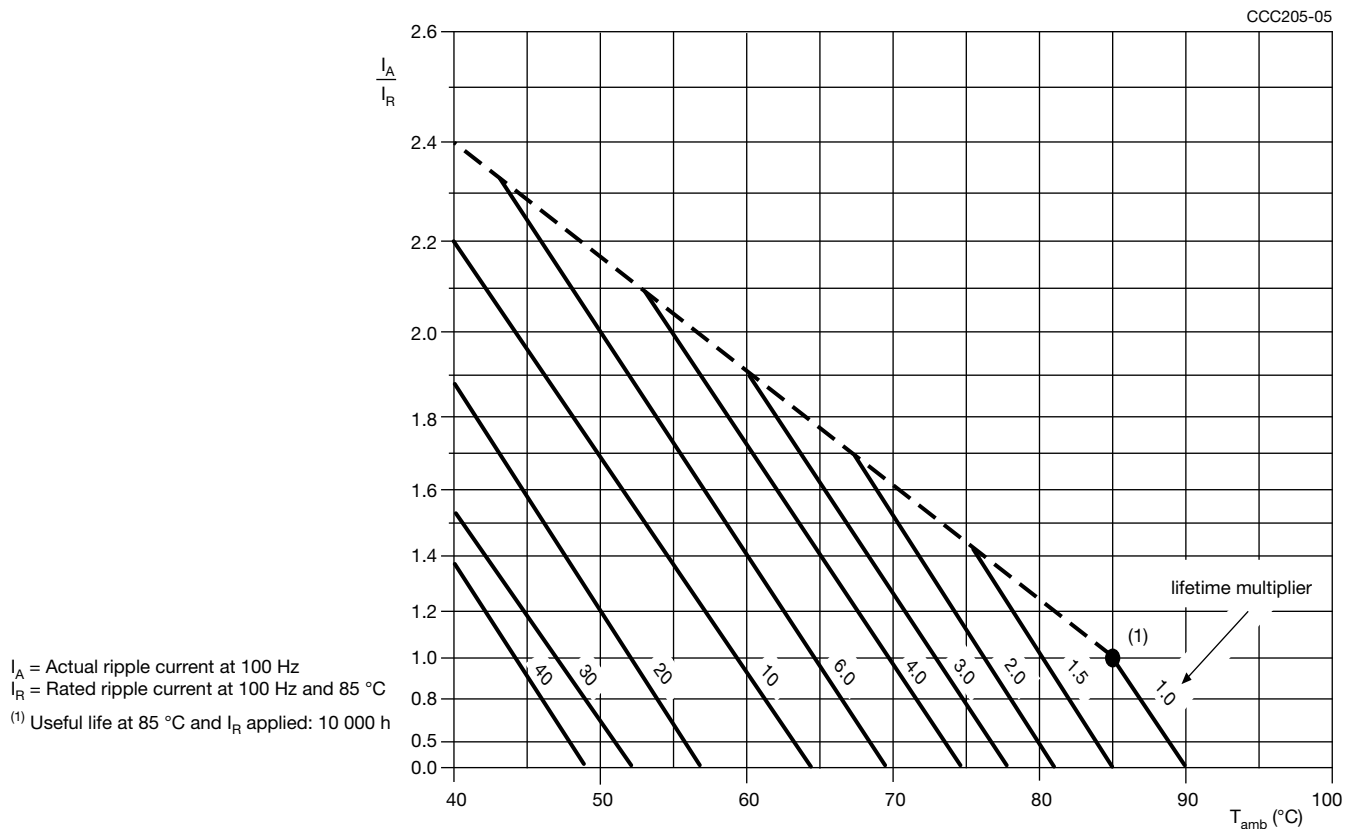


Fig. 3 - Multiplier of useful life as a function of ambient temperature and ripple current load

Table 4

| MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY | | | | | |
|---|------|------|------|------|--------|
| FREQUENCY (Hz) | | | | | |
| 50 | 100 | 200 | 400 | 1000 | 10 000 |
| I_R MULTIPLIER | | | | | |
| 0.90 | 1.00 | 1.20 | 1.30 | 1.40 | 1.50 |



Table 5

| TEST PROCEDURES AND REQUIREMENTS | | | |
|--|--|---|---|
| TEST | | PROCEDURE (quick reference) | REQUIREMENTS |
| NAME OF TEST | REFERENCE | | |
| Endurance | IEC 60384-4 / EN 130300 subclause 4.13 | T _{amb} = 85 °C; U _R applied; 2000 h | ΔC/C: ± 10 % tan δ ≤ 1.3 x spec. limit Z ≤ 2 x spec. limit I _{L5} ≤ spec. limit |
| Useful life | CECC 30301 subclause 1.8.1 | T _{amb} = 85 °C; U _R and I _R applied | ΔC/C: ± 30 % tan δ ≤ 3 x spec. limit Z ≤ 3 x spec. limit I _{L5} ≤ spec. limit no short or open circuit, no visible damage Total failure percentage: ≤ 3 % |
| Shelf life (storage at high temperature) | IEC 60384-4 / EN 130300 subclause 4.17 | T _{amb} = 85 °C; no voltage applied; 500 h after test: U _R to be applied for 30 min, 24 h to 48 h before measurement | ΔC/C: ± 10 % tan δ ≤ 1.2 x spec. limit I _{L5} ≤ 2 x 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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