

## Aluminum Electrolytic Capacitors Power Miniaturized General Purpose - Snap-In



Fig. 1

| QUICK REFERENCE DATA                                |                        |
|---|------------------------|
| DESCRIPTION   | VALUE                  |
| Nominal case size (D x L in mm)                     | 20 x 25 to 35 x 45     |
| Rated capacitance range (E6 series), C <sub>R</sub> | 820 μF to 47 000 μF    |
| Tolerance on C <sub>R</sub>                         | ± 20 %                 |
| Rated voltage range, U <sub>R</sub>                 | 16 V to 100 V          |
| Category temperature range                          | -40 °C to +105 °C      |
| Endurance test at +105 °C                           | 2000 h                 |
| Useful life at +105 °C                              | 2000 h                 |
| Useful life at +85 °C                               | > 5000 h               |
| Shelf life at 0 V, 105 °C                           | 1000 h                 |
| Based on sectional specification                    | IEC 60384-4 / EN130300 |
| Climatic category IEC 60068                         | 40 / 105 / 56          |

**FEATURES**

- Useful life: 2000 h at +105 °C, > 5000 h at +85 °C
- Voltage range from 16 V to 100 V
- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Pressure relief on the top of the aluminum case
- PET insulation sleeve
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


**RoHS  
COMPLIANT**
**APPLICATIONS**

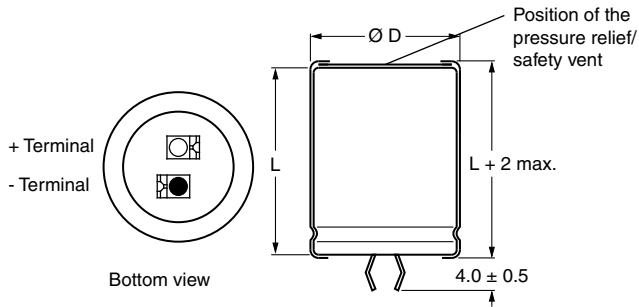
- General purpose, industrial
- Standard and switched mode power supplies
- Audio systems
- DC/DC converters
- Telecom
- Smoothing and filtering

**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 (± 20 %)
- Rated voltage (in V)
- Date code; abbreviation in 2 digits in accordance with IEC 60062
- Name of manufacturer
- Code for factory of origin (04)
- “-” sign to identify the negative terminal, visible from the top and side of the capacitor
- Relevant part of ordering code. Example MAL225638472E3, marking will show: 256 38472
- Climatic category in accordance with IEC 60068
- LL for Long Life

| SELECTION CHART FOR C <sub>R</sub> , U <sub>R</sub> , AND RELEVANT NOMINAL CASE SIZES (∅ D x L in mm) |                    |         |         |         |         |         |         |
|---|--------------------|---------|---------|---------|---------|---------|---------|
| C <sub>R</sub><br>(μF)  | U <sub>R</sub> (V) |         |         |         |         |         |         |
|   | 16                 | 25      | 35      | 50      | 63      | 80      | 100     |
| 820   | -                  | -       | -       | -       | -       | -       | 22 x 30 |
| 1200  | -                  | -       | -       | -       | 22 x 25 | -       | 25 x 30 |
| 1500  | -                  | -       | -       | -       | -       | 22 x 35 | -       |
| 2200  | -                  | -       | -       | 22 x 25 | 22 x 30 | 25 x 30 | 25 x 40 |
| 2700  | -                  | -       | -       | 22 x 25 | -       | -       | 30 x 35 |
| 3300  | -                  | -       | 22 x 25 | 22 x 30 | 25 x 35 | 35 x 25 | 30 x 40 |
| 3900  | -                  | -       | -       | 22 x 35 | -       | -       | -       |
| 4700  | -                  | -       | 22 x 25 | 25 x 30 | 25 x 40 | 35 x 30 | 35 x 40 |
| 5600  | -                  | -       | -       | -       | -       | 35 x 45 | 35 x 45 |
| 6800  | -                  | -       | 25 x 30 | 25 x 40 | 35 x 30 | 35 x 40 | -       |
| 8200  | -                  | 22 x 25 | -       | -       | -       | -       | -       |
| 10 000  | 20 x 25            | -       | 30 x 30 | 30 x 40 | 35 x 40 | -       | -       |
| 15 000  | 22 x 30            | 22 x 40 | -       | -       | -       | -       | -       |
| 22 000  | 25 x 30            | 25 x 40 | 35 x 40 | -       | -       | -       | -       |
| 33 000  | 30 x 30            | -       | -       | -       | -       | -       | -       |
| 47 000  | 35 x 35            | -       | -       | -       | -       | -       | -       |

**DIMENSIONS in millimeters AND AVAILABLE FORMS**


The minus and/or plus terminal can be marked with an imprinted sign.

Fig. 2 - Two terminal snap-in

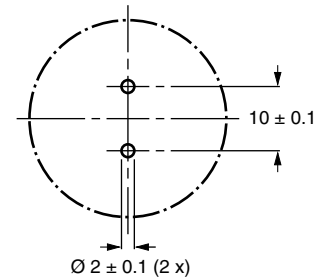


Fig. 3 - Mounting hole diagram

**Table 1**

| <b>DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES</b> |                           |                         |                     |   |   |
|---|---------------------------|-------------------------|---------------------|---|---|
| <b>NOMINAL CASE SIZE<br/>Ø D x L</b>                            | <b>Ø D<sub>max.</sub></b> | <b>L<sub>max.</sub></b> | <b>MASS<br/>(g)</b> | <b>PACKAGING<br/>QUANTITIES<br/>(units per box)</b> | <b>CARDBOARD BOX<br/>DIMENSIONS<br/>L x W x H</b> |
| 20 x 25   | 21                        | 27                      | ≈ 10                | 104   | 310 x 200 x 42                                    |
| 22 x 25   | 23                        | 27                      | ≈ 11                | 84  | 310 x 200 x 42                                    |
| 22 x 30   | 23                        | 32                      | ≈ 15                | 84  | 310 x 200 x 47                                    |
| 22 x 35   | 23                        | 37                      | ≈ 17                | 84  | 310 x 200 x 52                                    |
| 22 x 40   | 23                        | 42                      | ≈ 19                | 84  | 310 x 200 x 57                                    |
| 25 x 25   | 26                        | 27                      | ≈ 15                | 66  | 310 x 200 x 42                                    |
| 25 x 30   | 26                        | 32                      | ≈ 18                | 66  | 310 x 200 x 47                                    |
| 25 x 35   | 26                        | 37                      | ≈ 20                | 66  | 310 x 200 x 52                                    |
| 25 x 40   | 26                        | 42                      | ≈ 27                | 66  | 310 x 200 x 57                                    |
| 25 x 50   | 26                        | 52                      | ≈ 28                | 66  | 310 x 200 x 67                                    |
| 30 x 30   | 31                        | 32                      | ≈ 32                | 45  | 310 x 200 x 47                                    |
| 30 x 35   | 31                        | 37                      | ≈ 35                | 45  | 310 x 200 x 52                                    |
| 30 x 40   | 31                        | 42                      | ≈ 37                | 45  | 310 x 200 x 57                                    |
| 30 x 50   | 31                        | 52                      | ≈ 42                | 45  | 310 x 200 x 67                                    |
| 35 x 25   | 36                        | 27                      | ≈ 32                | 40  | 310 x 200 x 42                                    |
| 35 x 30   | 36                        | 32                      | ≈ 38                | 40  | 310 x 200 x 47                                    |
| 35 x 35   | 36                        | 37                      | ≈ 43                | 40  | 310 x 200 x 52                                    |
| 35 x 40   | 36                        | 42                      | ≈ 50                | 40  | 310 x 200 x 57                                    |
| 35 x 45   | 36                        | 47                      | ≈ 57                | 40  | 310 x 200 x 62                                    |

| <b>ELECTRICAL DATA</b> |   |
|------------------------|---|
| <b>SYMBOL</b>          | <b>DESCRIPTION</b>                                  |
| $C_R$                  | Rated capacitance at 120 Hz, +20 °C                 |
| $I_R$                  | Rated RMS ripple current at 120 Hz, +105 °C         |
| $I_{L5}$               | Max. leakage current after 5 min at $U_R$           |
| ESR                    | Max. equivalent series resistance at 120 Hz, +20 °C |

**Notes**

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

**ORDERING EXAMPLE**

Aluminum electrolytic capacitor 256 series;  
 4700 µF / 63 V;  
 2-terminal snap-in: MAL225638472E3



Table 2

| ELECTRICAL DATA AND ORDERING INFORMATION |                        |                              |  |                           |  |  |                                 |                |
|--|------------------------|------------------------------|--|---------------------------|--|--|---------------------------------|----------------|
| U <sub>R</sub><br>(V)                    | C <sub>R</sub><br>(µF) | CASE SIZE<br>Ø D x L<br>(mm) | I <sub>R</sub><br>120 Hz<br>+105 °C<br>(A) | tan δ<br>120 Hz<br>+20 °C | TYP. ESR<br>120 Hz<br>+20 °C <sup>(1)</sup><br>(Ω) | MAX. ESR<br>120 Hz<br>+20 °C <sup>(1)</sup><br>(Ω) | I <sub>L</sub><br>5 min<br>(mA) | ORDERING CODE  |
| 16                                       | 10 000                 | 20 x 25                      | 1.61                                       | 0.50                      | 0.047  | 0.066  | 1.20                            | MAL225615103E3 |
|  | 15 000                 | 22 x 30                      | 2.20                                       | 0.50                      | 0.031  | 0.044  | 1.47                            | MAL225625153E3 |
|  | 22 000                 | 25 x 30                      | 2.77                                       | 0.50                      | 0.021  | 0.030  | 1.50                            | MAL225635223E3 |
|  | 33 000                 | 30 x 30                      | 3.48                                       | 0.50                      | 0.014  | 0.020  | 1.50                            | MAL225645333E3 |
|  | 47 000                 | 35 x 35                      | 4.85                                       | 0.50                      | 0.010  | 0.014  | 1.50                            | MAL225655473E3 |
| 25                                       | 8200                   | 22 x 25                      | 1.73                                       | 0.45                      | 0.040  | 0.073  | 1.36                            | MAL225626822E3 |
|  | 15 000                 | 22 x 40                      | 2.65                                       | 0.45                      | 0.022  | 0.040  | 1.50                            | MAL225626153E3 |
|  | 22 000                 | 25 x 40                      | 3.22                                       | 0.45                      | 0.015  | 0.027  | 1.50                            | MAL225636223E3 |
|  | 22 000                 | 30 x 30                      | 3.18                                       | 0.45                      | 0.015  | 0.027  | 1.50                            | MAL225646223E3 |
| 35                                       | 3300                   | 22 x 25                      | 1.31                                       | 0.40                      | 0.074  | 0.161  | 1.02                            | MAL225620332E3 |
|  | 4700                   | 22 x 25                      | 1.63                                       | 0.40                      | 0.053  | 0.113  | 1.22                            | MAL225620472E3 |
|  | 6800                   | 25 x 30                      | 2.04                                       | 0.40                      | 0.037  | 0.078  | 1.46                            | MAL225630682E3 |
|  | 10 000                 | 30 x 30                      | 2.75                                       | 0.40                      | 0.027  | 0.053  | 1.50                            | MAL225640103E3 |
|  | 22 000                 | 35 x 40                      | 4.69                                       | 0.40                      | 0.013  | 0.024  | 1.50                            | MAL225650223E3 |
| 50                                       | 2200                   | 22 x 25                      | 1.48                                       | 0.35                      | 0.088  | 0.211  | 0.99                            | MAL225621222E3 |
|  | 2700                   | 22 x 25                      | 1.53                                       | 0.35                      | 0.072  | 0.172  | 1.10                            | MAL225621272E3 |
|  | 3300                   | 22 x 30                      | 1.76                                       | 0.35                      | 0.059  | 0.141  | 1.22                            | MAL225621332E3 |
|  | 3900                   | 22 x 35                      | 1.97                                       | 0.35                      | 0.050  | 0.119  | 1.32                            | MAL225621392E3 |
|  | 4700                   | 25 x 30                      | 2.18                                       | 0.35                      | 0.042  | 0.099  | 1.45                            | MAL225631472E3 |
|  | 6800                   | 25 x 40                      | 2.92                                       | 0.35                      | 0.030  | 0.068  | 1.50                            | MAL225631682E3 |
| 10 000                                   | 30 x 40                | 3.55                         | 0.35                                       | 0.022                     | 0.046  | 1.50   | MAL225641103E3                  |                |
| 63                                       | 1200                   | 22 x 25                      | 1.19                                       | 0.30                      | 0.118  | 0.332  | 0.82                            | MAL225628122E3 |
|  | 2200                   | 22 x 30                      | 1.55                                       | 0.30                      | 0.069  | 0.181  | 1.12                            | MAL225628222E3 |
|  | 2200                   | 25 x 25                      | 1.60                                       | 0.30                      | 0.069  | 0.181  | 1.12                            | MAL225638222E3 |
|  | 3300                   | 25 x 35                      | 2.06                                       | 0.30                      | 0.049  | 0.121  | 1.37                            | MAL225638332E3 |
|  | 4700                   | 25 x 40                      | 2.51                                       | 0.30                      | 0.038  | 0.085  | 1.50                            | MAL225638472E3 |
|  | 4700                   | 30 x 30                      | 2.48                                       | 0.30                      | 0.038  | 0.085  | 1.50                            | MAL225648472E3 |
|  | 6800                   | 35 x 30                      | 3.30                                       | 0.30                      | 0.028  | 0.059  | 1.50                            | MAL225658682E3 |
|  | 10 000                 | 35 x 40                      | 3.90                                       | 0.30                      | 0.020  | 0.040  | 1.50                            | MAL225658103E3 |
| 80                                       | 1500                   | 22 x 35                      | 1.48                                       | 0.25                      | 0.081  | 0.221  | 1.04                            | MAL225622152E3 |
|  | 2200                   | 25 x 30                      | 1.65                                       | 0.25                      | 0.056  | 0.151  | 1.26                            | MAL225632222E3 |
|  | 3300                   | 35 x 25                      | 2.30                                       | 0.25                      | 0.040  | 0.101  | 1.50                            | MAL225652332E3 |
|  | 4700                   | 35 x 30                      | 2.64                                       | 0.25                      | 0.030  | 0.071  | 1.50                            | MAL225652472E3 |
|  | 5600                   | 35 x 45                      | 3.39                                       | 0.25                      | 0.026  | 0.059  | 1.50                            | MAL225652562E3 |
|  | 6800                   | 35 x 40                      | 3.56                                       | 0.25                      | 0.022  | 0.049  | 1.50                            | MAL225652682E3 |
| 100                                      | 820                    | 22 x 30                      | 1.14                                       | 0.20                      | 0.100  | 0.324  | 0.86                            | MAL225629821E3 |
|  | 1200                   | 25 x 30                      | 1.56                                       | 0.20                      | 0.072  | 0.221  | 1.04                            | MAL225639122E3 |
|  | 2200                   | 25 x 40                      | 2.15                                       | 0.20                      | 0.044  | 0.121  | 1.41                            | MAL225639222E3 |
|  | 2700                   | 30 x 35                      | 2.37                                       | 0.20                      | 0.036  | 0.098  | 1.50                            | MAL225649272E3 |
|  | 3300                   | 30 x 40                      | 2.77                                       | 0.20                      | 0.030  | 0.080  | 1.50                            | MAL225649332E3 |
|  | 4700                   | 35 x 40                      | 3.30                                       | 0.20                      | 0.023  | 0.056  | 1.50                            | MAL225659472E3 |
| 5600                                     | 35 x 45                | 3.51                         | 0.20                                       | 0.020                     | 0.047  | 1.50   | MAL225659562E3                  |                |

Note

<sup>(1)</sup> ESR at 100 Hz is approximately 1.05 x ESR 120 Hz

| ADDITIONAL ELECTRICAL DATA         |                |  |
|------------------------------------|----------------|--|
| PARAMETER                          | CONDITIONS     | VALUE                                  |
| <b>Voltage</b>                     |                |  |
| Surge voltage                      | at +85 °C      | U <sub>S</sub> = 1.25 x U <sub>R</sub> |
| Reverse voltage                    | at +105 °C     | U <sub>rev</sub> ≤ 1 V                 |
| <b>Inductance</b>                  |                |  |
| Equivalent series inductance (ESL) | All case sizes | Typ. 19 nH                             |
|                                    |                | Max. 25 nH                             |

**RIPPLE CURRENT AND USEFUL LIFE**
**Table 3**

| ENDURANCE TEST DURATION AND USEFUL LIFE |                           |
|---|---------------------------|
| ENDURANCE AT 105 °C (h)                 | USEFUL LIFE AT 105 °C (h) |
| 2000                                    | 2000                      |

**Note**

- Multiplier of useful life code: CCC208

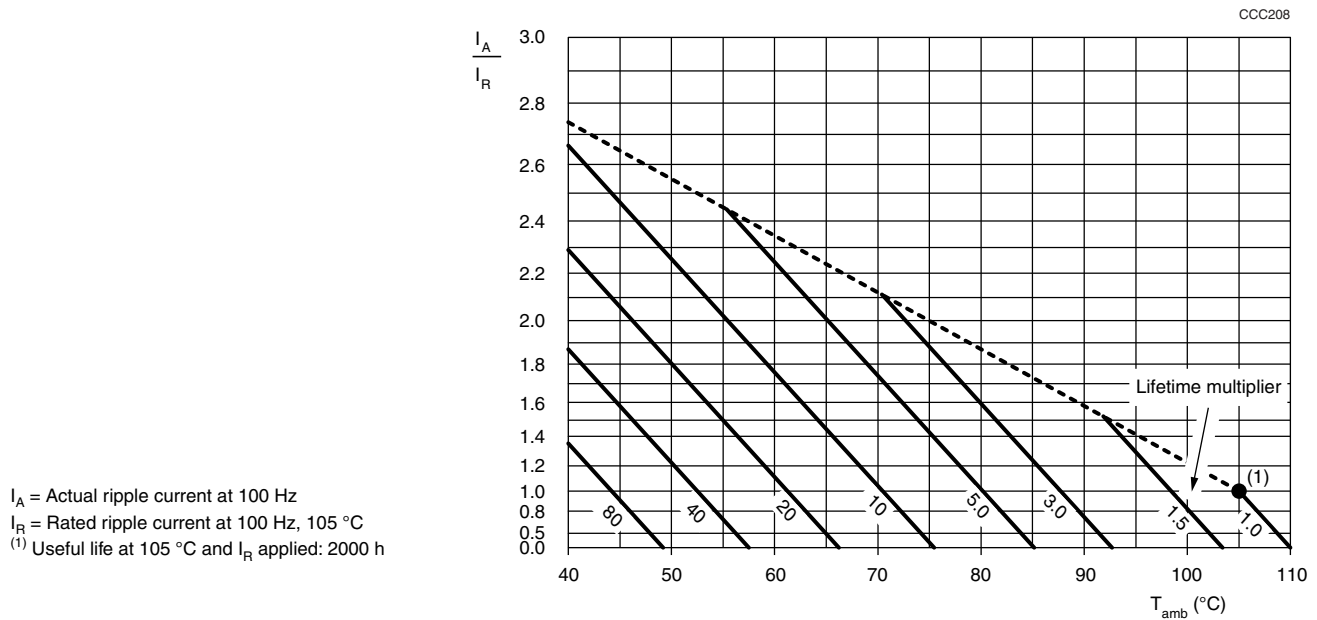


Fig. 4 - Multiplier of useful life as a function of ambient temperature and ripple current load

**Table 4**

| MULTIPLIER OF RIPPLE CURRENT ( $I_R$ ) AS A FUNCTION OF FREQUENCY |      |      |      |      |          |
|---|------|------|------|------|----------|
| FREQUENCY (Hz)  |      |      |      |      |          |
| 50  | 100  | 120  | 500  | 1000 | ≥ 10 000 |
| $I_R$ MULTIPLIER  |      |      |      |      |          |
| 0.92  | 0.95 | 1.00 | 1.13 | 1.19 | 1.20     |



Table 5

| TEST PROCEDURES AND REQUIREMENTS            |                                       |   |   |
|---|---------------------------------------|---|---|
| TEST  |                                       | PROCEDURE<br>(quick reference)  | REQUIREMENTS  |
| NAME OF TEST                                | REFERENCE                             |   |   |
| Endurance                                   | IEC 60384-4 / EN130300 subclause 4.13 | $T_{amb} = 105\text{ }^{\circ}\text{C}$ ; $U_R$ and $I_R$ applied; 2000 h   | $\Delta C/C: \pm 20\%$<br>$\tan \delta \leq 2 \times \text{spec. limit}$<br>$I_{L5} \leq \text{spec. limit}$  |
| Useful life                                 | CECC 30301 subclause 4.13             | $T_{amb} = 105\text{ }^{\circ}\text{C}$ ; $U_R$ and $I_R$ applied; 2000 h<br><br>$T_{amb} = 85\text{ }^{\circ}\text{C}$ ; $U_R$ and $I_R$ applied; > 5000 h | $\Delta C/C: \pm 20\%$<br>$\tan \delta \leq 2 \times \text{spec. limit}$<br>$I_{L5} \leq \text{spec. limit}$<br>no short or open circuit,<br>no visible damage<br>total failure percentage $\leq 1\%$ |
| Shelf life<br>(storage at high temperature) | IEC 60384-4 / EN130300 subclause 4.17 | $T_{amb} = 105\text{ }^{\circ}\text{C}$ ; no voltage applied; 1000 h<br>after test: $U_R$ to be applied for 30 min, 24 h to 48 h before measurement         | $\Delta C/C: \pm 20\%$<br>$\tan \delta \leq 1.5 \times \text{spec. limit}$<br>$I_{L5} \leq 2 \times \text{spec. limit}$   |
| Vibration                                   | IEC 60384-4 / EN130300 subclause 4.8  | 10 Hz to 55 Hz; 0.037 m or 5 g (whichever is less); 3 axis; 2 h per axis  | $\Delta C/C: \pm 10\%$<br>$\tan \delta \leq \text{spec. limit}$<br>$I_{L5} \leq \text{spec. limit}$   |

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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