

# Aluminum Electrolytic Capacitors

## Power High Ripple Current Long Life 4-Terminal Snap-In



### ADDITIONAL RESOURCES

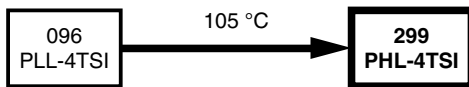


Fig. 1

| QUICK REFERENCE DATA             |                             |
|----------------------------------|-----------------------------|
| DESCRIPTION                      | VALUE                       |
| Nominal case size (D x L in mm)  | 35 x 50 to 45 x 100         |
| Rated capacitance range $C_R$    | 470 $\mu$ F to 2200 $\mu$ F |
| Tolerance on $C_R$               | $\pm 20\%$                  |
| Rated voltage range, $U_R$       | 400 V to 450 V              |
| Category temperature range       | -40 °C to +105 °C           |
| Endurance test at 105 °C         | 2000 h                      |
| Useful life at 105 °C            | 5000 h                      |
| Shelf life at 0 V, 105 °C        | 1000 h                      |
| Based on sectional specification | IEC 60384-4 / EN 130300     |
| Climatic category IEC 60068      | 40 / 105 / 56               |

### FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Large types, minimized dimensions, cylindrical aluminum case, insulated with a blue sleeve
- Pressure relief on the side of the aluminum case
- Very long useful life: 5000 h at 105 °C
- Temperature range up to 105 °C
- Stable mounting and keyed polarity
- High ripple current capability
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


**RoHS  
COMPLIANT**

### APPLICATIONS

- Switched mode power supplies
- Renewable energy power converters
- Energy storage in pulse systems

### MARKING

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

- Rated capacitance (in  $\mu$ F)
- Tolerance code on rated capacitance, code letter in accordance with IEC 60062 (M for  $\pm 20\%$ )
- 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
- (Partial) ordering code
- Climatic category in accordance with IEC 60068

| SELECTION CHART FOR $C_R$ , $U_R$ , AND RELEVANT NOMINAL CASE SIZES ( $\varnothing$ D x L in mm) |           |          |
|--|-----------|----------|
| $C_R$<br>( $\mu$ F)  | $U_R$ (V) |          |
|  | 400       | 450      |
| 470  | -         | 35 x 50  |
|  | -         | 40 x 40  |
| 560  | 35 x 50   | 35 x 60  |
|  | -         | 40 x 50  |
| 680  | 40 x 40   | 35 x 70  |
|  | 35 x 60   | 35 x 80  |
| 820  | 40 x 50   | 40 x 60  |
|  | -         | 35 x 100 |
| 1000   | 35 x 70   | 40 x 80  |
|  | -         | 45 x 60  |
|  | 35 x 80   | -        |
| 1200   | 40 x 70   | 45 x 70  |
|  | 45 x 60   | -        |
|  | 35 x 100  | 40 x 100 |
| 1500   | 45 x 70   | 45 x 80  |
|  | 40 x 100  | 45 x 100 |
| 1800   | 45 x 80   | -        |
|  | 45 x 100  | -        |
| 2200   | 45 x 100  | -        |

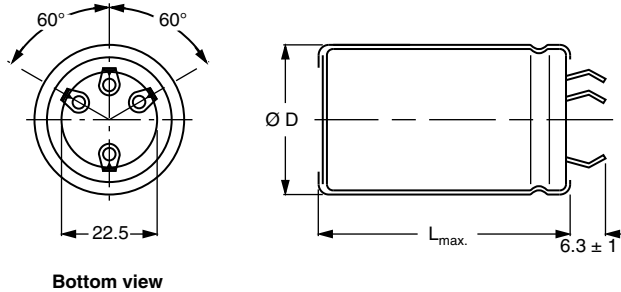
**DIMENSIONS in millimeters AND AVAILABLE FORMS**
**4-TERMINAL SNAP-IN**


Fig. 2 - 4-Terminal snap-in

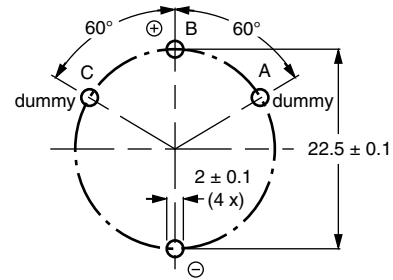


Fig. 3 - Mounting hole diagram

Dummy terminals (A and C) must be free from the electrical circuit.

Table 1

| <b>DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES</b> |                     |                   |          |                                      |                                    |
|---|---------------------|-------------------|----------|--------------------------------------|------------------------------------|
| NOMINAL CASE SIZE<br>Ø D x L                                    | Ø D <sub>MAX.</sub> | L <sub>max.</sub> | MASS (g) | PACKAGING QUANTITIES (units per box) | CARDBOARD BOX DIMENSIONS L x W x H |
| 35 x 50   | 36                  | 52                | 72       | 50                                   | 390 x 198 x 60                     |
| 35 x 60   | 36                  | 62                | 91       | 50                                   | 390 x 198 x 70                     |
| 35 x 70   | 36                  | 72                | 103      | 50                                   | 377 x 375 x 97                     |
| 35 x 80   | 36                  | 82                | 115      | 50                                   | 377 x 375 x 107                    |
| 35 x 100  | 36                  | 102               | 151      | 50                                   | 377 x 375 x 127                    |
| 40 x 40   | 41                  | 42                | 70       | 50                                   | 440 x 223 x 60                     |
| 40 x 50   | 41                  | 52                | 94       | 50                                   | 440 x 223 x 70                     |
| 40 x 60   | 41                  | 62                | 118      | 25                                   | 230 x 230 x 80                     |
| 40 x 70   | 41                  | 72                | 134      | 25                                   | 230 x 230 x 90                     |
| 40 x 80   | 41                  | 82                | 150      | 25                                   | 230 x 230 x 100                    |
| 40 x 100  | 41                  | 102               | 176      | 25                                   | 230 x 230 x 120                    |
| 45 x 60   | 46                  | 62                | 150      | 36                                   | 377 x 375 x 87                     |
| 45 x 70   | 46                  | 72                | 170      | 36                                   | 377 x 375 x 97                     |
| 45 x 80   | 46                  | 82                | 190      | 36                                   | 377 x 375 x 107                    |
| 45 x 100  | 46                  | 102               | 250      | 36                                   | 377 x 375 x 127                    |

| <b>ELECTRICAL DATA</b> |  |
|------------------------|--|
| SYMBOL                 | DESCRIPTION  |
| C <sub>R</sub>         | Rated capacitance at 100 Hz                        |
| I <sub>R</sub>         | Rated RMS ripple current at 100 Hz and 105 °C      |
| I <sub>L5</sub>        | Max. leakage current after 5 min at U <sub>R</sub> |
| ESR                    | Max. equivalent series resistance at 100 Hz        |
| Z                      | Max. impedance at 10 kHz                           |

**Note**

- Unless otherwise specified, all electrical values in Table 2 apply at T<sub>amb</sub> = 20 °C, P = 86 kPa to 106 kPa, RH = 45 % to 75 %

**ORDERING EXAMPLE**

Electrolytic capacitor 299 series

2200 µF / 400 V

**4-terminal snap-in:**

Ordering code: MAL2 299 56222 E3

Former 12NC: 2222 299 56222



Table 2

| ELECTRICAL DATA AND ORDERING INFORMATION |                        |   |   |                                  |                            |                            |                          |                          |                                   |
|--|------------------------|---|---|----------------------------------|----------------------------|----------------------------|--------------------------|--------------------------|-----------------------------------|
| U <sub>R</sub><br>(V)                    | C <sub>R</sub><br>(µF) | NOMINAL<br>CASE SIZE<br>Ø D x L<br>(mm) | I <sub>R</sub><br>100 Hz<br>105 °C<br>(A) | I <sub>L5</sub><br>5 min<br>(mA) | TYP. ESR<br>100 Hz<br>(mΩ) | MAX. ESR<br>100 Hz<br>(mΩ) | TYP. Z<br>10 kHz<br>(mΩ) | MAX. Z<br>10 kHz<br>(mΩ) | CATALOG<br>NUMBER<br>MAL2299..... |
| 400                                      | 560                    | 35 x 50                                 | 2.70                                      | 0.452                            | 170                        | 220                        | 130                      | 160                      | 56561E3                           |
|  | 680                    | 40 x 40                                 | 2.79                                      | 0.548                            | 150                        | 190                        | 110                      | 140                      | 56681E3                           |
|  | 820                    | 35 x 60                                 | 3.44                                      | 0.660                            | 120                        | 150                        | 90                       | 110                      | 56821E3                           |
|  | 820                    | 40 x 50                                 | 3.51                                      | 0.660                            | 120                        | 160                        | 90                       | 110                      | 66821E3                           |
|  | 1000                   | 35 x 70                                 | 3.88                                      | 0.804                            | 100                        | 130                        | 70                       | 90                       | 56102E3                           |
|  | 1200                   | 35 x 80                                 | 4.34                                      | 0.964                            | 90                         | 110                        | 60                       | 80                       | 56122E3                           |
|  | 1200                   | 40 x 70                                 | 4.50                                      | 0.964                            | 90                         | 110                        | 60                       | 80                       | 66122E3                           |
|  | 1200                   | 45 x 60                                 | 4.61                                      | 0.964                            | 90                         | 110                        | 60                       | 80                       | 76122E3                           |
|  | 1500                   | 35 x 100                                | 5.54                                      | 1.204                            | 70                         | 90                         | 50                       | 60                       | 56152E3                           |
|  | 1500                   | 45 x 70                                 | 5.20                                      | 1.204                            | 70                         | 90                         | 60                       | 70                       | 66152E3                           |
|  | 1800                   | 40 x 100                                | 6.02                                      | 1.444                            | 50                         | 70                         | 40                       | 50                       | 56182E3                           |
|  | 1800                   | 45 x 80                                 | 5.74                                      | 1.444                            | 60                         | 80                         | 50                       | 60                       | 66182E3                           |
|  | 2200                   | 45 x 100                                | 6.77                                      | 1.764                            | 50                         | 60                         | 40                       | 50                       | 56222E3                           |
| 450                                      | 470                    | 35 x 50                                 | 2.54                                      | 0.427                            | 190                        | 240                        | 130                      | 160                      | 57471E3                           |
|  | 470                    | 40 x 40                                 | 2.45                                      | 0.427                            | 190                        | 240                        | 140                      | 170                      | 67471E3                           |
|  | 560                    | 35 x 60                                 | 2.96                                      | 0.508                            | 160                        | 200                        | 100                      | 130                      | 57561E3                           |
|  | 560                    | 40 x 50                                 | 3.05                                      | 0.508                            | 160                        | 200                        | 110                      | 140                      | 67561E3                           |
|  | 680                    | 35 x 70                                 | 3.34                                      | 0.616                            | 120                        | 160                        | 90                       | 110                      | 57681E3                           |
|  | 820                    | 35 x 80                                 | 3.76                                      | 0.742                            | 110                        | 140                        | 70                       | 90                       | 57821E3                           |
|  | 820                    | 40 x 60                                 | 3.73                                      | 0.742                            | 110                        | 140                        | 80                       | 100                      | 67821E3                           |
|  | 1000                   | 35 x 100                                | 4.74                                      | 0.904                            | 90                         | 110                        | 60                       | 80                       | 57102E3                           |
|  | 1000                   | 40 x 80                                 | 4.41                                      | 0.904                            | 90                         | 110                        | 60                       | 80                       | 67102E3                           |
|  | 1000                   | 45 x 60                                 | 4.34                                      | 0.904                            | 90                         | 120                        | 60                       | 80                       | 77102E3                           |
|  | 1200                   | 45 x 70                                 | 4.84                                      | 1.084                            | 80                         | 100                        | 60                       | 70                       | 57122E3                           |
|  | 1500                   | 40 x 100                                | 5.67                                      | 1.354                            | 60                         | 80                         | 40                       | 50                       | 57152E3                           |
|  | 1500                   | 45 x 80                                 | 5.39                                      | 1.354                            | 60                         | 80                         | 50                       | 60                       | 67152E3                           |
|  | 1800                   | 45 x 100                                | 6.36                                      | 1.624                            | 50                         | 70                         | 40                       | 50                       | 57182E3                           |

| ADDITIONAL ELECTRICAL DATA         |                               |  |
|------------------------------------|-------------------------------|--|
| PARAMETER                          | CONDITIONS                    | VALUE  |
| <b>Voltage</b>                     |                               |  |
| Surge voltage                      | ≥ 400 V versions              | U <sub>s</sub> = 1.1 x U <sub>R</sub>                          |
| Reverse voltage                    |                               | U <sub>rev</sub> ≤ 1 V   |
| <b>Current</b>                     |                               |  |
| Leakage current                    | After 1 min at U <sub>R</sub> | I <sub>L1</sub> ≤ 0.006 C <sub>R</sub> x U <sub>R</sub> + 4 µA |
|                                    | After 5 min at U <sub>R</sub> | I <sub>L5</sub> ≤ 0.002 C <sub>R</sub> x U <sub>R</sub> + 4 µA |
| <b>Inductance</b>                  |                               |  |
| Equivalent series inductance (ESL) | All case sizes                | Ca. 20 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                                    | 5000                      |

**Note**

- Multiplier of useful life code: CCC206-5

CCC206-5

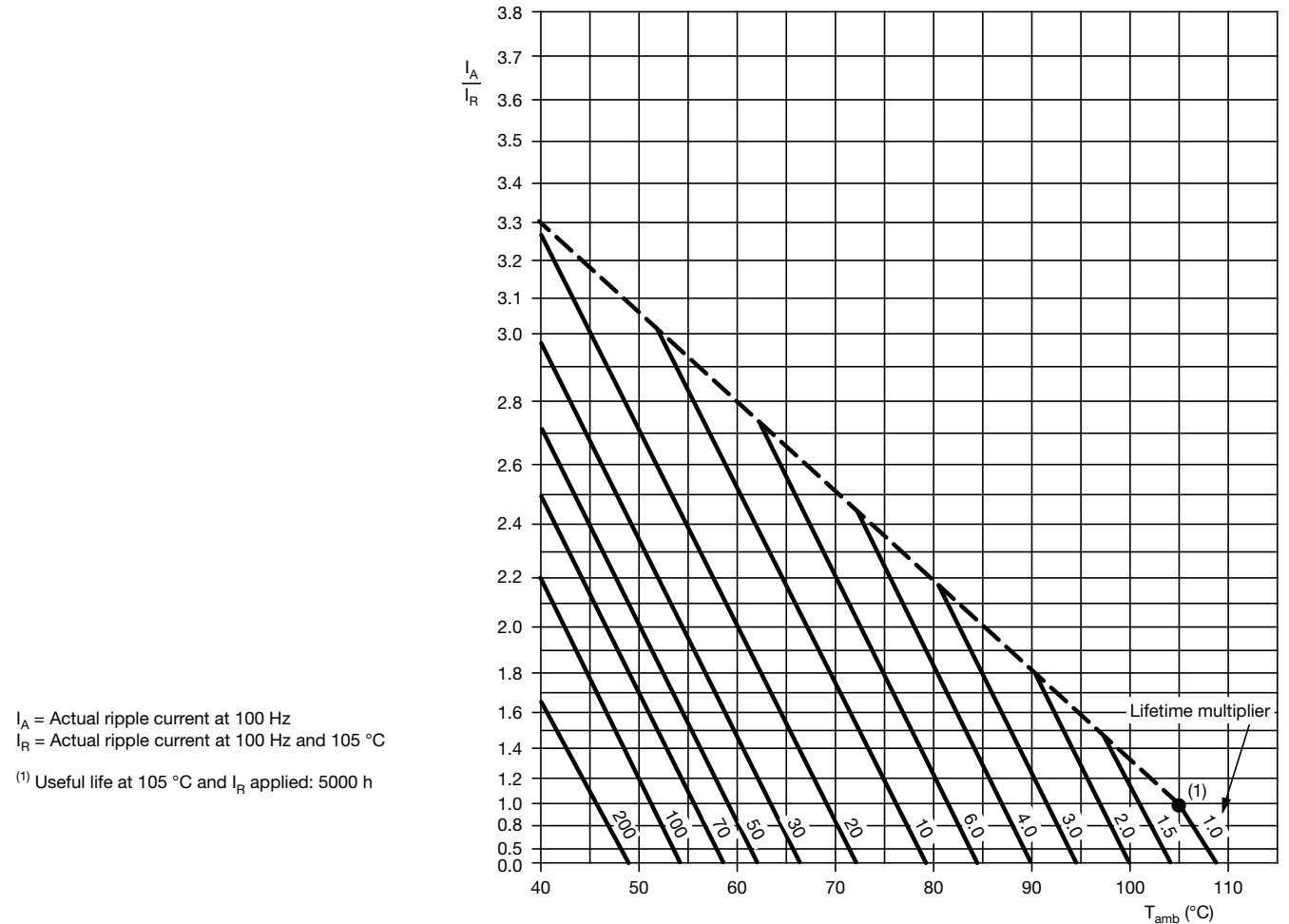


Fig. 4 - Multiplier of useful life as a function of ambient temperature and ripple current load

Table 4

| MULTIPLIER OF RIPPLE CURRENT ( $I_R$ ) AS A FUNCTION OF FREQUENCY |     |     |     |      |        |
|---|-----|-----|-----|------|--------|
| FREQUENCY (Hz)  |     |     |     |      |        |
| 50  | 100 | 200 | 400 | 1000 | 10 000 |
| $I_R$ MULTIPLIER  |     |     |     |      |        |
| 0.9   | 1.0 | 1.2 | 1.3 | 1.4  | 1.5    |



Table 5

| <b>TEST PROCEDURES AND REQUIREMENTS</b> |                                       |  |  |
|---|---------------------------------------|--|--|
| <b>TEST</b>                             |                                       | <b>PROCEDURE<br/>(quick reference)</b>   | <b>REQUIREMENTS</b>  |
| <b>NAME OF TEST</b>                     | <b>REFERENCE</b>                      |  |  |
| Endurance                               | IEC 60384-4 / EN130300 subclause 4.13 | $T_{amb} = 105\text{ }^{\circ}\text{C}$ ; $U_R$ applied<br>2000 h  | $\Delta C/C: \pm 10\%$<br>$ESR \leq 1.3 \times \text{spec. limit}$<br>$Z \leq 2 \times \text{spec. limit}$<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;<br>5000 h   | $\Delta C/C: \pm 30\%$<br>$ESR \leq 3 \times \text{spec. limit}$<br>$Z \leq 3 \times \text{spec. limit}$<br>$I_{L5} \leq \text{spec. limit}$<br>no short or open circuit,<br>no visible damage<br>total failure percentage: $\leq 3\%$ |
| Shelf life                              | IEC 60384-4 / EN130300 subclause 4.17 | $T_{amb} = 105\text{ }^{\circ}\text{C}$ ; no voltage applied;<br>1000 h<br><br>After test: $U_R$ to be applied for 30 min<br>24 h to 48 h before measurement | $\Delta C/C: \pm 10\%$<br>$ESR \leq 1.2 \times \text{spec. limit}$<br>$I_{L5} \leq 2 \times \text{spec. limit}$  |

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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