

## Aluminum Electrolytic Capacitors

### Power Ultra High Ripple Current Snap-In for Solar



#### LINKS TO ADDITIONAL RESOURCES

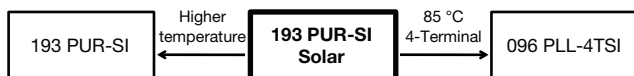


Fig. 1

| QUICK REFERENCE DATA                            |                            |
|-------------------------------------------------|----------------------------|
| DESCRIPTION                                     | VALUE                      |
| Nominal case size (D x L in mm)                 | 35 x 30 to 35 x 60         |
| Rated capacitance range, $C_R$                  | 220 $\mu$ F to 560 $\mu$ F |
| Tolerance on $C_R$                              | $\pm 20 \%$                |
| Rated voltage, $U_R$                            | 500 V      570 V           |
| Rated temperature range                         | -40 °C to +60 °C           |
| Endurance at $U_R$ , 60 °C, no ripple applied   | 6000 h                     |
| Category voltage, $U_C$                         | 450 V      475 V           |
| Category temperature range                      | -40 °C to +105 °C          |
| Useful life at $U_C$ , 105 °C, $I_R$ applied    | 6000 h                     |
| Operation up to 600 V, 60 °C, no ripple applied | -      1000 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

- Tailored design for solar PV inverters
- Specified for higher voltage, up to 600 V at specific operation conditions
- Long useful life: 6000 h at +105 °C
- > 25 years 24/7 application life at 60 °C
- High ripple current capability
- High reliability
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



#### APPLICATIONS

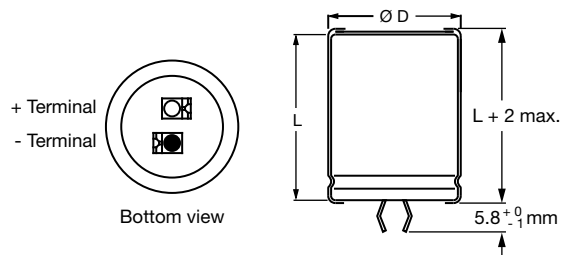
- Solar PV inverters
- Industrial motor control
- Power supply

#### 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 ( $\pm 20 \%$ )
- Rated voltage (in V)
- Two digit date code, in accordance with IEC 60062
- 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
- “LL” for long life grade

| SELECTION CHART FOR $C_R$ , $U_R$ , AND RELEVANT NOMINAL CASE SIZES ( $\varnothing$ D x L in mm) |              |         |         |         |         |
|--------------------------------------------------------------------------------------------------|--------------|---------|---------|---------|---------|
| $C_R$<br>( $\mu$ F)                                                                              | $U_R$<br>(V) |         |         |         |         |
| 220                                                                                              | 35 x 30      | -       | -       | -       | -       |
| 330                                                                                              | -            | 35 x 40 | -       | -       | -       |
| 390                                                                                              | -            | -       | 35 x 45 | -       | -       |
| 470                                                                                              | -            | -       | -       | 35 x 50 | -       |
| 560                                                                                              | -            | -       | -       | -       | 35 x 60 |

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


The minus terminal can be marked with a black dot or with an imprinted “-” sign.

Fig. 2 - Two terminal snap-in

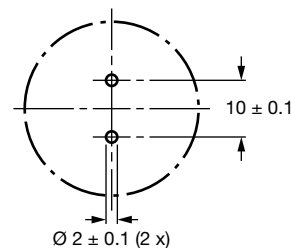
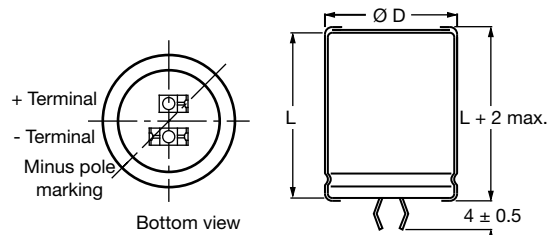
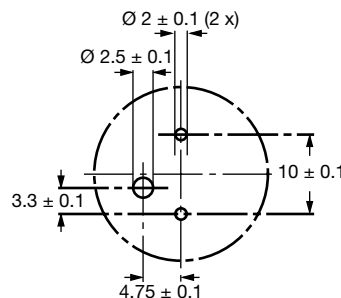


Fig. 3 - Mounting hole diagram

**THREE TERMINAL SNAP-IN**


The negative terminal has **TWO** pins which are **BOTH** electrically connected

Fig. 4 - Three terminal snap-in



The 10 mm spacing of the 2 pin snap-in is used as the base layout and a third hole is added. The third hole is closer to the negative primary hole so that polarization is always maintained, together with added mechanical stability.

Fig. 5 - Mounting hole diagram

Table 1

| <b>DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES</b> |                     |                   |          |                                     |                                    |
|-----------------------------------------------------------------|---------------------|-------------------|----------|-------------------------------------|------------------------------------|
| NOMINAL CASE SIZE                                               | Ø D <sub>max.</sub> | L <sub>max.</sub> | MASS (g) | PACKAGING QUANTITIES (unit per box) | CARDBOARD BOX DIMENSIONS L x W x H |
| 35 x 30                                                         | 36                  | 32                | 40       | 50                                  | 390 x 198 x 44                     |
| 35 x 40                                                         | 36                  | 42                | 56       | 50                                  | 390 x 198 x 54                     |
| 35 x 45                                                         | 36                  | 47                | 64       | 50                                  | 390 x 198 x 59                     |
| 35 x 50                                                         | 36                  | 52                | 72       | 50                                  | 390 x 198 x 64                     |
| 35 x 60                                                         | 36                  | 62                | 88       | 50                                  | 377 x 375 x 88                     |

| ELECTRICAL DATA |                                               |
|-----------------|-----------------------------------------------|
| SYMBOL          | DESCRIPTION                                   |
| $C_R$           | Rated capacitance at 100 Hz                   |
| $I_R$           | Rated RMS ripple current at 100 Hz and 105 °C |
| $I_{L5}$        | Max. leakage current after 5 min at $U_R$     |
| 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  $T_{amb} = 20\text{ °C}$ ,  $P = 86\text{ kPa}$  to  $106\text{ kPa}$ ,  $RH = 45\%$  to  $75\%$

**Table 2**

| ELECTRICAL DATA AND ORDERING INFORMATION |              |                            |                                               |                                                 |                        |                                        |                                      |                               |                |
|------------------------------------------|--------------|----------------------------|-----------------------------------------------|-------------------------------------------------|------------------------|----------------------------------------|--------------------------------------|-------------------------------|----------------|
| $U_R$<br>(V)                             | $U_C$<br>(V) | $C_R$<br>( $\mu\text{F}$ ) | CASE SIZE<br>$\varnothing D \times L$<br>(mm) | $I_R$<br>100 Hz<br>105 °C<br>(A) <sup>(1)</sup> | $I_L$<br>5 min<br>(mA) | ESR<br>100 Hz<br>MAX.<br>(m $\Omega$ ) | Z<br>10 kHz<br>MAX.<br>(m $\Omega$ ) | ORDERING CODE<br>MAL2193..... |                |
|                                          |              |                            |                                               |                                                 |                        |                                        |                                      | 2-TERM.                       | 3-TERM.        |
| 500                                      | 450          | 220                        | 35 x 30                                       | 1.35                                            | 0.99                   | 900                                    | 600                                  | MAL219390101E3                | MAL219390111E3 |
|                                          |              | 330                        | 35 x 40                                       | 1.74                                            | 1.49                   | 600                                    | 400                                  | MAL219390102E3                | MAL219390112E3 |
|                                          |              | 390                        | 35 x 45                                       | 1.94                                            | 1.76                   | 500                                    | 350                                  | MAL219390103E3                | MAL219390113E3 |
|                                          |              | 470                        | 35 x 50                                       | 2.18                                            | 2.12                   | 450                                    | 300                                  | MAL219390104E3                | MAL219390114E3 |
|                                          |              | 560                        | 35 x 60                                       | 2.52                                            | 2.52                   | 350                                    | 250                                  | MAL219390105E3                | MAL219390115E3 |
| 570                                      | 475          | 220                        | 35 x 30                                       | 1.32                                            | 1.05                   | 600                                    | 450                                  | MAL219390121E3                | MAL219390131E3 |
|                                          |              | 330                        | 35 x 40                                       | 1.70                                            | 1.57                   | 400                                    | 300                                  | MAL219390122E3                | MAL219390132E3 |
|                                          |              | 390                        | 35 x 45                                       | 1.90                                            | 1.85                   | 350                                    | 250                                  | MAL219390123E3                | MAL219390133E3 |
|                                          |              | 470                        | 35 x 50                                       | 2.14                                            | 2.23                   | 300                                    | 200                                  | MAL219390124E3                | MAL219390134E3 |
|                                          |              | 560                        | 35 x 60                                       | 2.46                                            | 2.66                   | 250                                    | 150                                  | MAL219390125E3                | MAL219390135E3 |

**Notes**

- Other case sizes, terminations and capacitance values available on request

<sup>(1)</sup> At  $U_{max.} \leq U_C$ 

| ADDITIONAL ELECTRICAL DATA         |                      |                                   |
|------------------------------------|----------------------|-----------------------------------|
| PARAMETER                          | CONDITIONS           | VALUE                             |
| <b>Voltage</b>                     |                      |                                   |
| Surge voltage                      |                      | $U_S = 1.1 \times U_C$            |
| Reverse voltage                    |                      | $U_{rev} \leq 1\text{ V}$         |
| <b>Current</b>                     |                      |                                   |
| Leakage current                    | After 5 min at $U_C$ | $I_{L5} \leq 0.01 C_R \times U_C$ |
| <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 |                                 |        |
|-----------------------------------------|---------------------------------|--------|
| PARAMETER                               | CONDITIONS                      | VALUE  |
| Endurance                               | $U_R$ , 60 °C, no $I_R$ applied | 6000 h |
| Useful life                             | $U_C$ , 105 °C, $I_R$ applied   |        |

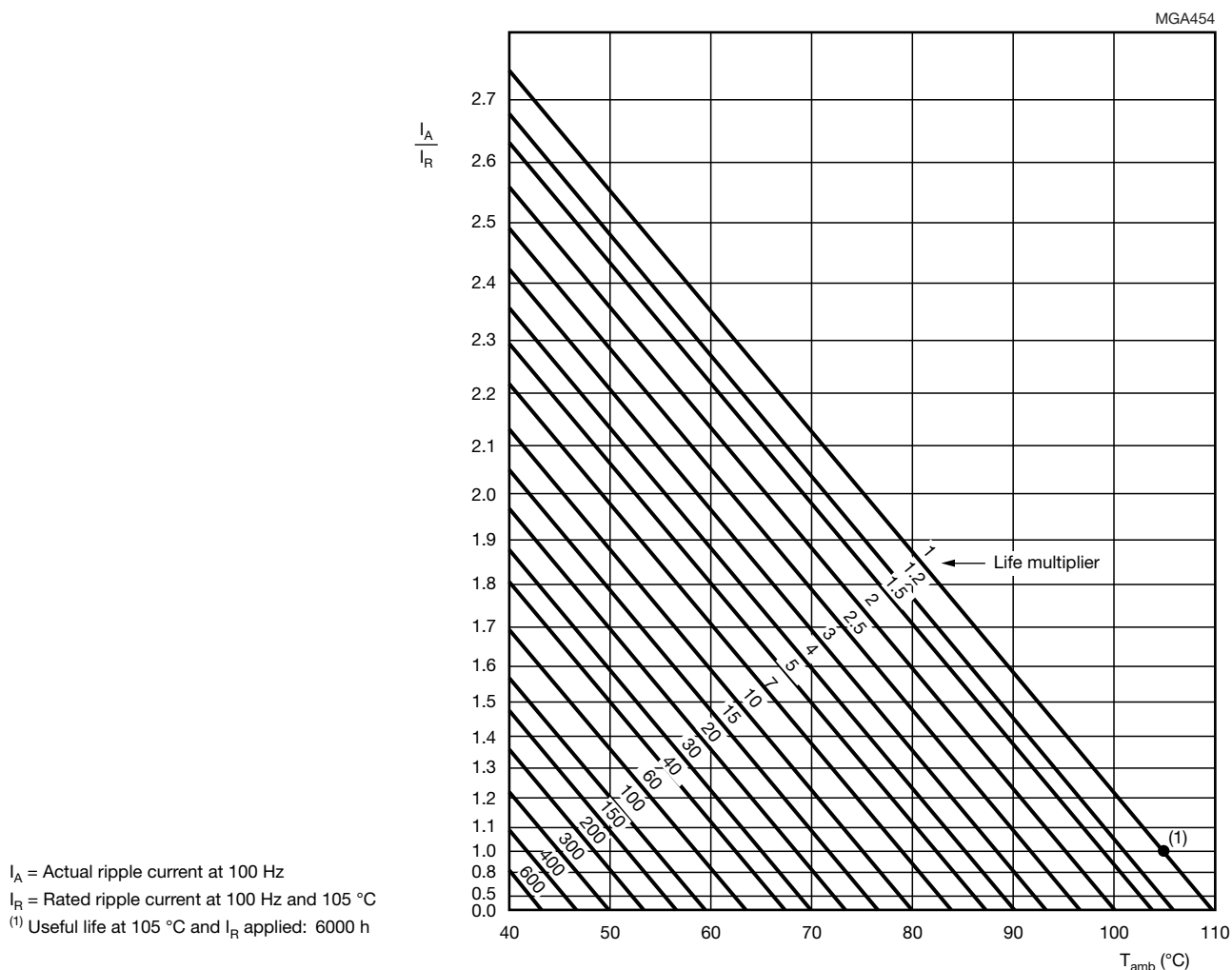


Fig. 6 - Multiplier of useful life as a function of ambient temperature and ripple current load

Table 4

| MULTIPLIER OF RIPPLE CURRENT ( $I_R$ ) AS A FUNCTION OF FREQUENCY |      |      |      |      |          |
|-------------------------------------------------------------------|------|------|------|------|----------|
| FREQUENCY (Hz)                                                    |      |      |      |      |          |
| 50                                                                | 100  | 120  | 200  | 1000 | ≥ 10 000 |
| $I_R$ MULTIPLIER                                                  |      |      |      |      |          |
| 0.90                                                              | 1.00 | 1.05 | 1.15 | 1.30 | 1.40     |



Table 5

| TEST PROCEDURES AND REQUIREMENTS               |                                             |                                                                                                                                                           |                                                                                                                                                                                                                                      |
|------------------------------------------------|---------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TEST                                           |                                             | PROCEDURE<br>(quick reference)                                                                                                                            | REQUIREMENTS                                                                                                                                                                                                                         |
| NAME OF TEST                                   | REFERENCE                                   |                                                                                                                                                           |                                                                                                                                                                                                                                      |
| Endurance                                      | IEC 60384-4 /<br>EN130301<br>subclause 4.13 | $T_{amb} = 60\text{ }^{\circ}\text{C}$ ; $U_R$ applied;<br>6000 h                                                                                         | $\Delta C/C: \pm 15\%$<br>$ESR \leq 1.5 \times \text{spec. limit}$<br>$Z \leq 2 \times \text{spec. limit}$<br>$I_{L5} \leq \text{spec. limit}$                                                                                       |
| Useful life                                    | EN130301<br>subclause 1.8.1                 | $T_{amb} = 105\text{ }^{\circ}\text{C}$ ; $U_C$ and $I_R$ applied;<br>6000 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 $\leq 1\%$ |
| Shelf life<br>(storage at<br>high temperature) | IEC 60384-4 /<br>EN130300<br>subclause 4.17 | $T_{amb} = 105\text{ }^{\circ}\text{C}$ ; no voltage applied;<br>1000 h<br>After test: $U_C$ to be applied for 30 min,<br>24 h to 48 h before measurement | $\Delta C/C: \pm 15\%$<br>$ESR \leq 1.5 \times \text{spec. limit}$<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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