

## Double Layer Capacitors

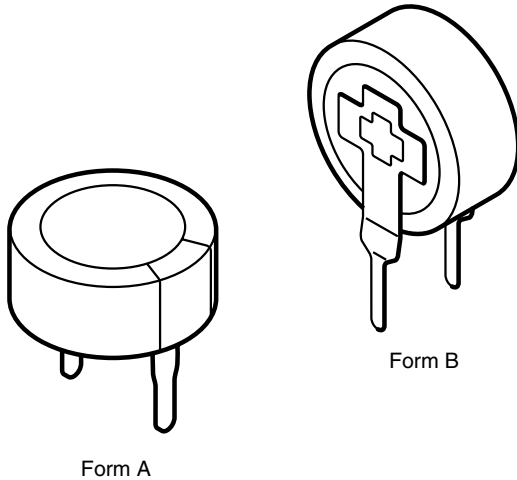


Fig.1 Component outline

### FEATURES

- Polarized capacitor with high charge density, alternative product to rechargeable backup batteries
- Dielectric: electric double layer
- Radial leads, cylindrical case, insulated with a blue vinyl sleeve
- Available in both vertical and low-profile versions
- Unlimited charge and discharge cycle numbers
- No charge-discharge control circuitry and no series resistor necessary
- Maintenance-free, no periodic replacement or service necessary
- Ecologically beneficial (no Cd, no Li)
- Lead (Pb)-free versions are RoHS compliant



**RoHS**  
COMPLIANT

### APPLICATIONS

- Energy storage, for backup of semiconductor memories (CMOS) in all fields of electronics
- Telecommunication, audio-video, EDP
- General industrial, clock and timer systems

### MARKING

The capacitors are marked with the following information:

- Rated capacitance (in F)
- Rated voltage (in V)
- Date code, in accordance with IEC 60062
- Name of manufacturer
- Negative terminal identification
- Upper category temperature (at 85 °C types only)

| QUICK REFERENCE DATA                    |  |                     |                         |                               |
|---|--|---------------------|-------------------------|-------------------------------|
| DESCRIPTION                             | VALUE                                    |                     |                         |                               |
|   | STANDARD FORM A                          | HIGH VOLTAGE FORM A | HIGH TEMPERATURE FORM A | VERTICAL, MINIATURIZED FORM B |
| Nominal case sizes (Ø D x L in mm)      | 13 x 7 and 21 x 7.5                      | 13 x 9 and 21 x 9   | 13 x 9 and 21 x 9       | 11.5 x 13 (vertical)          |
| Rated capacitance range, C <sub>R</sub> | 0.047 to 1.0 F                           | 0.047 to 0.68 F     | 0.047 to 0.68 F         | 0.047 to 0.33 F               |
| Tolerance on C <sub>R</sub> at 20 °C    | - 20 to + 80 %                           |                     |                         |                               |
| Rated voltage, U <sub>R</sub>           | 5.5 V                                    | 6.3 V               | 5.5 V                   | 5.5 V                         |
| Maximum surge voltage, U <sub>S</sub>   | 6.3 V                                    | 7.0 V               | 6.3 V                   | 6.3 V                         |
| Category temperature range              | - 25 to + 70 °C                          | - 25 to + 70 °C     | - 25 to + 85 °C         | - 25 to + 70 °C               |
| Useful life at U <sub>R</sub> :         |  |                     |                         |                               |
| at 85 °C                                | -  | -                   | 1000 hours              | -                             |
| at 70 °C                                | 1000 hours                               | 1000 hours          | 2800 hours              | 1000 hours                    |
| at 40 °C                                | 8000 hours                               | 8000 hours          | 23 000 hours            | 8000 hours                    |
| at 25 °C                                | 23 000 hours                             | 23 000 hours        | 64 000 hours            | 23 000 hours                  |
| Shelf life at 0 V                       | 1000 hours at upper category temperature |                     |                         |                               |
| Climatic category IEC 60068             | 25/070/21                                | 25/070/21           | 25/085/21               | 25/070/21                     |

| <b>SELECTION CHART FOR <math>C_R</math>, <math>U_R</math> AND FORM AT UPPER CATEGORY TEMPERATURE (UCT)</b> |      |               |             |               |
|--|------|---------------|-------------|---------------|
| $C_R$<br>(F)   | FORM | $U_R = 5.5 V$ |             | $U_R = 6.3 V$ |
|  |      | UCT = 85 °C   | UCT = 70 °C | UCT = 70 °C   |
| 0.047  | A    | 13 x 9        | 13 x 7      | 13 x 9        |
|  | B    | -             | 11.5 x 13   | -             |
| 0.1  | A    | 13 x 9        | 13 x 7      | 13 x 9        |
|  | B    | -             | 11.5 x 13   | -             |
| 0.22   | A    | -             | 13 x 7      | -             |
|  | B    | -             | 11.5 x 13   | -             |
| 0.33   | A    | -             | 13 x 7      | -             |
|  | B    | -             | 11.5 x 13   | -             |
| 0.47   | A    | 21 x 9        | 21 x 7.5    | 21 x 9        |
|  | B    | -             | -           | -             |
| 0.68   | A    | 21 x 9        | -           | 21 x 9        |
|  | B    | -             | -           | -             |
| 1.0  | A    | -             | 21 x 7.5    | -             |

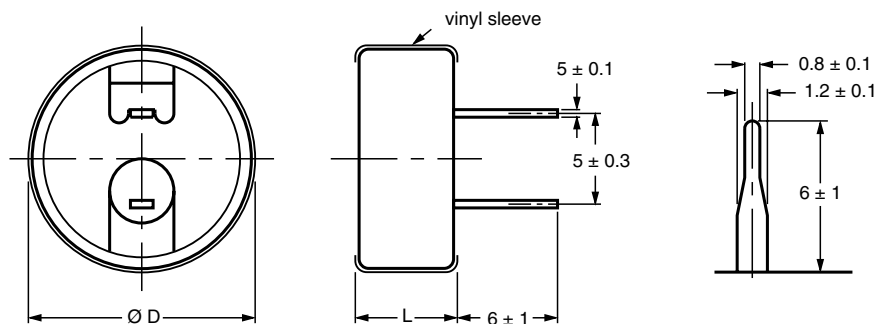
**DIMENSIONS** in millimeters **AND AVAILABLE FORMS**


Fig.2 Form A: Low profile

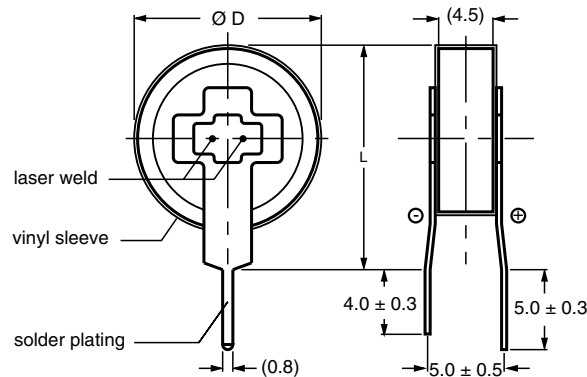


Fig.3 Form B: Vertical

| <b>DIMENSIONS</b> in millimeters, <b>MASS AND PACKAGING QUANTITIES</b> |           |      |                        |            |          |                      |
|--|-----------|------|------------------------|------------|----------|----------------------|
| NOMINAL CASE SIZE<br>$\varnothing D \times L$ (mm)                     | CASE CODE | FORM | $\varnothing D_{max.}$ | $L_{max.}$ | MASS (g) | PACKAGING QUANTITIES |
| 11.5 x 13  | 1         | B    | 11.8                   | 13.5       | ≈ 1.5    | 2000                 |
| 13 x 7   | 2         | A    | 13.5                   | 7.5        | ≈ 2.8    | 1000                 |
| 13 x 9   | 3         | A    | 13.5                   | 9.5        | ≈ 3.4    | 1000                 |
| 21 x 7.5   | 4         | A    | 21.5                   | 8.0        | ≈ 7.1    | 500                  |
| 21 x 9   | 5         | A    | 21.5                   | 9.5        | ≈ 8.8    | 500                  |

**Note**

Detailed tape dimensions see section 'PACKAGING'

| ELECTRICAL DATA |   |
|-----------------|---|
| SYMBOL          | DESCRIPTION   |
| $C_R$           | rated capacitance, tolerance - 20/+ 80 %, measured by constant current discharge method |
| UCT             | upper category temperature  |
| $I_L$           | max. leakage current after 30 minutes at $U_R$  |
| $R_I$           | max. internal resistance at 1 kHz   |

**ORDERING EXAMPLE**

Double layer capacitor 196 series

1.0 F/5.5 V

Nominal case size:  $\varnothing$  21 x 7.5 mm; Form A

Ordering code: MAL219612105E3

Former 12 NC: 2222 196 12105

**Note**

Unless otherwise specified, all electrical values in Table 1 apply at  $T_{amb} = 20\text{ }^\circ\text{C}$ ,  $P = 86$  to  $106\text{ kPa}$  and  $RH = 45$  to  $75\%$ .

Table 1

| ELECTRICAL DATA AND ORDERING INFORMATION |              |   |              |      |                             |                                       |                                |                |
|--|--------------|---|--------------|------|-----------------------------|---------------------------------------|--------------------------------|----------------|
| $U_R$<br>(V)                             | $C_R$<br>(F) | NOMINAL<br>CASE SIZE<br>$\varnothing$ D x L<br>(mm) | CASE<br>CODE | FORM | UCT<br>( $^\circ\text{C}$ ) | $I_L$<br>30 min.<br>( $\mu\text{A}$ ) | $R_I$<br>1 kHz<br>( $\Omega$ ) | ORDERING CODE  |
| <b>Standard series</b>                   |              |   |              |      |                             |                                       |                                |                |
| 5.5                                      | 0.047        | 13 x 7  | 2            | A    | 70                          | 69                                    | 120                            | MAL219612473E3 |
|  | 0.1          | 13 x 7  | 2            | A    | 70                          | 100                                   | 75                             | MAL219612104E3 |
|  | 0.22         | 13 x 7  | 2            | A    | 70                          | 135                                   | 75                             | MAL219612224E3 |
|  | 0.33         | 13 x 7  | 2            | A    | 70                          | 182                                   | 75                             | MAL219612334E3 |
|  | 0.47         | 21 x 7.5  | 4            | A    | 70                          | 216                                   | 30                             | MAL219612474E3 |
|  | 1.0          | 21 x 7.5  | 4            | A    | 70                          | 315                                   | 30                             | MAL219612105E3 |
| <b>High temperature series</b>           |              |   |              |      |                             |                                       |                                |                |
| 5.5                                      | 0.047        | 13 x 9  | 3            | A    | 85                          | 69                                    | 300                            | MAL219622473E3 |
|  | 0.1          | 13 x 9  | 3            | A    | 85                          | 100                                   | 200                            | MAL219622104E3 |
|  | 0.47         | 21 x 9  | 5            | A    | 85                          | 216                                   | 50                             | MAL219622474E3 |
|  | 0.68         | 21 x 9  | 5            | A    | 85                          | 260                                   | 50                             | MAL219622684E3 |
| <b>Vertical, miniaturized series</b>     |              |   |              |      |                             |                                       |                                |                |
| 5.5                                      | 0.047        | 11.5 x 13   | 1            | B    | 70                          | 69                                    | 120                            | MAL219632473E3 |
|  | 0.1          | 11.5 x 13   | 1            | B    | 70                          | 100                                   | 75                             | MAL219632104E3 |
|  | 0.22         | 11.5 x 13   | 1            | B    | 70                          | 135                                   | 75                             | MAL219632224E3 |
|  | 0.33         | 11.5 x 13   | 1            | B    | 70                          | 182                                   | 75                             | MAL219632334E3 |
| <b>High voltage series</b>               |              |   |              |      |                             |                                       |                                |                |
| 6.3                                      | 0.047        | 13 x 9  | 3            | A    | 70                          | 69                                    | 300                            | MAL219613473E3 |
|  | 0.1          | 13 x 9  | 3            | A    | 70                          | 100                                   | 200                            | MAL219613104E3 |
|  | 0.47         | 21 x 9  | 5            | A    | 70                          | 216                                   | 50                             | MAL219613474E3 |
|  | 0.68         | 21 x 9  | 5            | A    | 70                          | 260                                   | 50                             | MAL219613684E3 |

**MEASURING OF CHARACTERISTICS**

**CAPACITANCE (C)**

Capacitance shall be measured by constant current discharge method.

| DISCHARGE CURRENT AS A FUNCTION OF RATED CAPACITANCE |       |     |      |      |      |      |     |      |
|--|-------|-----|------|------|------|------|-----|------|
| PARAMETER  | VALUE |     |      |      |      |      |     | UNIT |
| Rated capacitance, C <sub>R</sub>                    | 0.047 | 0.1 | 0.22 | 0.33 | 0.47 | 0.68 | 1.0 | F    |
| Discharge current, I <sub>D</sub>                    | 0.1   |     |      | 1.0  |      |      |     | mA   |



Fig.4 Voltage diagram for capacitance measurement

Capacitance value C<sub>R</sub> is given by discharge current I<sub>D</sub>, time T and rated voltage U<sub>R</sub>, according to the following equation:

$$C(F) = \frac{I_D(mA) \times 10^{-3} \times T(s)}{U_R(V) - 2}$$



Fig.5 Test circuit for capacitance measurement

**INTERNAL RESISTANCE (R<sub>I</sub>) AT 1 kHz**

$$R_I(\Omega) = \frac{V_C(V)}{10^{-3}}$$



Fig.6 Test circuit for R<sub>I</sub> measurement

**LEAKAGE CURRENT (I<sub>L</sub>)**

Leakage current shall be measured after 30 minutes application of rated voltage U<sub>R</sub>:

$$I_L(\mu A) = \frac{V(V)}{10^{-4}}$$



Fig.7 Test circuit for leakage current



Fig.8 Typical leakage current as a function of time



**DISCHARGE CHARACTERISTICS**

Backup time of 196 DLC series capacitors depends on minimum memory holding voltage and discharge current (corresponding with the current consumption of the load). For minimum backup times of standard and vertical miniaturized series see Figs 9 and 10 (charging time  $\geq 24$  hours).

Figure 11 shows the backup time when a 196 DLC capacitor is discharged by a constant resistance (charging time  $\geq 24$  hours).

The horizontal axis shows the initial value of discharge current if 5 V is connected to the capacitor via a fixed series resistor.

**EXAMPLE: 1  $\mu$ A CORRESPONDS TO 5 M $\Omega$  AND 0.1  $\mu$ A CORRESPONDS TO 50 M $\Omega$**

The vertical axis shows that period of time during which the voltage drops from 5 to 2 V.



Fig.9 Typical backup time as a function of discharge current



Fig.11 Typical backup time as a function of initial discharge current

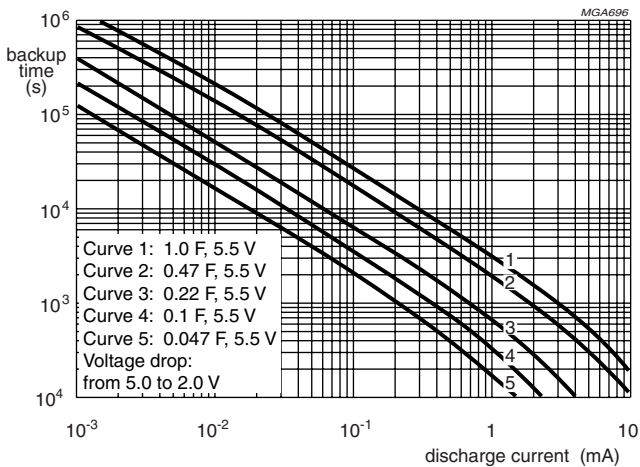


Fig.10 Typical backup time as a function of discharge current

Table 2

| <b>TEST PROCEDURES AND REQUIREMENTS</b> for standard and vertical miniaturized series (5.5 V; 70 °C) |  |  |  |
|--|--|--|--|
| <b>NAME OF TEST</b>  | <b>IEC 60384-4/<br/>EN130300<br/>subclause</b> | <b>PROCEDURE<br/>(quick reference)</b>   | <b>REQUIREMENTS</b>  |
| Robustness of terminations   | 4.4  | tensile strength; application of loading force for 10 seconds:<br>20 N (standard series)<br>5 N (vertical miniaturized series)   | no breaks  |
| Resistance to soldering heat   | 4.5  | solder bath; 260 °C; 5 seconds   | $\Delta C/C: \pm 10 \%$<br>$R_1$ and $I_L \leq \text{spec. limit}$   |
| Solderability  | 4.6  | solder bath; 235 °C; 2 seconds   | $\geq 75 \%$ tinning   |
| Vibration  | 4.8  | 10 to 55 Hz; 1.5 mm; 3 directions;<br>2 hours per direction  | $\Delta C/C: \pm 10 \%$<br>$R_1$ and $I_L \leq \text{spec. limit}$   |
| Damp heat, steady state  | 4.12   | 500 hours at 55 °C; RH 90 to 95 %;<br>no voltage applied   | $\Delta C/C: \pm 30 \%$<br>$R_1 \leq 4 \times \text{spec. limit}$<br>$I_L \leq 2 \times \text{spec. limit}$  |
| Endurance  | 4.13   | $T_{\text{amb}} = 70 \text{ °C}$ ; 5.5 V applied;<br>1000 hours  | $\Delta C/C: \pm 30 \%$<br>$R_1 \leq 4 \times \text{spec. limit}$<br>$I_L \leq 2 \times \text{spec. limit}$  |
| Storage at upper category temperature  | 4.17   | $T_{\text{amb}} = 70 \text{ °C}$ ;<br>no voltage applied;<br>1000 hours  | $\Delta C/C: \pm 30 \%$<br>$R_1 \leq 4 \times \text{spec. limit}$<br>$I_L \leq 2 \times \text{spec. limit}$  |
| Self discharge   | -  | 24 hours storage at room temperature after application of 5 V for 1 hour   | remaining voltage: $\geq 4 \text{ V}$  |
| Characteristics at high and low temperature  | 4.19   | step 1: reference measurement at + 20 °C of C, $R_1$ and $I_L$<br>step 2: measurement at - 25 °C<br>step 3: measurement at + 20 °C<br>step 4: measurement at + 70 °C<br>step 5: measurement at + 20 °C | $\Delta C/C: \pm 30 \%$ of + 20 °C value<br>$R_1 \leq 5 \times \text{the } + 20 \text{ °C value}$<br>$I_L \leq 4 \times \text{the } + 20 \text{ °C value}$ |



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