

Double Layer Capacitors

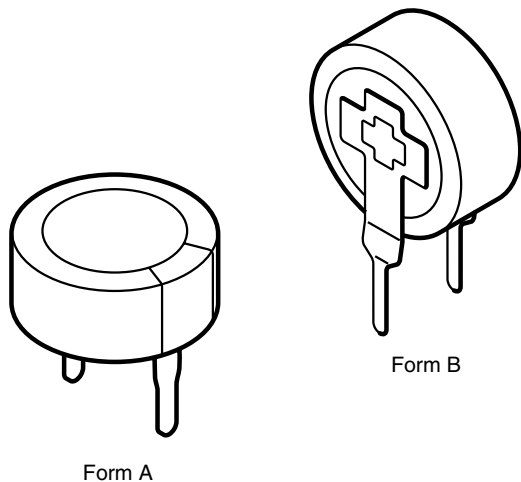


Fig.1 Component outline

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 _R | 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 _R at 20 °C | - 20 to + 80 % | | | |
| Rated voltage, U _R | 5.5 V | 6.3 V | 5.5 V | 5.5 V |
| Maximum surge voltage, U _S | 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 _R : | | | | |
| 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 |

| SELECTION CHART FOR C_R , U_R AND FORM AT UPPER CATEGORY TEMPERATURE (UCT) | | | | |
|--|------|---------------|-------------|---------------|
| C_R (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**

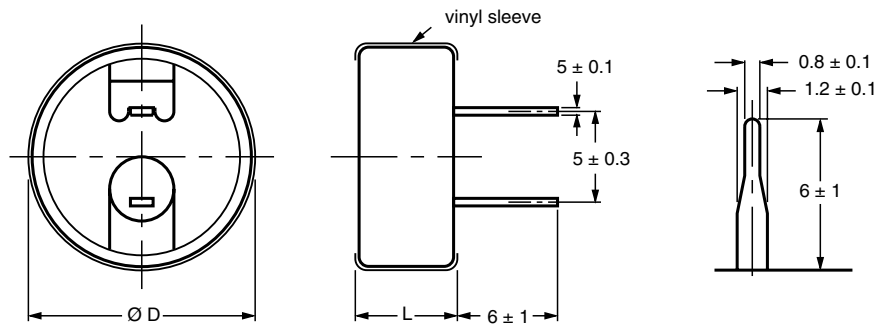


Fig.2 Form A: Low profile

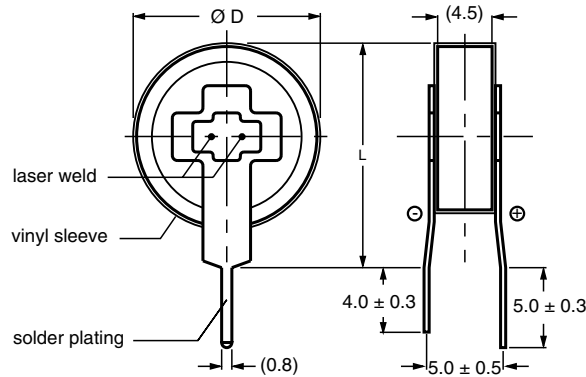


Fig.3 Form B: Vertical

| DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES | | | | | | |
|--|-----------|------|---------------------|-------------------|----------|----------------------|
| NOMINAL CASE SIZE Ø D x L (mm) | CASE CODE | FORM | Ø 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 kPa and $RH = 45$ to 75% .

Table 1

| ELECTRICAL DATA AND ORDERING INFORMATION | | | | | | | | |
|--|--------------|---|--------------|------|-----------------------------|---------------------------------------|--------------------------------|----------------|
| U_R (V) | C_R (F) | NOMINAL CASE SIZE \varnothing D x L (mm) | CASE CODE | FORM | UCT ($^\circ\text{C}$) | I_L 30 min. (μA) | R_I 1 kHz (Ω) | ORDERING CODE |
| Standard series | | | | | | | | |
| 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 | |
| High temperature series | | | | | | | | |
| 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 |
| Vertical, miniaturized series | | | | | | | | |
| 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 |
| High voltage series | | | | | | | | |
| 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 _R | 0.047 | 0.1 | 0.22 | 0.33 | 0.47 | 0.68 | 1.0 | F |
| Discharge current, I _D | 0.1 | | | 1.0 | | | | mA |



Fig.4 Voltage diagram for capacitance measurement

Capacitance value C_R is given by discharge current I_D, time T and rated voltage U_R, 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_I) AT 1 kHz

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



Fig.6 Test circuit for R_I measurement

LEAKAGE CURRENT (I_L)

Leakage current shall be measured after 30 minutes application of rated voltage U_R:

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



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 ≥ 24 hours).

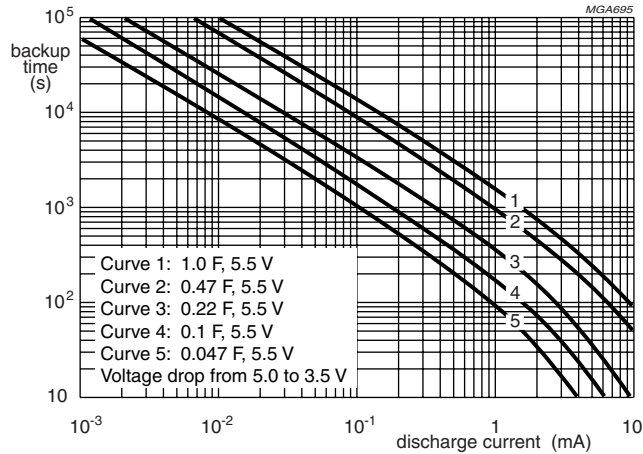


Fig.9 Typical backup time as a function of discharge current

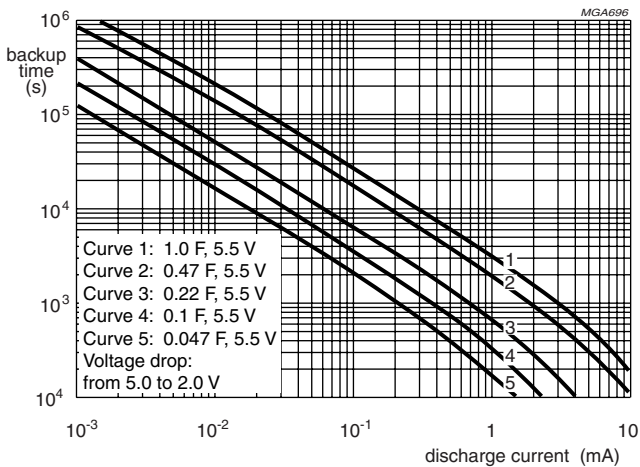


Fig.10 Typical backup time as a function of discharge current

Figure 11 shows the backup time when a 196 DLC capacitor is discharged by a constant resistance (charging time ≥ 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 μ A CORRESPONDS TO 5 M Ω AND 0.1 μ A CORRESPONDS TO 50 M Ω

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

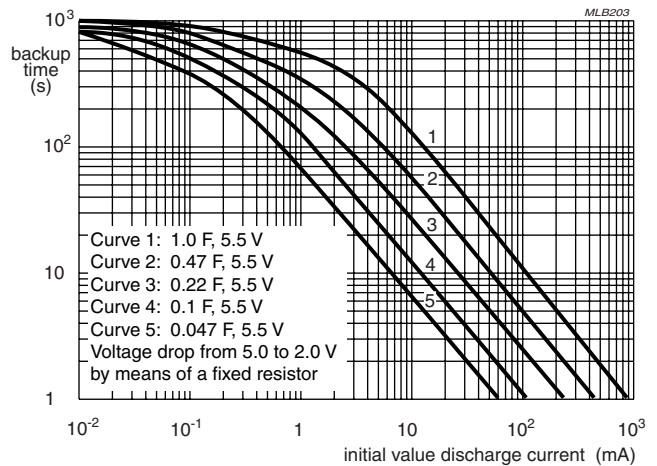


Fig.11 Typical backup time as a function of initial discharge current

Table 2

| TEST PROCEDURES AND REQUIREMENTS for standard and vertical miniaturized series (5.5 V; 70 °C) | | | |
|--|--|--|--|
| NAME OF TEST | IEC 60384-4/ EN130300 subclause | PROCEDURE (quick reference) | REQUIREMENTS |
| Robustness of terminations | 4.4 | tensile strength; application of loading force for 10 seconds: 20 N (standard series) 5 N (vertical miniaturized series) | no breaks |
| Resistance to soldering heat | 4.5 | solder bath; 260 °C; 5 seconds | $\Delta C/C: \pm 10 \%$ 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; 2 hours per direction | $\Delta C/C: \pm 10 \%$ R_1 and $I_L \leq \text{spec. limit}$ |
| Damp heat, steady state | 4.12 | 500 hours at 55 °C; RH 90 to 95 %; no voltage applied | $\Delta C/C: \pm 30 \%$ $R_1 \leq 4 \times \text{spec. limit}$ $I_L \leq 2 \times \text{spec. limit}$ |
| Endurance | 4.13 | $T_{\text{amb}} = 70 \text{ °C}$; 5.5 V applied; 1000 hours | $\Delta C/C: \pm 30 \%$ $R_1 \leq 4 \times \text{spec. limit}$ $I_L \leq 2 \times \text{spec. limit}$ |
| Storage at upper category temperature | 4.17 | $T_{\text{amb}} = 70 \text{ °C}$; no voltage applied; 1000 hours | $\Delta C/C: \pm 30 \%$ $R_1 \leq 4 \times \text{spec. limit}$ $I_L \leq 2 \times \text{spec. limit}$ |
| 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 step 2: measurement at - 25 °C step 3: measurement at + 20 °C step 4: measurement at + 70 °C step 5: measurement at + 20 °C | $\Delta C/C: \pm 30 \%$ of + 20 °C value $R_1 \leq 5 \times \text{the } + 20 \text{ °C value}$ $I_L \leq 4 \times \text{the } + 20 \text{ °C value}$ |



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