Energy Storage Double Layer Capacitors

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 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)
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

Pb-free
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 F to 1.0 F	0.047 F to 0.68 F	0.047 F to 0.68 F	0.047 F 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 °C to +70 °C	-25 °C to +70 °C	-25 °C to +85 °C	-25 °C to +70 °C
Useful life at U_R:				
at 85 °C	-	-	1000 h	-
at 70 °C	1000 h	1000 h	2800 h	1000 h
at 40 °C	8000 h	8000 h	23 000 h	8000 h
at 25 °C	23 000 h	23 000 h	64 000 h	23 000 h
Shelf life at 0 V	1000 h 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 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

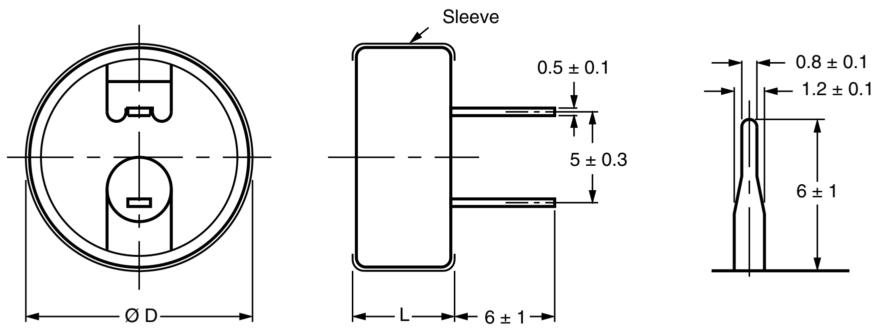

Fig. 1 - **Form A:** Low profile

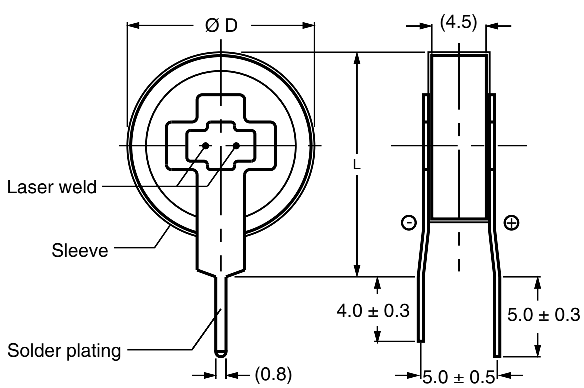

Fig. 2 - **Form B:** Vertical

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

- Packaging: bulk in box.

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 min at U_R
R_I	Max. internal resistance at 1 kHz

Note

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

ORDERING EXAMPLE

Double layer capacitor 196 series

1.0 F / 5.5 V

Nominal case size: Ø 21 mm x 7.5 mm; Form A

Ordering code: MAL2 19612105E3
Former 12 NC: 2222 19612105

Table 1

ELECTRICAL DATA AND ORDERING INFORMATION								
U_R (V)	**C_R (µF)**	**NOMINAL CASE SIZE Ø D x L (mm)**	**CASE CODE**	**FORM**	**UCT (°C)**	**I_L 30 min (µA)**	**R_I 1 kHz (Ω)**	**ORDERING CODE**
STANDARD SERIES								
5.5	47 000	13 x 7	2	A	70	69	120	MAL219612473E3
	100 000	13 x 7	2	A	70	100	75	MAL219612104E3
	220 000	13 x 7	2	A	70	135	75	MAL219612224E3
	330 000	13 x 7	2	A	70	182	75	MAL219612334E3
	470 000	21 x 7.5	4	A	70	216	30	MAL219612474E3
	1 000 000	21 x 7.5	4	A	70	315	30	MAL219612105E3
HIGH TEMPERATURE SERIES								
5.5	47 000	13 x 9	3	A	85	69	300	MAL219622473E3
	100 000	13 x 9	3	A	85	100	200	MAL219622104E3
	470 000	21 x 9	5	A	85	216	50	MAL219622474E3
	680 000	21 x 9	5	A	85	260	50	MAL219622684E3
VERTICAL, MINIATURIZED SERIES								
5.5	47 000	11.5 x 13	1	B	70	69	120	MAL219632473E3
	100 000	11.5 x 13	1	B	70	100	75	MAL219632104E3
	220 000	11.5 x 13	1	B	70	135	75	MAL219632224E3
	330 000	11.5 x 13	1	B	70	182	75	MAL219632334E3
HIGH VOLTAGE SERIES								
6.3	47 000	13 x 9	3	A	70	69	300	MAL219613473E3
	100 000	13 x 9	3	A	70	100	200	MAL219613104E3
	470 000	21 x 9	5	A	70	216	50	MAL219613474E3
	680 000	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

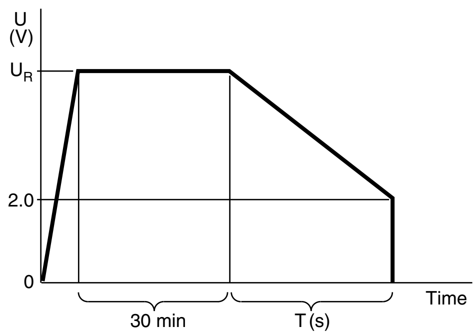

Fig. 3 - Voltage diagram for capacitance measurement

Capacitance value C_R is given by discharge current I_D, time T and rated voltage U_R, according to the following equation:

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

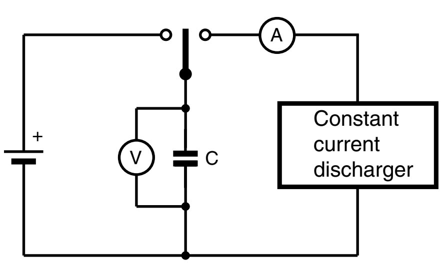

Fig. 4 - Test circuit for capacitance measurement

INTERNAL RESISTANCE (R_I) AT 1 kHz

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

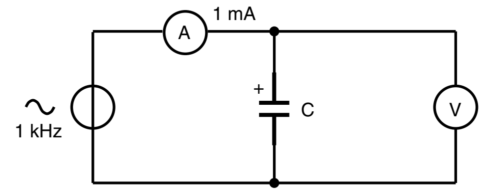

Fig. 5 - Test circuit for R_I measurement

LEAKAGE CURRENT (I_L)

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

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

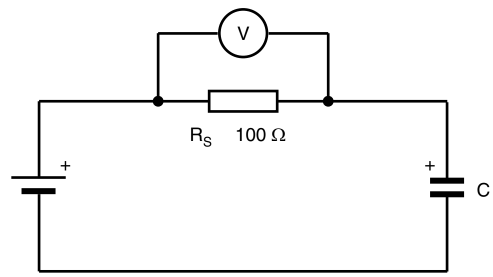

Fig. 6 - Test circuit for leakage current

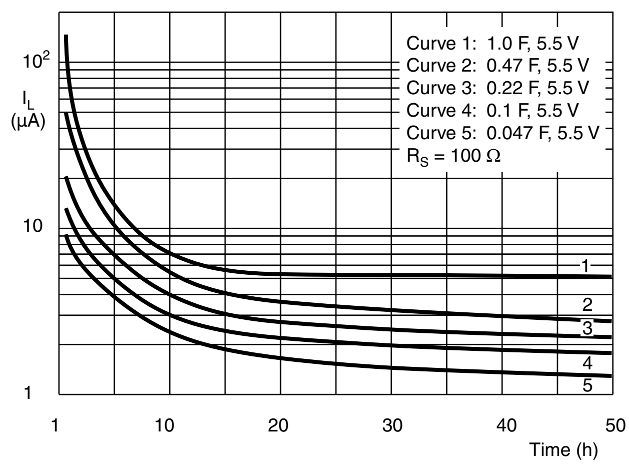

Fig. 7 - Typical leakage current as a function of time

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 Figures 8 and 9 (charging time ≥ 24 h).

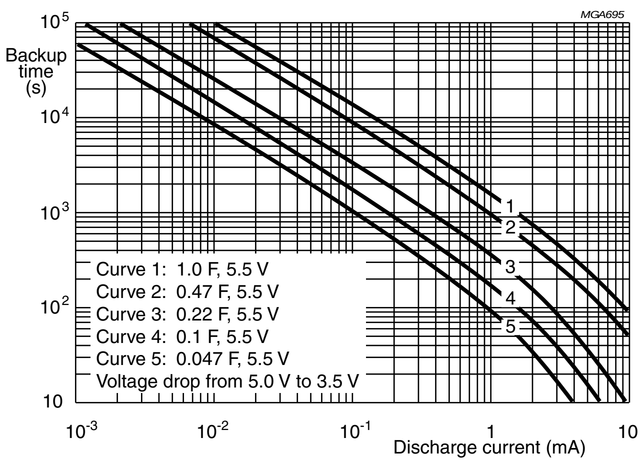

Fig. 8 - Typical backup time as a function of discharge current

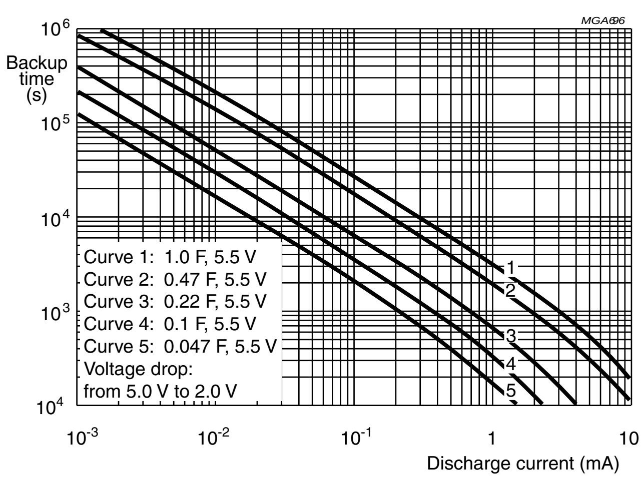

Fig. 9 - Typical backup time as a function of discharge current

Figure 10 shows the backup time when a 196 DLC capacitor is discharged by a constant resistance
(charging time ≥ 24 h).

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 μA corresponds to 5 MΩ and 0.1 μA corresponds to 50 MΩ

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

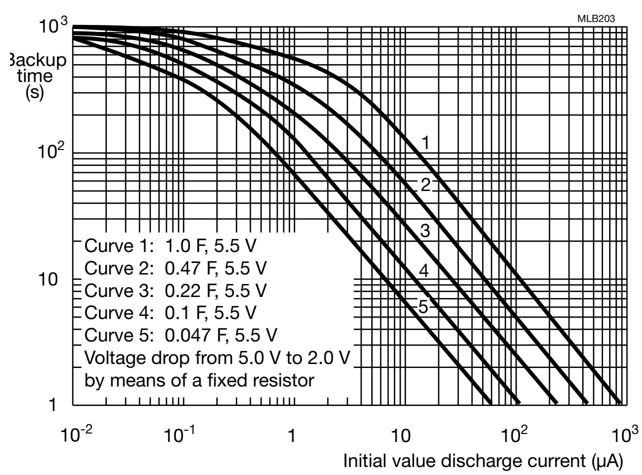

Fig. 10 - Typical backup time as a function of initial discharge current

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 s: 20 N (standard series) 5 N (vertical miniaturized series)	No breaks
Resistance to soldering heat	4.5	Solder bath; 260 °C; 5 s	ΔC/C: ± 10 % R_I and I_L ≤ spec. limit
Solderability	4.6	Solder bath; 235 °C; 2 s	≥ 75 % tinning
Vibration	4.8	10 Hz to 55 Hz; 1.5 mm; 3 directions; 2 h per direction	ΔC/C: ± 10 % R_I and I_L ≤ spec. limit
Damp heat, steady state	4.12	500 h at 55 °C; RH 90 % to 95 %; no voltage applied	ΔC/C: ± 30 % R_I ≤ 4 x spec. limit I_L ≤ 2 x spec. limit
Endurance	4.13	T_{amb} = 70 °C; 5.5 V applied; 1000 h	ΔC/C: ± 30 % R_I ≤ 4 x spec. limit I_L ≤ 2 x spec. limit
Useful life	-	T_{amb} = 70 °C; 5.5 V applied; 1000 h	ΔC/C: ± 30 % R_I ≤ 4 x spec. limit I_L ≤ 2 x spec. limit
Storage at upper category temperature	4.17	T_{amb} = 70 °C; no voltage applied; 1000 h	ΔC/C: ± 30 % R_I ≤ 4 x spec. limit I_L ≤ 2 x spec. limit
Self discharge	-	24 h storage at room temperature after application of 5 V for 1 h	Remaining voltage: ≥ 4 V
Characteristics at high and low temperature	4.19	Step 1: reference measurement at +20 °C of C, R_I 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	ΔC/C: ± 30 % of +20 °C value R_I ≤ 5 x the +20 °C value I_L ≤ 4 x the +20 °C value

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