

# **Energy Storage Double Layer Capacitors**



#### **FEATURES**

 Polarized capacitor with high charge density, alternative product to rechargeable backup batteries



COMPLIANT

• 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 <a href="https://www.vishay.com/doc?99912">www.vishay.com/doc?99912</a>

#### **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 (Low Leakage Series)									
	VALUE								
DESCRIPTION	STANDARD FORM A	HIGH TEMPERATURE FORM A	STANDARD FORM B						
Nominal case sizes (Ø D x L in mm)	13.5 x 7 and 20.5 x 8	13.5 x 7 and 20.5 x 10.5	11.5 x 13 and 19 x 20.5						
Rated capacitance range, C <sub>R</sub>	0.22 F to 1.5 F	0.22 F to 1 F	0.22 F to 1.5 F						
Tolerance on C <sub>R</sub> at 20 °C		-20 % to +80 %							
Rated voltage, U <sub>R</sub>	5.5 V	5.5 V	5.5 V						
Maximum surge voltage, U <sub>S</sub>	6.0 V	6.0 V	6.0 V						
Category temperature range	-25 °C to +70 °C	-40 °C to +85 °C	-25 °C to +70 °C						
Useful life at U <sub>R</sub> :									
at 85 °C	-	1000 h	-						
at 70 °C	1000 h	2800 h	1000 h						
at 40 °C	8000 h	23 000 h	8000 h						
at 25 °C	23 000 h	64 000 h	23 000 h						
Shelf life at 0 V		1000 h at upper category temperatu	ure						
Climatic category IEC 60068	25 / 070 / 21	25 / 085 / 21	25 / 070 / 21						



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QUICK REFERENCE DATA (Standard Series)									
	VALUE								
DESCRIPTION	STANDARD FORM A	HIGH TEMPERATURE FORM A	VERTICAL 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	11.5 x 13 (vertical)						
Rated capacitance range, C <sub>R</sub>	0.047 F to 1.0 F	0.047 F to 0.68 F	0.047 F 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	5.5 V	5.5 V						
Maximum surge voltage, U <sub>S</sub>	6.3 V	6.3 V	6.3 V						
Category temperature range	-25 °C to +70 °C	-25 °C to +85 °C	-25 °C to +70 °C						
Useful life at U <sub>R</sub> :									
at 85 °C	-	1000 h	-						
at 70 °C	1000 h	2800 h	1000 h						
at 40 °C	8000 h	23 000 h	8000 h						
at 25 °C	23 000 h	64 000 h	23 000 h						
Shelf life at 0 V	<u> </u>	1000 h at upper category temperature							
Climatic category IEC 60068	25 / 070 / 21	25 / 085 / 21	25 / 070 / 21						

	IART FOR C <sub>R</sub> , U	U <sub>R</sub> = 5.5 V								
C <sub>R</sub> (F)	FORM	STANDAF	D SERIES	LOW LEAKAGE SERIES						
(-)		UCT = 85 °C	UCT = 70 °C	UCT = 85 °C	UCT = 70 °C					
0.047	Α	13 x 9	13 x 7	-	-					
0.047	В	-	11.5 x 13	-	-					
0.1	А	13 x 9	13 x 7	-	-					
0.1	В	-	11.5 x 13	-	-					
0.00	Α	-	13 x 7	13.5 x 9	13.5 x 7					
0.22	В	-	11.5 x 13	-	11.5 x 13					
0.00	Α	-	13 x 7	13.5 x 9	13.5 x 7					
0.33	В	-	11.5 x 13	-	11.5 x 13					
0.47	Α	21 x 9	21 x 7.5	20.5 x 10.5	13.5 x 7					
0.47	В	-	-	-	11.5 x 13					
0.69	Α	21 x 9	-	20.5 x 10.5	-					
0.68	В	-	-	-	-					
1.0	Α	-	21 x 7.5	20.5 x 10.5	20.5 x 8					
1.0	В	-	-	-	19 x 20.5					
1 5	Α	-	-	-	20.5 x 8					
1.5	В	-	-	-	19 x 20.5					



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

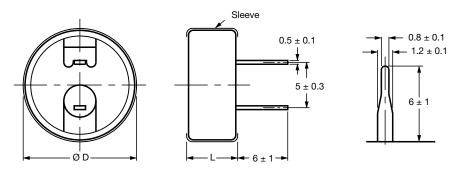


Fig. 1 - Form A: Low profile

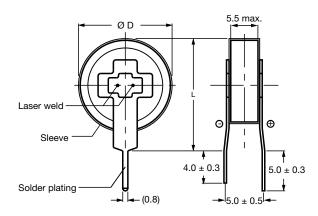


Fig. 2 - Form B: Vertical

<b>DIMENSIONS</b> in millimeters,	DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES (Low Leakage Series)								
NOMINAL CASE SIZE Ø D x L (mm)	CASE CODE	FORM	Ø D <sub>max.</sub>	L <sub>max.</sub>	MASS (g)	PACKAGING QUANTITIES			
11.5 x 13	6	В	12	14	≈ 1.6	2000			
19 x 20.5	7	В	19.5	21.5	≈ 4.0	800			
13.5 x 7	8	Α	14	7.5	≈ 3.5	1000			
13.5 x 9	8a	Α	14	9.5	≈ 4.1	800			
20.5 x 8	9	Α	21	8.5	≈ 9.0	1000			
20.5 x 10.5	10	А	21	11	≈ 10.0	600			

DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES (Standard Series)								
NOMINAL CASE SIZE Ø D x L (mm)	CASE CODE	FORM	Ø D <sub>max.</sub>	L <sub>max.</sub>	MASS (g)	PACKAGING QUANTITIES		
11.5 x 13	1	В	11.8	13.5	≈ 1.5	1000		
13 x 7	2	Α	13.5	7.5	≈ 2.8	1000		
13 x 9	3	Α	13.5	9.5	≈ 3.4	1000		
21 x 7.5	4	Α	21.5	8.0	≈ 7.1	500		
21 x 9	5	Α	21.5	9.5	≈ 8.8	500		

#### Note

• Packaging: bulk in box



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ELECTRI	ELECTRICAL DATA					
SYMBOL	DESCRIPTION					
C <sub>R</sub>	Rated capacitance, tolerance -20 % / +80 %, measured by constant current discharge method					
UCT	Upper category temperature					
IL	Max. leakage current after 30 min at U <sub>R</sub>					
R <sub>I</sub>	Max. internal resistance at 1 kHz					

#### Note

• Unless otherwise specified, all electrical values in Table 1 apply at T<sub>amb</sub> = 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 20.5 mm x 8 mm; form A

Ordering code: MAL219642105E3

#### Table 1

ELE	CTRICAL	DATA AND ORDE	RING INF	ORMATIC	N (Low Le	eakage Ser	ies) <sup>(1)</sup>	
U <sub>R</sub> (V)	C <sub>R</sub> (F)	NOMINAL CASE SIZE Ø D x L (mm)	CASE CODE	FORM	UCT (°C)	I <sub>L</sub> 30 min (μΑ)	R <sub>I</sub> 1 kHz (Ω)	ORDERING CODE
STANI	DARD SERIE	S						
	0.22	13.5 x 7	8	Α	70	3	75	MAL219642224E3
	0.33	13.5 x 7	8	Α	70	5	50	MAL219642334E3
5.5	0.47	13.5 x 7	8	Α	70	5	50	MAL219642474E3
	1.0	20.5 x 8	9	Α	70	8	30	MAL219642105E3
	1.5	20.5 x 8	9	Α	70	8	30	MAL219642155E3
STANI	DARD SERIE	S, VERTICAL						
	0.22	11.5 x 13	6	В	70	3	75	MAL219652224E3
	0.33	11.5 x 13	6	В	70	5	50	MAL219652334E3
5.5	0.47	11.5 x 13	6	В	70	5	50	MAL219652474E3
	1.0	19 x 20.5	7	В	70	8	30	MAL219652105E3
	1.5	19 x 20.5	7	В	70	8	30	MAL219652155E3
HIGH	TEMPERATI	URE SERIES						
	0.22	13.5 x 9	8a	Α	85	3	75	MAL219662224E3
	0.33	13.5 x 9	8a	Α	85	5	50	MAL219662334E3
5.5	0.47	20.5 x 10.5	10	Α	85	10	50	MAL219662474E3
	0.68	20.5 x 10.5	10	Α	85	8	30	MAL219662684E3
	1.0	20.5 x 10.5	10	Α	85	10	30	MAL219662105E3

#### Note

Table 2

ELE	ELECTRICAL DATA AND ORDERING INFORMATION (Standard Series) (1)									
U <sub>R</sub> (V)	C <sub>R</sub> (F)	NOMINAL CASE SIZE Ø D x L (mm)	CASE CODE	FORM	UCT (°C)	l <sub>L</sub> 30 min (μΑ)	R <sub>I</sub> 1 kHz (Ω)	ORDERING CODE		
STAN	DARD SERIE	S								
	0.047	13 x 7	2	Α	70	69	120	MAL219612473E3		
	0.10	13 x 7	2	Α	70	100	75	MAL219612104E3		
5.5	0.22	13 x 7	2	Α	70	135	75	MAL219612224E3		
5.5	0.33	13 x 7	2	Α	70	182	75	MAL219612334E3		
	0.47	21 x 7.5	4	Α	70	216	30	MAL219612474E3		
	1.0	21 x 7.5	4	Α	70	315	30	MAL219612105E3		
HIGH	TEMPERAT	JRE SERIES								
	0.047	13 x 9	3	Α	85	69	300	MAL219622473E3		
5.5	0.10	13 x 9	3	Α	85	100	200	MAL219622104E3		
5.5	0.47	21 x 9	5	Α	85	216	50	MAL219622474E3		
	0.68	21 x 9	5	Α	85	260	50	MAL219622684E3		
VERTI	CAL, MINIA	TURIZED SERIES								
	0.047	11.5 x 13	1	В	70	69	120	MAL219632473E3		
5.5	0.10	11.5 x 13	1	В	70	100	75	MAL219632104E3		
5.5	0.22	11.5 x 13	1	В	70	135	75	MAL219632224E3		
	0.33	11.5 x 13	1	В	70	182	75	MAL219632334E3		

#### Note

<sup>(1)</sup> Preferred for ordering

<sup>(1)</sup> Not recommended for new design



#### **MEASURING OF CHARACTERISTICS**

## **CAPACITANCE (C)**

Capacitance shall be measured by constant current discharge method.

DISCHARGE CURRENT AS A FUNCTION OF RATED CAPACITANCE									
PARAMETER				VAL	UE				UNIT
Rated capacitance, C <sub>R</sub>	0.047	0.1	0.22	0.33	0.47	0.68	1.0	1.5	F
Discharge current, I <sub>D</sub>		0.	.1			1.0	)		mA

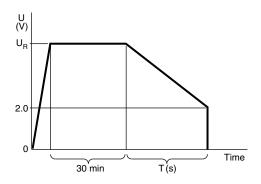


Fig. 3 - Voltage diagram for capacitance measurement

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

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

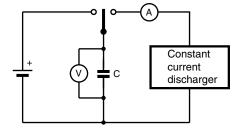


Fig. 4 - Test circuit for capacitance measurement

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

$$R_{I}(\Omega) = \frac{V_{C}(V)}{10^{-3}}$$

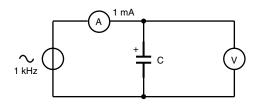


Fig. 5 - Test circuit for R<sub>I</sub> measurement

# LEAKAGE CURRENT (IL)

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

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

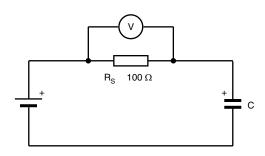


Fig. 6 - Test circuit for leakage current

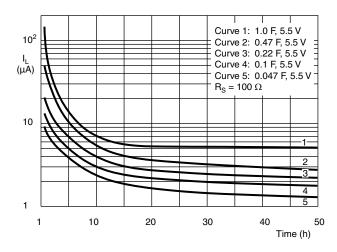


Fig. 7 - Typical leakage current as a function of time

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#### **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  $\geq 24 \text{ h}$ ).

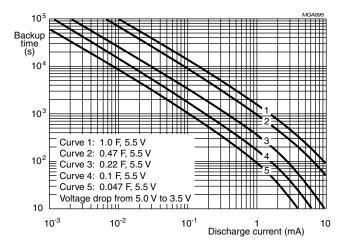


Fig. 8 - Typical backup time as a function of discharge current

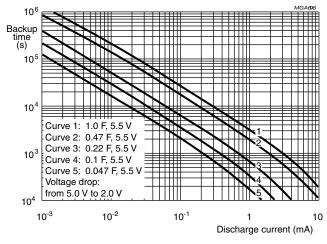


Fig. 9 - Typical backup time as a function of discharge current

Figure 10 shows the backup time when a 196 DLC capacitor is discharged by a constant resistance (charging time  $\geq$  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 $\mu\text{A}$ corresponds to 5 $\text{M}\Omega$ and 0.1 $\mu\text{A}$ corresponds to 50 $\text{M}\Omega$

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

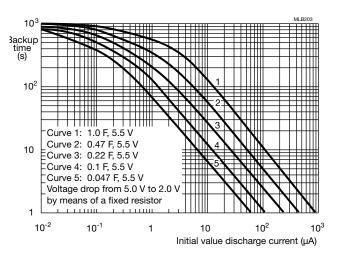


Fig. 10 - Typical backup time as a function of initial discharge current



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## Table 3

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	$\Delta$ C/C: ± 10 % R <sub>I</sub> and I <sub>L</sub> ≤ 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	$\Delta$ C/C: ± 10 % R <sub>I</sub> and I <sub>L</sub> ≤ spec. limit
Damp heat, steady state	4.12	500 h at 55 °C; RH 90 % to 95 %; no voltage applied	$\Delta$ C/C: ± 30 % R <sub>I</sub> ≤ 4 x spec. limit I <sub>L</sub> ≤ 2 x spec. limit
Endurance	4.13	T <sub>amb</sub> = 70 °C; 5.5 V applied; 1000 h	$\Delta$ C/C: ± 30 % R <sub>I</sub> ≤ 4 x spec. limit I <sub>L</sub> ≤ 2 x spec. limit
Useful life	-	T <sub>amb</sub> = 70 °C; 5.5 V applied; 1000 h	$\Delta$ C/C: $\pm$ 30 % R <sub>I</sub> $\leq$ 4 x spec. limit I <sub>L</sub> $\leq$ 2 x spec. limit
Storage at upper category temperature	4.17	T <sub>amb</sub> = 70 °C; no voltage applied; 1000 h	$\Delta$ C/C: ± 30 % R <sub>I</sub> ≤ 4 x spec. limit I <sub>L</sub> ≤ 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 <sub>I</sub> and I <sub>L</sub> 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 $R_{I} \le 5$ x the +20 °C value $I_{L} \le 4$ x the +20 °C value

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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