

Electrical Double Layer Energy Storage Capacitors Power and Energy Versions

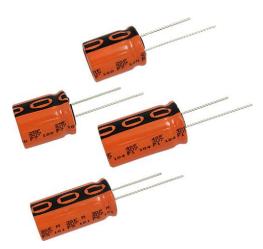


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QUICK REFERENCE DATA										
DESCRIPTION	VALUE									
Nominal case sizes (Ø D x L in mm)	10 x 20; 10 x 25; 10 x 30; 12.5 x 20; 12.5 x 25; 12.5 x 30; 12.5 x 40; 16 x 20; 18 x 20; 16 x 25, 18 x 25; 16 x 31; 18 x 31, 18 x 35, 18 x 40									
Rated capacitance range, C _R	5 F to 60 F									
Rated voltage, U _R (65 °C / 85 °C)	2.7 V / 2.3 V									
Category temperature range	-40 °C to +85 °C									
Endurance test at 85 °C	1000 h									
Useful life at 85 °C	1000 h									
Useful life at 20 °C	> 10 years									
Shelf life at 20 °C	2 years									
Cycle life	> 500 000 cycles									

FEATURES

- Polarized energy storage capacitor with high capacity and energy density
- · Energy version with high stability available
- Rated voltage: 2.7 V
- Available in through-hole (radial) version
- Useful life: 1000 h at 85 °C
- Rapid charge and discharge
- · Maintenance-free, no service necessary
- AEC-Q200 qualified
- Material categorization: for definitions of compliance please see <u>www.vishay.com/doc?99912</u>

APPLICATIONS

- Power backup
- Burst power support
- · Storage device for energy harvesting
- Micro UPS power source
- Energy recovery

MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance (in F)
- Rated voltage (in V)
- Date code, in accordance with IEC 60062
- Code indicating factory of origin
- Logo of manufacturer
- · Negative terminal identification
- Series number (220)

PACKAGING

Supplied loose in box, taped ammo, or in ESD trays.

SELECTION CHART FOR C_R , U_R , and relevant nominal case sizes (\emptyset D x L in mm)							
C _R (F)	U _R (V) = 2.7 V						
5	10 x 20						
7	10 x 25						
8	12.5 x 20						
10	10 x 30						
12	12.5 x 25						
15	12.5 x 30; 16 x 20						
20	16 x 20; 16 x 25; 18 x 20						
22	12.5 x 40						
25	16 x 25; 18 x 20; 18 x 25						
30	16 x 31; 18 x 25						
35	16 x 31, 18 x 31 ⁽¹⁾						
40	18 x 31 ⁽¹⁾						
45, 50	18 x 35						
55, 60	18 x 40						

Note

(1) Preferred case size



DIMENSIONS in millimeters **AND AVAILABLE FORMS**

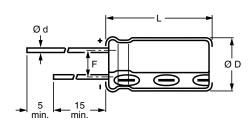


Fig. 1 - Form CA / TRAY: Long leads

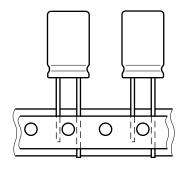


Fig. 2 - Form TFA: Taped in box (ammopack)

Table 1

DIMENSIONS in millimeters, MASS, AND PACKAGING QUANTITIES											
NOMINAL CASE SIZE	CASE CODE	Ød	a D		F	MASS	PACKAGING QUANTITIES				
ØDxL	CASE CODE	øа	Ø D _{max} .	L _{max} .		(g)	FORM CA	FORM TFA	FORM TRAY		
10 x 20	16	0.6	10.5	22	5.0 ± 0.5	≈ 2.2	500	800	-		
10 x 25	16L	0.6	10.5	27	5.0 ± 0.5	≈ 3.0	500	800	-		
10 x 30	16LL	0.8	10.5	32	5.0 ± 0.5	≈ 3.5	500	800	-		
12.5 x 20	17	0.6	13.0	22	5.0 ± 0.5	≈ 4.0	500	500	-		
12.5 x 25	18	0.6	13.0	27	5.0 ± 0.5	≈ 5.0	250	500	-		
12.5 x 30	18L	0.8	13.0	33.5	5.0 ± 0.5	≈ 5.5	250	500	-		
12.5 x 40	18LL	0.8	13.0	42.5	5.0 ± 0.5	≈ 7.0	250	-	-		
16 x 20	19a	0.8	16.5	22	7.5 ± 0.5	≈ 6.0	250	250	200		
16 x 25	19	0.8	16.5	27	7.5 ± 0.5	≈ 8.0	250	250	200		
18 x 20	1820	0.8	18.5	22	7.5 ± 0.5	≈ 7.0	100	250	200		
18 x 25	1825	0.8	18.5	27	7.5 ± 0.5	≈ 10.0	100	250	200		
16 x 31	20	0.8	16.5	33.5	7.5 ± 0.5	≈ 9.0	100	250	200		
18 x 31	1831	0.8	18.5	33.5	7.5 ± 0.5	≈ 12.5	100	250	200		
18 x 35	22	0.8	18.5	37.5	7.5 ± 0.5	≈ 14.5	100	250	200		
18 x 40	1840	0.8	18.5	42.5	7.5 ± 0.5	≈ 16.5	100	-	150		

ELECTRICAL DATA									
SYMBOL	DL DESCRIPTION								
C _R	Rated capacitance, tolerance -20 % / +50 %								
l _P	I _P Max. peak current								
lι	Max. leakage current after 0.5 h / 72 h at U _R								

Note

• Unless otherwise specified, all electrical values in Table 2 apply at $T_{amb} = 20$ °C, P = 86 kPa to 106 kPa and RH = 45 % to 75 %

ORDERING EXAMPLE

Capacitor series 220 EDLC

40 F / 2.7 V

Nominal case size: Ø 18 mm x 31 mm; Form tray

Ordering code: MAL222091001E3



Table 2

ELI	ELECTRICAL DATA AND ORDERING INFORMATION FOR ENERGY VERSION																				
U _R (V)	U _{CT} ⁽¹⁾ (V)	U _S (V) (< 1 s)	C _R (2)	NOMINAL CASE SIZE Ø D x L (mm)	MAX. ESR _{DC} ⁽²⁾ INITIAL (mΩ)	MAX. ESR _{AC} INITIAL, 1 kHz (mΩ)	CURRENT (A)		MAX. PEAK CURRENT		MAX. PEAK CURRENT		I _L MAX. LEAKAGE CURRENT AFTER (mA) (μA		E AT U _R (Wh)		SPECIFIC ENERGY Ed AT U _R (Wh/kg)		ORDERING CODE MAL2220		
65 °C	85 °C			(,		(11122)	65 °C	85 °C	0.5 h	72 h	65 °C	85 °C	65 °C	85 °C	FORM CA	FORM TFA	FORM TRAY				
2.7	2.3	2.85	15	16 x 20	40	30	25	20	6	75	0.015	0.011	2.5	1.8	50003E3	30003E3	90003E3				
2.7	2.3	2.85	20	16 x 25	38	28	25	20	6	75	0.020	0.015	2.5	1.8	50006E3	30006E3	90006E3				
2.7	2.3	2.85	20	18 x 20	38	28	25	20	6	75	0.020	0.015	2.9	2.1	50004E3	30004E3	90004E3				
2.7	2.3	2.85	25	18 x 25	36	26	25	20	11	115	0.025	0.018	2.5	1.8	50007E3	30007E3	90007E3				
2.7	2.3	2.85	30	16 x 31	36	26	25	20	15	150	0.030	0.022	3.4	2.5	50002E3	30002E3	90002E3				
2.7	2.3	2.85	35	18 x 31	35	25	25	20	15	150	0.035	0.029	3.5	2.6	50001E3	30001E3	90001E3				
2.7	2.3	2.85	45	18 x 35	30	21	25	20	20	200	0.046	0.033	3.2	2.3	50008E3	30008E3	90008E3				
2.7	2.3	2.85	55	18 x 40	25	18	25	20	25	250	0.056	0.040	3.4	2.5	50009E3	-	90009E3				

Notes

Table 3

ELI	ELECTRICAL DATA AND ORDERING INFORMATION FOR POWER VERSION																		
U _R (V)	U _{СТ} ⁽¹⁾ (V)	U _S (V) (< 1 s)	C _R ⁽²⁾ (F)	NOMINAL CASE SIZE Ø D x L (mm)	MAX. ESR _{DC} ⁽²⁾ INITIAL (mΩ)	MAX. ESR _{AC} INITIAL, 1 kHz (mΩ)	SR _{AC} CURRENT (A)		MAX. PEAK CURRENT (A)		I _I MA LEAK CURF AFT (mA)	X. AGE RENT ER	ENE	RED RGY T U _R /h)	ENE	T U _R		DERING C	
65 °C	85 °C			()		(11152)	65 °C	85 °C	0.5 h	72 h	65 °C	85 °C	65 °C	85 °C	FORM CA	FORM TFA	FORM TRAY		
2.7	2.3	2.85	5	10 x 20	45	28	12	10	2	25	0.005	0.004	2.3	1.8	51011E3	31011E3	-		
2.7	2.3	2.85	7	10 x 25	38	24	12	10	3	35	0.007	0.005	2.3	1.7	51012E3	31012E3	-		
2.7	2.3	2.85	8	12.5 x 20	42	21	15	12	4	40	0.008	0.006	2.0	1.5	51014E3	31014E3	-		
2.7	2.3	2.85	10	10 x 30	30	20	15	12	4	45	0.009	0.007	2.6	2.0	51013E3	31013E3	-		
2.7	2.3	2.85	12	12.5 x 25	33	19	17	14	5	55	0.011	0.008	2.2	1.6	51015E3	31015E3	-		
2.7	2.3	2.85	15	12.5 x 30	25	16	20	17	6	70	0.015	0.011	2.7	2.0	51016E3	31016E3	-		
2.7	2.3	2.85	20	16 x 20	24	18	25	20	8	75	0.020	0.015	3.4	2.3	51003E3	31003E3	91003E3		
2.7	2.3	2.85	22	12.5 x 40	22	11	25	20	9	75	0.021	0.015	3.0	2.1	51017E3	1	-		
2.7	2.3	2.85	25	16 x 25	22	16	25	20	8	75	0.025	0.018	3.2	2.3	51006E3	31006E3	91006E3		
2.7	2.3	2.85	25	18 x 20	20	15	25	20	8	75	0.025	0.018	3.6	2.6	51004E3	31004E3	91004E3		
2.7	2.3	2.85	30	18 x 25	19	13	30	25	12	140	0.030	0.022	3.0	2.2	51007E3	31007E3	91007E3		
2.7	2.3	2.85	35	16 x 31	20	14	30	25	15	200	0.035	0.026	3.9	2.9	51002E3	31002E3	91002E3		
2.7	2.3	2.85	40	18 x 31	18	12	35	30	20	200	0.041	0.029	3.3	2.3	51001E3	31001E3	91001E3		
2.7	2.3	2.85	50	18 x 35	15	10	35	30	25	250	0.051	0.037	3.5	2.6	51008E3	31008E3	91008E3		
2.7	2.3	2.85	60	18 x 40	13	9	35	30	30	300	0.061	0.044	3.7	2.7	51009E3	-	91009E3		

Notes

⁽¹⁾ U_{CT} = rated voltage at upper category temperature

⁽²⁾ Rated capacitance C_R and maximum ESR_{DC} are typical values for case sizes

 $^{^{(1)}}$ U_{CT} = rated voltage at upper category temperature

⁽²⁾ Rated capacitance C_R and maximum ESR_{DC} are typical values for case sizes



TEST PROCEDURES	AND REQUIR	EMENTS (1)								
NAME OF TEST	PROCEDURE (quick reference)									
Capacitance C _R and ESR _{DC}	Measured by DC d	ischarging method as described in "Measuring of Characteristics". (2)								
Maximum peak current	Non-repetitive current for maximum 1 s at specified operating temperature. Maximum operating voltage (refer to derating table) must not be exceeded. Usually to be tested with constant current discharge from U _R to 0.5 x U _R . Maximum current should not be used in normal operation and is only provided as reference value.									
Leakage current I _L	• • • • • • • • • • • • • • • • • • • •	Measured at U _R . Capacitor is charged to the rated voltage at 20 °C. Leakage current is the current at specified time that is required to keep the capacitor charged at the rated voltage.								
	After loading the capermissible maxim 1000 h:	apacitor of specified time at maximum category temperature $T_{max.}$ = 85 °C and derated um operating voltage U = 2.3 V, following parameters are valid within a timeframe of								
Endurance	Capacitance	Within ± 30 % of minimum initial specified value								
	ESR	Less than 3 x initial specified value								
	Leakage	Within specified value								
	After loading the capacitor of specified time at maximum category temperature T _{max.} = 85 °C and derated permissible maximum operating voltage U = 2.3 V, following parameters are valid within a timeframe of 1000 h:									
Useful life	Capacitance	Within ± 30 % of minimum initial specified value								
	ESR	Less than 3 x initial specified value								
	Leakage Within specified value									
	After loading the capacitor of specified time at maximum category temperature T _{max.} = 85 °C and without charge and under 40 % RH, following parameters are valid within a timeframe of 1000 h:									
Storage at upper	Capacitance	Within ± 30 % of minimum initial specified value								
category temperature	ESR	Less than 3 x initial specified value								
	Leakage	Within specified value								
Shelf life	Stored uncharged Parameter within in									
	Cycles at 20 °C between rated voltage and half of rated voltage U _R with constant current and 1 s rest between charge and discharge: > 500 000 cycles									
Cycle life	Capacitance	Within ± 30 % of minimum initial specified value								
	ESR	Less than 3 x initial specified value								
	E [Wh] = ½ x C x (l	J _R) ² x 1/3600								
Stored energy E, specific energy Ed and Ev	Ed [Wh/kg] = ½ x 0	C x (U _R) ² x 1/3600 x 1/mass								
specific effergy Lu affu Lv	Ev [Wh/L] = $\frac{1}{2}$ x C x (U _R) ² x 1/3600 x 1/volume									
Soldering	Hand or wave soldering allowed. For details refer to soldering requirements for radial aluminum electrolytic									
Cleaning	For printed circuit board cleaning apply non-aggressive cleaning agents only. For details refer to cleaning requirements for aluminum electrolytic capacitors in supplementary document.									
Environmental conditions	Do not expose capacitors to • temperatures outside specified range • high humidity atmospheres • corrosive atmospheres, e.g. halogenides, sulphurous or nitrous gases, acid or alkaline solutions, etc. • environments containing oil and grease									

Notes

- General remark: temperatures to be measured at capacitor case
- (1) Conditions: electrical measurements at 20 °C, unless otherwise specified
- $^{(2)}$ Rated capacitance C_R and ESR_{DC}

MEASURING OF CHARACTERISTICS

CAPACITANCE (C)

Capacitance shall be measured by constant current discharge method.

- Constant current charge with 10 mA/F to UR
- Constant voltage charge at UR
- Constant current discharge with 10 mA/F to 0.1 V

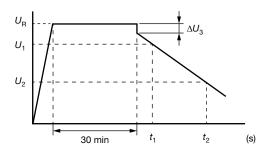


Fig. 3 - Voltage Diagram for Capacitance Measurement

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

$$C_{R}[F] = \frac{I_{D}[A] \times (t_{2}[s] - t_{1}[s])}{U_{1}[V] - U_{2}[V]}$$

 C_R Rated capacitance, in F U_{R} Rated voltage, in V

U₁ Starting voltage, 0.8 x U_R in V U2 Ending voltage, 0.4 x U_R in V

Voltage drop at internal resistance, in V ΔU_3

Time from start of discharge until voltage U₁ is t₁

reached, in s

Time from start of discharge until voltage U2 is t_2

reached, in s

 I_D Absolute value of discharge current, in A

EQUIVALENT SERIES RESISTANCE (ESRDC)

- Constant current charge to UR

- Constant voltage charge at UR

- Constant current discharge to 0.1 V

$$\mathsf{ESR}_{\mathsf{DC}}\left[\Omega\right] = \frac{\Delta \mathsf{U}_3\left[\mathsf{V}\right]}{\mathsf{I}_{\mathsf{D}}\left[\mathsf{A}\right]}$$

ESR_{DC} Equivalent series resistance, in Ω ΔU_R Voltage drop at internal resistance, in V Absolute value of discharge current, in A I_D

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