

## Aluminum Capacitors Power Ultra Miniature Snap-In


**RoHS  
COMPLIANT**
**FEATURES**

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Large types, very small dimensions, cylindrical aluminum case, insulated with a blue sleeve
- Charge and discharge proof
- Long useful life: 5000 h at 85 °C
- High ripple current capability
- Keyed polarity version available

**APPLICATIONS**

- General purpose, industrial and audio/video systems
- Smoothing and filtering
- Standard and switched mode power supplies
- Energy storage in pulse systems

**MARKING**

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

- Rated capacitance (in  $\mu\text{F}$ )
- Tolerance code on rated capacitance, code letter in accordance with IEC 60062 (M for  $\pm 20\%$ )
- Rated voltage (in V)
- Date code (YYMM)
- Name of manufacturer
- Code for factory of origin
- “-” sign to identify the negative terminal, visible from the top and side of the capacitor
- Code number
- Climatic category in accordance with IEC 60068

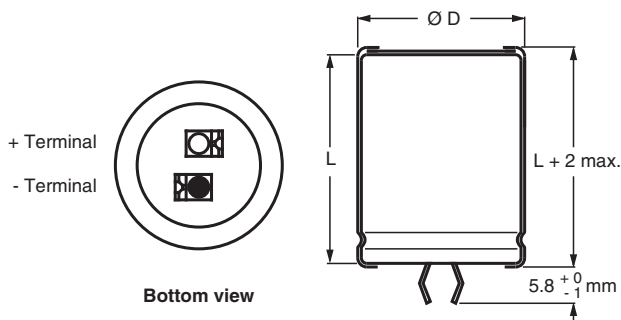


Fig. 1

QUICK REFERENCE DATA	
DESCRIPTION	VALUE
Nominal case size (Ø D x L in mm)	22 x 25 to 35 x 60
Rated capacitance range (E6 series), $C_R$	1000 $\mu\text{F}$ to 22 000 $\mu\text{F}$
Tolerance on $C_R$	$\pm 20\%$
Rated voltage range, $U_R$	10 V to 100 V
Category temperature range	- 40 °C to + 85 °C
Endurance test at 85 °C	2000 h
Useful life at 85 °C	5000 h
Useful life at 40 °C and 1.4 x $I_R$ applied	90 000 h
Shelf life at 0 V, 85 °C	500 h
Based on sectional specification	IEC 60384-4/EN130300
Climatic category IEC 60068	40/085/56

SELECTION CHART FOR $C_R$ , $U_R$ , AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)							
$C_R$ ( $\mu\text{F}$ )	$U_R$ (V)						
	16	25	40	50	63	80	100
1000	-	-	-	-	-	-	22 x 30
1200	-	-	-	-	-	-	22 x 35
1500	-	-	-	-	22 x 25	22 x 30	25 x 30
1800	-	-	-	-	25 x 25	-	-
2200	-	-	-	22 x 25	22 x 30	25 x 30	25 x 40
	-	-	-	-	25 x 25	-	30 x 30
2700	-	-	22 x 25	-	25 x 30	-	30 x 35
3300	-	-	22 x 30	22 x 30	25 x 35	25 x 40	30 x 40
	-	-	25 x 25	-	-	-	35 x 30
3900	-	-	-	25 x 30	25 x 40	-	-
4700	-	-	25 x 30	25 x 35	22 x 50	30 x 40	30 x 50
	-	22 x 25	-	-	30 x 30	-	35 x 40

SELECTION CHART FOR $C_R$ , $U_R$ , AND RELEVANT NOMINAL CASE SIZES ( $\varnothing D \times L$ in mm)							
$C_R$ ( $\mu F$ )	$U_R$ (V)						
	16	25	40	50	63	80	100
5600	-	25 x 25	-	25 x 40	30 x 35	-	-
6800	-	-	25 x 40	30 x 30	30 x 40	30 x 50	35 x 50
8200	-	-	30 x 30	30 x 35	30 x 50	-	35 x 60
10 000	25 x 30	22 x 40	30 x 35	30 x 40	35 x 40	35 x 50	-
12 000	-	25 x 40	30 x 40	30 x 50	35 x 50	-	-
15 000	25 x 40	30 x 35	30 x 50	-	35 x 60	-	-
	30 x 30	-	-	-	-	-	-
18 000	-	30 x 40	35 x 40	35 x 50	-	-	-
22 000	30 x 35	-	35 x 50	35 x 60	-	-	-
27 000	-	35 x 40	-	-	-	-	-
39 000	35 x 40	-	-	-	-	-	-

**DIMENSIONS in millimeters AND AVAILABLE FORMS**
**TWO TERMINAL SNAP-IN**


The minus terminal can be marked with a black dot or with an imprinted “-” sign.

Fig. 2 - Two terminal snap-in

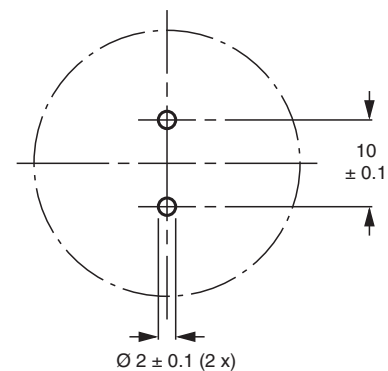
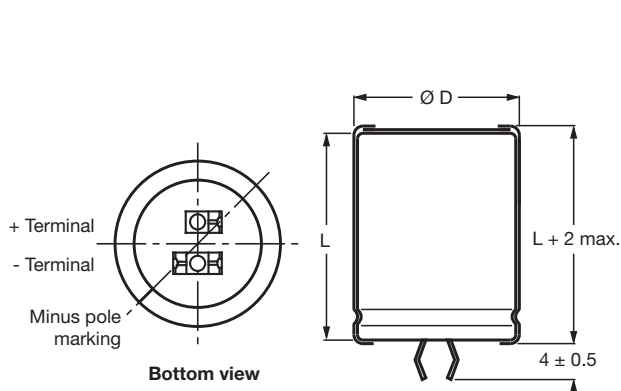
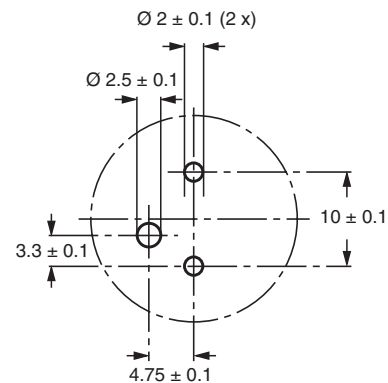


Fig. 3 - Mounting hole diagram

**THREE TERMINAL SNAP-IN**


The negative terminal has **TWO** pins which are **BOTH** electrically connected.

Fig. 4 - Three terminal snap-in



The 10 mm spacing of the 2 pin snap-in is used as the base layout and a third hole is added.

The third hole is closer to the negative primary hole so that polarization is always maintained, together with added mechanical stability.

Fig. 5 - Mounting hole diagram



Table 1

DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES					
NOMINAL CASE SIZE Ø D x L	Ø D <sub>max.</sub> (mm)	L <sub>max.</sub> (mm)	MASS (g)	PACKAGING QUANTITIES (units per box)	CARDBOARD BOX DIMENSIONS L x W x H
22 x 25	23	27	≈ 12	100	260 x 250 x 39
22 x 30	23	32	≈ 16	100	260 x 250 x 44
22 x 35	23	37	≈ 20	100	260 x 250 x 49
22 x 40	23	42	≈ 23	100	260 x 250 x 54
22 x 50	23	52	≈ 29	100	260 x 250 x 64
25 x 25	26	27	≈ 20	100	290 x 280 x 39
25 x 30	26	32	≈ 22	100	290 x 280 x 44
25 x 35	26	37	≈ 24	100	290 x 280 x 49
25 x 40	26	42	≈ 27	100	290 x 280 x 54
30 x 30	31	32	≈ 30	100	340 x 330 x 44
30 x 35	31	37	≈ 35	100	340 x 330 x 49
30 x 40	31	42	≈ 42	100	340 x 330 x 54
30 x 50	31	52	≈ 52	100	340 x 330 x 64
35 x 30	36	32	≈ 40	50	390 x 198 x 44
35 x 40	36	42	≈ 55	50	390 x 198 x 54
35 x 50	36	52	≈ 72	50	390 x 198 x 64
35 x 60	36	62	≈ 84	50	390 x 198 x 74

ELECTRICAL DATA	
SYMBOL	DESCRIPTION
C <sub>R</sub>	Rated capacitance at 100 Hz
I <sub>R</sub>	Rated RMS ripple current at 100 Hz and 85 °C
I <sub>L1</sub>	Max. leakage current after 1 min at U <sub>R</sub>
ESR	Max. equivalent series resistance at 100 Hz
Z	Max. impedance at 10 kHz

Note

- Unless otherwise specified, all electrical values in Table 2 apply at T<sub>amb</sub> = 20 °C, P = 86 kPa to 106 kPa, RH = 45 % to 75 %

ORDERING EXAMPLE

Electrolytic capacitor 156 series

1000 µF/25 V; ± 20 %

Nominal case size: Ø 25 x 40 mm

2-terminal snap-in:

Ordering code: MAL2 156 26123 E3

Former 12NC: 2222 156 26123

3-terminal snap-in:

Ordering code: MAL2 156 66123 E3

Former 12NC: 2222 156 66123

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION								
U <sub>R</sub> (V)	C <sub>R</sub> 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I <sub>R</sub> 100 Hz 85 °C (A)	I <sub>L5</sub> 5 min (µA)	MAX. ESR 100 Hz (mΩ)	MAX. Z 10 kHz (mΩ)	ORDERING CODE MAL2156.....	
							2-TERM.	3-TERM.
16	10 000	25 x 30	3.93	324	49	33	25103E3	65103E3
	15 000	25 x 40	4.98	484	36	26	35153E3	75153E3
	18 000	30 x 30	4.12	580	53	33	35183E3	75183E3
	22 000	30 x 35	4.71	708	44	29	25223E3	65223E3
	39 000	35 x 40	5.17	1252	45	26	25393E3	65393E3
25	4700	22 x 25	2.37	239	100	90	16472E3	56472E3
	5600	25 x 25	3.03	284	74	46	26562E3	66562E3
	10 000	22 x 40	4.40	504	41	27	16103E3	56103E3
	12 000	25 x 40	4.73	604	40	27	26123E3	66123E3
	15 000	30 x 35	4.55	754	47	31	26153E3	66153E3
	18 000	30 x 40	5.06	904	41	27	16183E3	56183E3
	27 000	35 x 40	5.04	1354	47	27	26273E3	66273E3



ELECTRICAL DATA AND ORDERING INFORMATION								
U <sub>R</sub> (V)	C <sub>R</sub> 100 Hz (μF)	NOMINAL CASE SIZE Ø D x L (mm)	I <sub>R</sub> 100 Hz 85 °C (A)	I <sub>L5</sub> 5 min (μA)	MAX. ESR 100 Hz (mΩ)	MAX. Z 10 kHz (mΩ)	ORDERING CODE MAL2156.....	
							2-TERM.	3-TERM.
40	2700	22 x 25	2.47	220	97	57	17272E3	57272E3
	3300	22 x 30	2.98	268	74	43	27332E3	67332E3
	3300	25 x 25	2.69	268	93	58	17332E3	57332E3
	4700	25 x 30	3.32	380	68	44	27472E3	67472E3
	6800	25 x 40	4.26	548	49	33	37682E3	77682E3
	8200	30 x 30	3.49	660	74	44	37822E3	77822E3
	10 000	30 x 35	4.02	804	60	38	17103E3	57103E3
	12 000	30 x 40	4.49	964	52	33	17123E3	57123E3
	15 000	30 x 50	5.39	1204	41	28	37153E3	77153E3
	18 000	35 x 40	4.39	1444	62	33	17183E3	57183E3
22 000	35 x 50	5.34	1764	47	28	27223E3	67223E3	
50	2200	22 x 25	2.34	224	107	62	11222E3	51222E3
	3300	22 x 30	2.92	334	76	46	11332E3	51332E3
	3900	25 x 30	3.17	394	74	47	21392E3	61392E3
	4700	25 x 35	3.64	474	62	40	21472E3	61472E3
	5600	25 x 40	4.09	564	53	35	21562E3	61562E3
	6800	30 x 30	3.35	684	79	48	21682E3	61682E3
	8200	30 x 35	3.88	824	65	40	21822E3	61822E3
	10 000	30 x 40	4.32	1004	56	35	11103E3	51103E3
	12 000	30 x 50	5.23	1204	43	29	11123E3	51123E3
	18 000	35 x 50	5.18	1804	50	29	11183E3	51183E3
22 000	35 x 60	5.97	2204	51	46	11223E3	51223E3	
63	1500	22 x 25	2.13	193	128	68	18152E3	58152E3
	1800	25 x 25	2.37	231	120	69	18182E3	58182E3
	2200	22 x 30	2.66	281	92	50	18222E3	58222E3
	2200	25 x 25	2.42	281	115	70	28222E3	68222E3
	2700	25 x 30	2.95	344	86	51	28272E3	68272E3
	3300	25 x 35	3.39	420	71	43	28332E3	68332E3
	3900	25 x 40	3.81	495	61	37	28392E3	68392E3
	4700	22 x 50	4.26	596	50	30	18472E3	58472E3
	4700	30 x 30	3.25	596	85	53	38472E3	78472E3
	5600	30 x 35	3.75	710	69	45	28562E3	68562E3
	6800	30 x 40	4.19	861	59	39	18682E3	58682E3
	6800	35 x 30	3.28	861	97	53	28682E3	68682E3
	8200	30 x 50	5.05	1037	46	32	38822E3	78822E3
	10 000	35 x 40	4.23	1264	67	39	18103E3	58103E3
	12 000	35 x 50	5.15	1516	51	32	18123E3	58123E3
15 000	35 x 60	5.89	1894	52	47	18153E3	58153E3	
80	1500	22 x 30	1.83	244	318	308	12152E3	52152E3
	2200	25 x 30	2.23	356	230	224	22222E3	62222E3
	3300	25 x 40	2.92	532	155	152	22332E3	62332E3
	4700	30 x 40	3.44	756	121	119	12472E3	52472E3
	6800	30 x 50	4.18	1092	88	87	12682E3	52682E3
	10 000	35 x 50	4.51	1604	74	73	12103E3	52103E3
100	1000	22 x 30	1.72	204	338	312	19102E3	59102E3
	1200	22 x 35	1.98	244	282	261	29122E3	59122E3
	1500	25 x 30	2.12	304	239	223	29152E3	59152E3
	2200	25 x 40	2.77	444	164	154	29222E3	59222E3
	2200	30 x 30	2.55	444	181	171	39222E3	79222E3
	2700	30 x 35	2.94	544	148	140	29272E3	59272E3
	3300	30 x 40	3.32	664	123	116	19332E3	59332E3
	3300	35 x 30	2.84	664	147	140	29332E3	69332E3
	4700	30 x 50	4.04	944	90	86	19472E3	59472E3
	4700	35 x 40	3.67	944	102	98	29472E3	69472E3
	6800	35 x 50	4.39	1364	76	73	19682E3	59682E3
	8200	35 x 60	5.21	1644	63	61	19822E3	59822E3



ADDITIONAL ELECTRICAL DATA		
PARAMETER	CONDITIONS	VALUE
<b>Voltage</b>		
Surge voltage		$U_s = 1.15 \times U_R$
Reverse voltage		$U_{rev} \leq 1 V$
<b>Current</b>		
Leakage current	After 1 min at $U_R$	$I_{L1} \leq 0.006 C_R \times U_R + 4 \mu A$
	After 5 min at $U_R$	$I_{L5} \leq 0.002 C_R \times U_R + 4 \mu A$
<b>Inductance</b>		
Equivalent series inductance (ESL)	All case sizes	Typ. 19 nH
		Max. 25 nH

**RIPPLE CURRENT AND USEFUL LIFE**

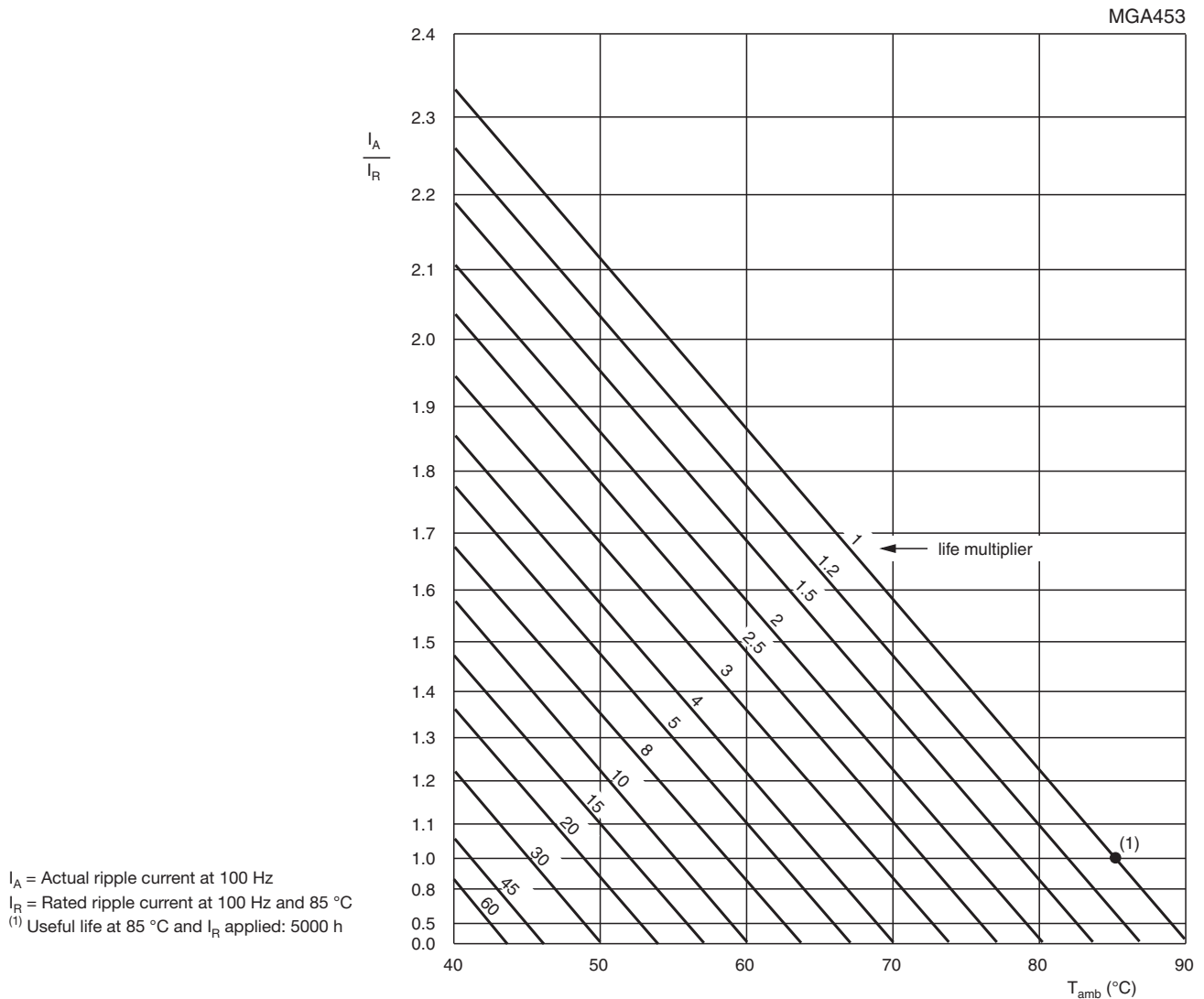


Fig. 6 - Multiplier of useful life as a function of ambient temperature and ripple current load



Table 3

MULTIPLIER OF RIPPLE CURRENT ( $I_R$ ) AS A FUNCTION OF FREQUENCY		
FREQUENCY (Hz)	$I_R$ MULTIPLIER	
	$U_R = 10\text{ V TO }25\text{ V}$	$U_R = 40\text{ V TO }100\text{ V}$
50	0.93	0.91
100	1.00	1.00
200	1.04	1.05
400	1.07	1.09
1000	1.11	1.13
2000	1.13	1.15
4000	1.15	1.18
$\geq 10\ 000$	1.18	1.22

Table 4

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4/EN130300 subclause 4.13	$T_{amb} = 85\text{ °C}$ ; $U_R$ applied: 2000 h	$\Delta C/C: \pm 15\%$ ESR $\leq 1.3 \times$ spec. limit $Z \leq 2 \times$ spec. limit $I_{L5} \leq$ spec. limit
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 85\text{ °C}$ ; $U_R$ and $I_R$ applied: 5000 h	$\Delta C/C: \pm 15\%$ ESR $\leq 3 \times$ spec. limit $Z \leq 3 \times$ spec. limit $I_{L5} \leq$ spec. limit no short or open circuit, no visible damage total failure percentage: $\leq 1\%$
Shelf life (storage at high temperature)	IEC 60384-4/EN130300 subclause 4.17	$T_{amb} = 85\text{ °C}$ ; no voltage applied; 500 h After test: $U_R$ to be applied for 30 min, 24 h to 48 h before measurement	$\Delta C/C: \pm 10\%$ ESR $\leq 1.2 \times$ spec. limit $I_{L5} \leq 2 \times$ spec. limit



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