Aluminum Capacitors
Power Miniaturized General Purpose Snap-In

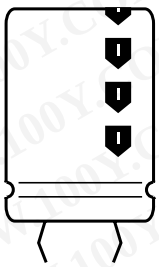
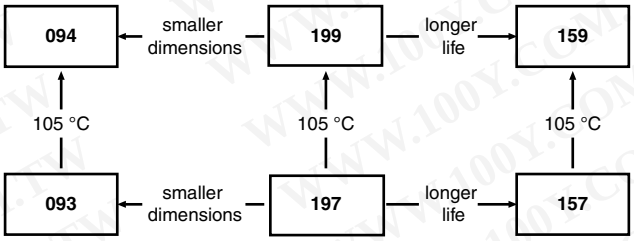


Fig.1 Component outlines



FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Large types, miniaturized dimensions, cylindrical aluminum case insulated with a blue sleeve
- Useful life: 2000 hours at 85 °C
- Compliant to RoHS directive 2002/95/EC

Pb-free
RoHS COMPLIANT

APPLICATIONS

- Consumer electronics
- Whitegood motor control
- Electronic drives
- Smps/ups

MARKING

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

- Rated capacitance (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for ± 20 %)
- Rated voltage (in V)
- Date code
- Name of manufacturer
- '-' sign to identify the negative terminal, visible from the top and side of the capacitor
- Code number (last 8 digits)
- Maximum operating temperature

QUICK REFERENCE DATA

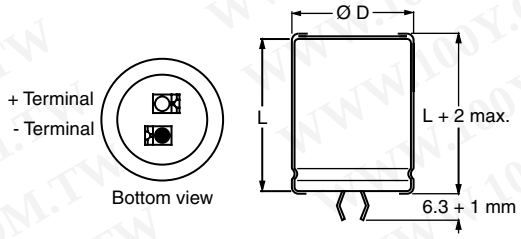
DESCRIPTION	VALUE
Nominal case size (Ø D x L in mm)	22 x 25 to 35 x 50
Rated capacitance range, C_R	68 µF to 2200 µF
Tolerence on C_R	± 20 %
Rated voltage range, U_R	200 V to 450 V
Category temperature range	- 25 °C to + 85 °C
Useful life at 85 °C	2000 hours
Useful life at 40 °C and 1.4 x I_R applied	36 000 hours
Shelf life at 0 V, 85 °C	500 hours
Based on sectional specification	IEC 60384-4/EN130300/W of JISC5141

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

C_R (µF)	U_R (V)				
	200	250	400	420	450
68	-	-	22 x 25	-	-
82	-	-	-	-	22 x 25
100	-	-	22 x 25	22 x 25	22 x 30
120	- -	-	-	-	22 x 30 25 x 25
150	-	-	22 x 30 25 x 25	-	22 x 35
180	-	-	22 x 35 25 x 30	22 x 35 25 x 30	22 x 40 25 x 30 30 x 25
220	-	22 x 25	22 x 40 25 x 30 30 x 25	25 x 35 30 x 25	22 x 50 25 x 35 30 x 25
270	22 x 25	22 x 30	22 x 50 30 x 25	22 x 50 30 x 30	30 x 30 35 x 25

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)					
C_R (µF)	U_R (V)				
	200	250	400	420	450
330	-	22 x 35	25 x 40 30 x 30 35 x 25	25 x 50 30 x 35	25 x 50 35 x 30
390	22 x 30 25 x 25	22 x 35 25 x 30	25 x 50 30 x 35 35 x 30	35 x 30	30 x 40 35 x 35
470	22 x 35	25 x 35	30 x 40 35 x 30	35 x 35	35 x 40
560	25 x 30	25 x 40	30 x 45 35 x 35	30 x 50 35 x 40	35 x 45
680	25 x 35	30 x 30	35 x 40	35 x 45	35 x 50
820	25 x 40	30 x 35	35 x 50	-	-
1000	30 x35	30 x 40	-	-	-
1200	30 x 40	35 x 40	-	-	-
1500	30 x 45	35 x 45	-	-	-
1800	30 x 50 35 x 40	35 x 50	- -	- -	- -
2200	35 x 45	-	-	-	-

DIMENSIONS in millimeters AND AVAILABLE FORMS



The minus and/or plus terminal can be marked with an imprinted sign

Fig.2 Two terminal snap-in

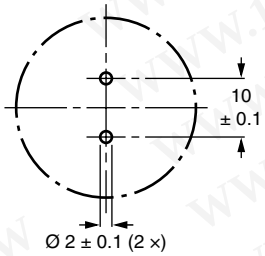


Fig.3 Mounting hole diagram

Table 1

DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES					
NOMINAL CASE SIZE Ø D x L	Ø $D_{max.}$	$L_{max.}$	MASS (g)	PACKAGING QUANTITIES	CARDBOARD BOX DIMENSIONS L x W x H
22 x 25	22.5	26.5	≈ 12	216	280 x 240 x 140
22 x 30	22.5	31.5	≈ 16	216	280 x 240 x 140
22 x 35	22.5	36.5	≈ 20	144	280 x 240 x 105
22 x 40	22.5	41.5	≈ 23	144	280 x 240 x 105
22 x 45	22.5	46.5	≈ 26	144	280 x 240 x 140
22 x 50	22.5	51.5	≈ 29	72	280 x 240 x 105
25 x 25	25.5	26.5	≈ 20	216	280 x 240 x 140
25 x 30	25.5	33.5	≈ 22	216	280 x 240 x 140
25 x 35	25.5	36.5	≈ 24	144	280 x 240 x 105
25 x 40	25.5	41.5	≈ 27	144	280 x 240 x 105
25 x 45	25.5	46.5	≈ 32	144	280 x 240 x 140
25 x 50	25.5	51.5	≈ 38	144	280 x 240 x 140
30 x 25	30.5	28.5	≈ 25	168	280 x 240 x 140
30 x 30	30.5	33.5	≈ 30	168	280 x 240 x 140
30 x 35	30.5	38.5	≈ 35	112	280 x 240 x 105
30 x 40	30.5	42.5	≈ 40	112	280 x 240 x 105
30 x 45	30.5	47.5	≈ 45	112	280 x 240 x 140
30 x 50	30.5	52.5	≈ 50	112	280 x 240 x 140
35 x 25	35.5	26.5	≈ 33	126	280 x 240 x 140
35 x 30	35.5	33.5	≈ 40	126	280 x 240 x 140
35 x 35	35.5	36.5	≈ 48	84	280 x 240 x 105
35 x 40	35.5	42.5	≈ 55	84	280 x 240 x 105
35 x 45	35.5	47.5	≈ 63	84	280 x 240 x 140
35 x 50	35.5	52.5	≈ 72	84	280 x 240 x 140

ELECTRICAL DATA	
SYMBOL	DESCRIPTION
C_R	rated capacitance at 120 Hz
I_R	rated RMS ripple current at 120 Hz, 85 °C
I_{L5}	max. leakage current after 5 minutes at U_R
ESR	max. equivalent series resistance at 120 Hz (1)

Notes

(1) ESR at 100 Hz is approximately 1.05 x ESR 120 Hz

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

ORDERING EXAMPLE

Electrolytic capacitor 093 series
330 µF/400 V; ± 20 %
Nominal case size: Ø 25 mm x 40 mm
2-terminal snap-in:
Ordering code: MAL2093 46331 E3
Former 12NC: 2222 093 46331

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 120 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 120 Hz (A)	I_{L5} (mA)	MAX. ESR (1) 120 Hz (Ω)	MAX. Z 10 kHz (Ω)	ORDERING CODE MAL2093.....
	270	22 x 25	1.26	1.08	0.47	0.31	52271E3
	390	22 x 30	1.55	1.50	0.33	0.22	52391E3
	390	25 x 25	1.46	1.50	0.36	0.25	42391E3
	470	22 x 35	1.78	1.50	0.27	0.18	52471E3
	560	25 x 30	1.83	1.50	0.25	0.17	42561E3
200	680	25 x 35	2.06	1.50	0.21	0.15	42681E3
	820	25 x 40	2.36	1.50	0.18	0.12	42821E3
	1000	30 x 35	2.35	1.50	0.18	0.13	32102E3
	1200	30 x 40	2.69	1.50	0.15	0.11	32122E3
	1500	30 x 45	3.00	1.50	0.12	0.09	32152E3
	1800	30 x 50	3.36	1.50	0.11	0.08	32182E3
	1800	35 x 40	2.91	1.50	0.14	0.10	22182E3
	2200	35 x 45	3.23	1.50	0.12	0.09	22222E3
	220	22 x 25	1.18	1.10	0.50	0.32	53221E3
	270	22 x 30	1.37	1.35	0.40	0.25	53271E3
	330	22 x 35	1.58	1.50	0.32	0.20	53331E3
	390	22 x 35	1.67	1.50	0.29	0.18	53391E3
	390	25 x 30	1.64	1.50	0.29	0.19	43391E3
	470	25 x 35	1.85	1.50	0.25	0.16	43471E3
250	560	25 x 40	2.11	1.50	0.21	0.14	43561E3
	680	30 x 30	2.01	1.50	0.22	0.15	33681E3
	820	30 x 35	2.23	1.50	0.19	0.13	33821E3
	1000	30 x 40	2.56	1.50	0.15	0.11	33102E3
	1200	35 x 40	3.82	1.50	0.15	0.11	23122E3
	1500	35 x 45	3.08	1.50	0.13	0.09	23152E3
	1800	35 x 50	3.35	1.50	0.11	0.08	23182E3
	68	22 x 25	0.80	0.54	2.06	1.49	56689E3
	100	22 x 25	0.98	0.80	1.48	1.09	56101E3
	150	22 x 30	1.11	1.20	1.00	0.74	56151E3
	150	25 x 25	1.10	1.20	1.03	0.77	46151E3
	180	22 x 35	1.26	1.44	0.83	0.61	56181E3
	180	25 x 30	1.27	1.44	0.81	0.59	46181E3
	220	22 x 40	1.46	1.50	0.68	0.50	56221E3
	220	25 x 30	1.38	1.50	0.70	0.52	46221E3
	220	30 x 25	1.43	1.50	0.71	0.53	36221E3
	270	22 x 50	1.58	1.50	0.53	0.39	56271E3
	270	30 x 25	1.53	1.50	0.63	0.48	36271E3
400	330	25 x 40	1.82	1.50	0.49	0.37	46331E3
	330	30 x 30	1.77	1.50	0.50	0.39	36331E3
	330	35 x 25	1.77	1.50	0.58	0.46	26331E3
	390	25 x 50	2.21	1.50	0.40	0.30	46391E3
	390	30 x 35	1.98	1.50	0.43	0.33	36391E3
	390	35 x 30	2.10	1.50	0.44	0.34	26391E3
	470	30 x 40	2.20	1.50	0.37	0.28	36471E3
	470	35 x 30	2.14	1.50	0.40	0.32	26471E3
	560	30 x 45	2.48	1.50	0.30	0.23	36561E3
	560	35 x 35	2.35	1.50	0.34	0.27	26561E3
	680	35 x 40	2.68	1.50	0.28	0.22	26681E3
	820	35 x 50	3.18	1.50	0.22	0.17	26821E3

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 120 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 120 Hz (A)	I_{L5} (mA)	MAX. ESR (1) 120 Hz (Ω)	MAX. Z 10 kHz (Ω)	ORDERING CODE MAL2093.....
420	100	22 x 25	0.89	0.84	1.44	1.05	54101E3
	180	22 x 35	1.29	1.50	0.81	0.59	54181E3
	180	25 x 30	1.29	1.50	0.78	0.57	44181E3
	220	25 x 35	1.47	1.50	0.67	0.50	44221E3
	220	30 x 25	1.44	1.50	0.69	0.52	34221E3
	270	22 x 50	1.61	1.50	0.54	0.39	54271E3
	270	30 x 30	1.67	1.50	0.56	0.41	34271E3
	330	25 x 50	1.47	1.50	0.43	0.31	44331E3
	330	30 x 35	1.88	1.50	0.46	0.35	34331E3
	390	35 x 30	2.05	1.50	0.47	0.37	24391E3
	470	35 x 35	2.27	1.50	0.37	0.28	24471E3
	560	30 x 50	2.66	1.50	0.31	0.25	34561E3
	560	35 x 40	2.57	1.50	0.34	0.27	24561E3
	680	35 x 45	2.87	1.50	0.28	0.23	24681E3
450	82	22 x 25	0.80	0.74	1.77	1.31	57829E3
	100	22 x 30	0.95	0.90	1.45	1.07	57101E3
	120	22 x 30	1.00	1.08	1.26	0.95	57121E3
	120	25 x 25	1.00	1.08	1.29	0.97	47121E3
	150	22 x 35	1.17	1.35	1.01	0.76	57151E3
	180	22 x 40	1.34	1.50	0.85	0.63	57181E3
	180	25 x 30	1.27	1.50	0.86	0.65	47181E3
	180	30 x 25	1.32	1.50	0.86	0.65	37181E3
	220	22 x 50	1.45	1.50	0.66	0.49	57221E3
	220	25 x 35	1.45	1.50	0.73	0.56	47221E3
	220	30 x 25	1.42	1.50	0.76	0.59	37221E3
	270	30 x 30	1.64	1.50	0.61	0.47	37271E3
	270	35 x 25	1.66	1.50	0.68	0.54	27271E3
	330	25 x 50	2.07	1.50	0.46	0.35	47331E3
	330	35 x 30	1.98	1.50	0.50	0.39	27331E3
	390	30 x 40	2.11	1.50	0.42	0.32	37391E3
	390	35 x 35	2.18	1.50	0.43	0.33	27391E3
	470	35 x 40	2.47	1.50	0.35	0.27	27471E3
	560	35 x 45	2.74	1.50	0.30	0.23	27561E3
	680	35 x 50	3.07	1.50	0.25	0.20	27681E3

Note

(1) ESR at 100 Hz is approximately 1.05 x ESR 120 Hz

ADDITIONAL ELECTRICAL DATA

PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage	≥ 200 V versions	$U_S = 1.1 \times U_R$
Reverse voltage	≤ 1 V	-
Current		
Leakage current	After 5 minutes at U_R	$I_{L5} \leq 0.02\ C_R \times U_R$ or 1.5 mA, whichever is smaller
Inductance		
Equivalent series inductance (ESL)	All case sizes	19 nH typical/25 nH max.

Table 3

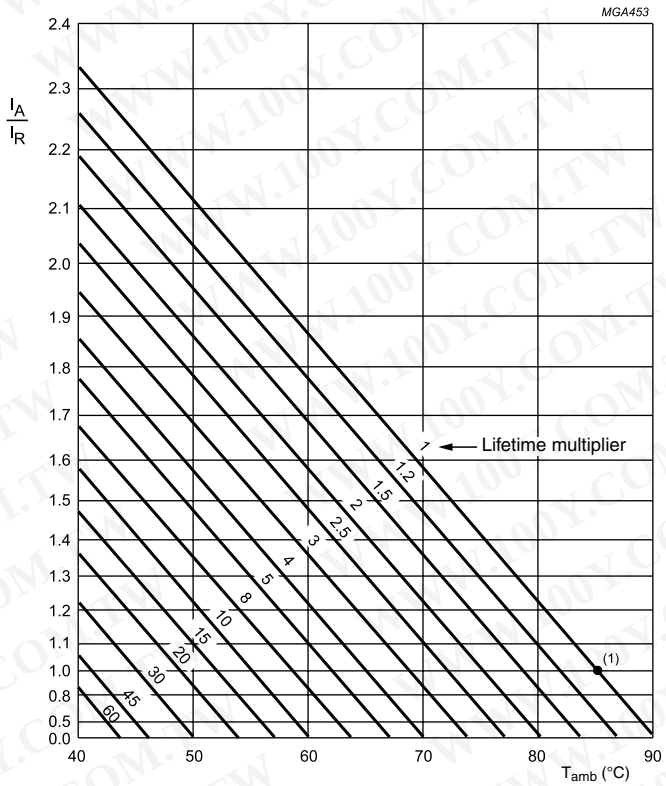
LOW TEMPERATURE CHARACTERISTIC (at 120 Hz)

DESCRIPTION		U_R (V) (1)
		200 to 450
Impedance ratio	Z (- 25 °C)/Z (+ 20 °C)	4

Note

(1) Impedance ratio shall not exceed the given values

RIPPLE CURRENT AND USEFUL LIFE



I_A = actual ripple current at 120 Hz

I_R = rated ripple current at 120 Hz and 85 °C

(1) Useful life at 85 °C and I_R applied: 2000 hours

Fig.4 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 4

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY	
FREQUENCY (Hz)	I_R MULTIPLIER
	400 V and 450 V
60	0.90
100	0.95
120	1.00
500	1.20
1000	1.30
≥ 10 000	1.40

Table 5

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 85 °C; U_R and I_R applied: 2000 hours	ΔC/C: ± 30 % ESR ≤ 3 x spec. limit I_{L5} ≤ spec. limit no short or open circuit, no visible damage total failure percentage: ≤ 3 %
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	T_{amb} = 85 °C; no voltage applied; 500 hours After test: U_R to be applied for 30 minutes, 24 hours to 48 hours before measurement	ΔC/C: ± 20 % ESR ≤ 2 x spec. limit I_{L5} ≤ 1 x spec. limit

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