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Aluminum Capacitors
Power Miniaturized Economy Long Life Snap-In

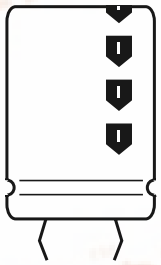
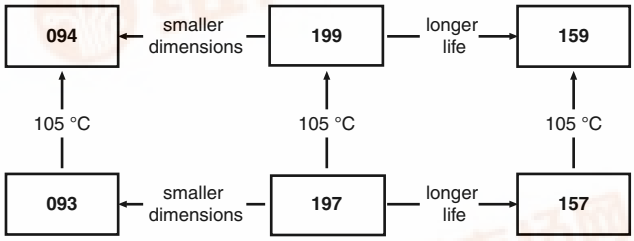


Fig.1 Component outlines



QUICK REFERENCE DATA	
DESCRIPTION	VALUE
Nominal case size (Ø D x L in mm)	22 x 25 to 35 x 60
Rated capacitance range, C_R	56 µF to 2200 µF
Tolerance on C_R	± 20 %
Rated voltage range, U_R	200 V to 450 V
Category temperature range	- 25 °C to + 105 °C
Useful life at 105 °C	2000 hours
Useful life at 40 °C and 1.6 x I_R applied	180 000 hours
Shelf life at 0 V, 105 °C	500 hours
Based on sectional specification	IEC 60384-4/EN130300/W of JISC5141

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 105 °C
- Compliant to RoHS directive 2002/95/EC

Pb-free
RoHS COMPLIANT

APPLICATIONS

- Consumer and Telecom
- Whitegood motor control
- Electronic drives
- Smps/ups

MARKING

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

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

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
56	-	-	22 x 25	22 x 25	22 x 25
68	-	-	22 x 25	22 x 25	22 x 25
82	-	-	22 x 25	22 x 25	22 x 30
	-	-	-	-	25 x 25
100	-	-	22 x 25	22 x 30	22 x 30
	-	-	-	25 x 25	25 x 25
120	-	-	22 x 30	22 x 30	22 x 35
	-	-	25 x 25	25 x 25	25 x 30
150	-	-	22 x 35	22 x 35	22 x 40
	-	-	-	25 x 30	25 x 30
	-	-	-	-	30 x 25

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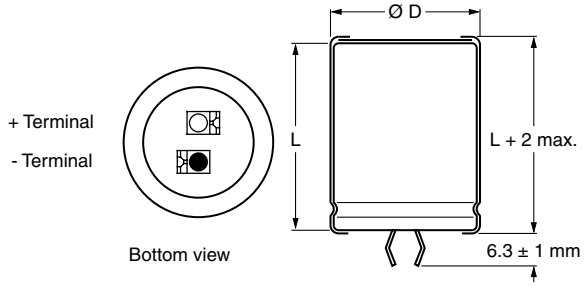
SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)					
C_R (µF)	U_R (V)				
	200	250	400	420	450
180	-	-	30 x 25	22 x 40	22 x 50
	-	-	-	25 x 30	25 x 35
	-	-	-	30 x 25	30 x 25
220	22 x 25	22 x 30	22 x 50	22 x 50	25 x 40
	-	-	25 x 35	25 x 40	30 x 30
	-	-	30 x 25	30 x 30	35 x 25
	-	-	-	35 x 25	-
270	22 x 25	22 x 30	30 x 30	25 x 50	25 x 50
	-	-	35 x 25	-	30 x 35
	-	-	-	-	35 x 30
330	22 x 30	22 x 35	25 x 50	35 x 30	30 x 45
	-	-	30 x 35	-	35 x 35
	-	-	35 x 30	-	-
390	22 x 35	25 x 30	30 x 40	35 x 35	30 x 50
	25 x 30	-	35 x 30	-	35 x 40
470	22 x 35	25 x 35	30 x 45	35 x 40	35 x 45
	25 x 30	-	35 x 35	-	-
560	25 x 30	25 x 40	30 x 50	35 x 45	35 x 50
	-	-	35 x 40	-	-
680	22 x 50	30 x 30	35 x 45	35 x 50	35 x 60
	25 x 40	-	-	-	-
820	30 x 30	-	-	-	-
1000	25 x 50	30 x 45	-	-	-
	30 x 35		-	-	-
1200	30 x 40	35 x 40	-	-	-
1500	30 x 50	35 x 45	-	-	-
	35 x 40		-	-	-
1800	-	35 x 50	-	-	-
2200	35 x 50	-	-	-	-

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

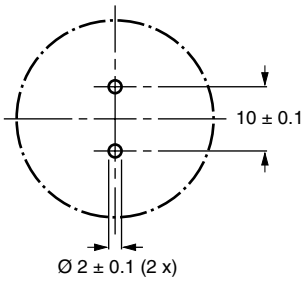


Fig.3 Mounting hole diagram

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
35 x 60	36.5	62.5	≈ 87	42	280 x 240 x 105

ELECTRICAL DATA	
SYMBOL	DESCRIPTION
C_R	rated capacitance at 120 Hz
I_R	rated RMS ripple current at 120 Hz, 105 °C
I_{L5}	max. leakage current after 5 minutes at U_R
ESR	max. equivalent series resistance at 120 Hz (1)

Note

(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 094 series
330 µF/400 V; ± 20 %
Nominal case size: Ø 25 mm x 50 mm

2-terminal snap-in:
Ordering code: MAL2 094 46331 E3
Former 12NC: 2222 094 46331

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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 120 Hz [1] (Ω)	MAX. Z 10 kHz (Ω)	ORDERING CODE MAL2094.....
200	220	22 x 25	1.04	0.88	0.46	0.30	52221E3
	270	22 x 25	1.12	1.08	0.40	0.26	52271E3
	330	22 x 30	1.30	1.32	0.32	0.21	52331E3
	390	22 x 35	1.49	1.50	0.27	0.17	52391E3
	390	25 x 30	1.47	1.50	0.27	0.18	42391E3
	470	22 x 35	1.58	1.50	0.24	0.15	52471E3
	470	25 x 30	1.55	1.50	0.24	0.16	42471E3
	560	25 x 30	1.61	1.50	0.22	0.15	42561E3
	680	22 x 50	1.96	1.50	0.16	0.10	52681E3
	680	25 x 40	1.98	1.50	0.17	0.11	42681E3
	820	30 x 30	1.86	1.50	0.18	0.13	32821E3
	1000	25 x 50	2.56	1.50	0.12	0.08	42102E3
	1000	30 x 35	2.04	1.50	0.16	0.12	32102E3
	1200	30 x 40	2.35	1.50	0.13	0.09	32122E3
	1500	30 x 50	2.87	1.50	0.10	0.07	32152E3
	1500	35 x 40	2.54	1.50	0.13	0.09	22152E3
	2200	35 x 50	3.02	1.50	0.10	0.07	22222E3
250	220	22 x 30	1.33	1.10	0.41	0.25	53221E3
	270	22 x 30	1.22	1.35	0.35	0.22	53271E3
	330	22 x 35	1.40	1.50	0.29	0.18	53331E3
	390	25 x 30	1.46	1.50	0.26	0.17	43391E3
	470	25 x 35	1.64	1.50	0.22	0.14	43471E3
	560	25 x 40	1.87	1.50	0.19	0.12	43561E3
	680	30 x 30	1.76	1.50	0.20	0.14	33681E3
	1000	30 x 45	2.48	1.50	0.13	0.09	33102E3
	1200	35 x 40	2.47	1.50	0.13	0.10	23122E3
	1500	35 x 45	2.73	1.50	0.12	0.09	23152E3
	1800	35 x 50	2.96	1.50	0.10	0.07	23182E3
400	56	22 x 25	0.53	0.45	2.39	1.79	56569E3
	68	22 x 25	0.58	0.54	1.98	1.49	56689E3
	82	22 x 25	0.64	0.66	1.66	1.25	56829E3
	100	22 x 25	0.68	0.80	1.51	1.16	56101E3
	120	22 x 30	0.79	0.96	1.16	0.87	56121E3
	120	25 x 25	0.79	0.96	1.17	0.89	46121E3
	150	22 x 35	0.92	1.20	0.92	0.69	56151E3
	180	30 x 25	1.03	1.44	0.81	0.62	36181E3
	220	22 x 50	1.15	1.50	0.59	0.44	56221E3
	220	25 x 35	1.11	1.50	0.68	0.52	46221E3
	220	30 x 25	1.08	1.50	0.71	0.55	36221E3
	270	30 x 30	1.26	1.50	0.55	0.42	36271E3
	270	35 x 25	1.25	1.50	0.63	0.50	26271E3
	330	25 x 50	1.61	1.50	0.43	0.33	46331E3
	330	30 x 35	1.41	1.50	0.47	0.37	36331E3
	330	35 x 30	1.50	1.50	0.46	0.36	26331E3
	390	30 x 40	1.62	1.50	0.39	0.30	36391E3
	390	35 x 30	1.56	1.50	0.43	0.34	26391E3
	470	30 x 45	1.82	1.50	0.33	0.26	36471E3
	470	35 x 35	1.70	1.50	0.37	0.30	26471E3
	560	30 x 50	2.03	1.50	0.29	0.23	36561E3
	560	35 x 40	1.95	1.50	0.30	0.24	26561E3
	680	35 x 45	2.15	1.50	0.26	0.21	26681E3

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 120 Hz [1] (Ω)	MAX. Z 10 kHz (Ω)	ORDERING CODE MAL2094.....
420	56	22 x 25	0.54	0.47	2.24	1.64	54569E3
	68	22 x 25	0.59	0.57	1.86	1.36	54689E3
	82	22 x 25	0.64	0.69	1.60	1.20	54829E3
	100	22 x 30	0.74	0.84	1.27	0.93	54101E3
	100	25 x 25	0.74	0.84	1.29	0.96	44101E3
	120	22 x 30	0.79	1.01	1.15	0.87	54121E3
	120	25 x 25	0.79	1.01	1.16	0.89	44121E3
	150	22 x 35	0.92	1.26	0.91	0.69	54151E3
	150	25 x 30	0.93	1.26	0.86	0.64	44151E3
	180	22 x 40	1.06	1.50	0.76	0.57	54181E3
	180	25 x 30	1.00	1.50	0.78	0.59	44181E3
	180	30 x 25	1.03	1.50	0.76	0.58	34181E3
	220	22 x 50	1.15	1.50	0.59	0.44	54221E3
	220	25 x 40	1.22	1.50	0.59	0.44	44221E3
	220	30 x 30	1.19	1.50	0.59	0.44	34221E3
	220	35 x 25	1.19	1.50	0.67	0.52	24221E3
	270	25 x 50	1.50	1.50	0.47	0.34	44271E3
	330	35 x 30	1.49	1.50	0.45	0.35	24331E3
	390	35 x 35	1.65	1.50	0.39	0.31	24391E3
	470	35 x 40	1.86	1.50	0.32	0.25	24471E3
	560	35 x 45	2.06	1.50	0.27	0.21	24561E3
	680	35 x 50	2.30	1.50	0.23	0.18	24681E3
450	56	22 x 25	0.55	0.50	2.06	1.46	57569E3
	68	22 x 25	0.59	0.61	1.72	1.23	57689E3
	82	22 x 30	0.68	0.74	1.41	1.01	57829E3
	82	25 x 25	0.68	0.74	1.43	1.03	47829E3
	100	22 x 30	0.74	0.90	1.25	0.92	57101E3
	100	25 x 25	0.74	0.90	1.25	0.91	47101E3
	120	22 x 35	0.85	1.08	1.01	0.73	57121E3
	120	25 x 30	0.86	1.08	0.98	0.70	47121E3
	150	22 x 40	0.99	1.35	0.81	0.59	57151E3
	150	25 x 30	0.93	1.35	0.83	0.61	47151E3
	150	30 x 25	0.97	1.35	0.83	0.61	37151E3
	180	22 x 50	1.07	1.50	0.64	0.45	57181E3
	180	25 x 35	1.05	1.50	0.73	0.53	47181E3
	180	30 x 25	1.03	1.50	0.75	0.56	37181E3
	220	25 x 40	1.20	1.50	0.60	0.44	47221E3
	220	30 x 30	1.19	1.50	0.59	0.43	37221E3
	220	35 x 25	1.19	1.50	0.67	0.51	27221E3
	270	25 x 50	1.50	1.50	0.47	0.34	47271E3
	270	30 x 35	1.34	1.50	0.50	0.38	37271E3
	270	35 x 30	1.42	1.50	0.49	0.37	27271E3
	330	30 x 45	1.64	1.50	0.38	0.28	37331E3
	330	35 x 35	1.58	1.50	0.42	0.32	27331E3
	390	30 x 50	1.85	1.50	0.33	0.25	37391E3
	390	35 x 40	1.78	1.50	0.35	0.26	27391E3
	470	35 x 45	1.97	1.50	0.29	0.22	27471E3
	560	35 x 50	2.20	1.50	0.25	0.19	27561E3
	680	35 x 60	2.60	1.50	0.21	0.16	27681E3

Note

[1] ESR at 100 Hz is approximately 1.05 x ESR 120 Hz

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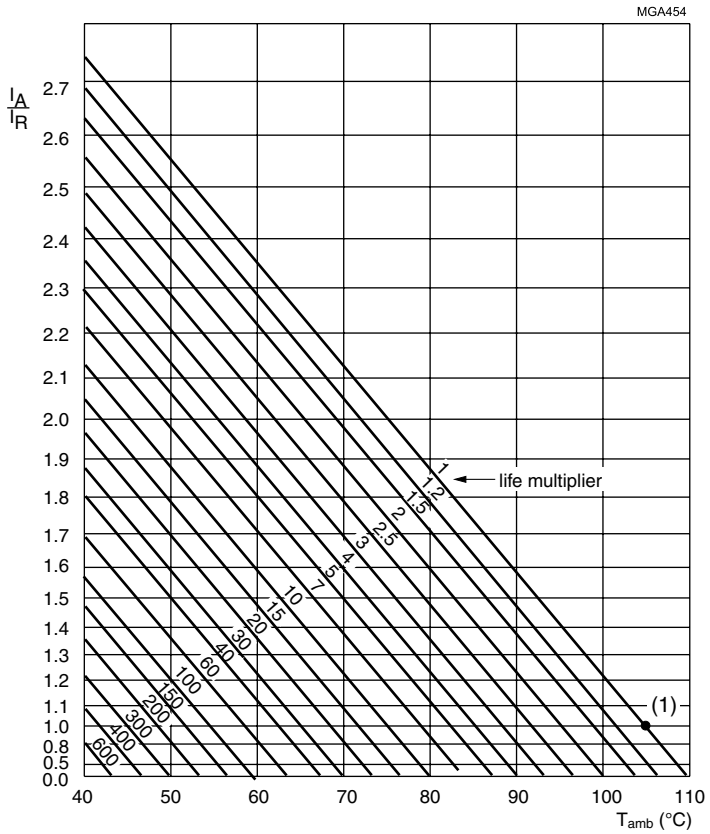
ADDITIONAL ELECTRICAL DATA		
PARAMETER	**CONDITIONS**	**VALUE**
Voltage		
Surge voltage	≥ 200 V versions	$U_s = 1.1 \times U_R$
Reverse voltage	≤ 1 V	-
Current		
Leakage current	After 5 minutes at U_R	$I_{L5} \leq 0.02\ C_R \times U_R$ or 1.5 mA, whichever is smaller
Inductance		
Equivalent series inductance (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 105 °C
(1) Useful life at 105 °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)	IR MULTIPLIER
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} = 105 °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} = 105 °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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