

## Aluminum Electrolytic Capacitors Power Miniaturized Economy Long Life Snap-In

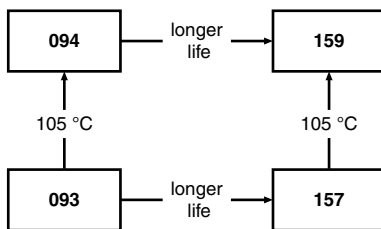


Fig. 1

QUICK REFERENCE DATA	
DESCRIPTION	VALUE
Nominal case size (Ø D x L in mm)	22 x 25 to 35 x 60
Rated capacitance range, C <sub>R</sub>	56 µF to 2200 µF
Tolerance on C <sub>R</sub>	± 20 %
Rated voltage range, U <sub>R</sub>	200 V to 450 V
Category temperature range	-25 °C to +105 °C
Endurance test at 105 °C	2000 h
Useful life at 105 °C	2000 h
Useful life at 40 °C and 1.6 x I <sub>R</sub> applied	180 000 h
Shelf life at 0 V, 105 °C	500 h
Max. RMS value of ripple voltage	12 V
Based on sectional specification	IEC 60384-4 / EN130300/W of JISC5141

### FEATURES

- Useful life: 2000 h at 105 °C
- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Large types, miniaturized dimensions, cylindrical aluminum case, insulated with a blue sleeve
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



### APPLICATIONS

- Consumer and telecom
- Whitegood motor control
- Electronic drives
- SMPS / UPS

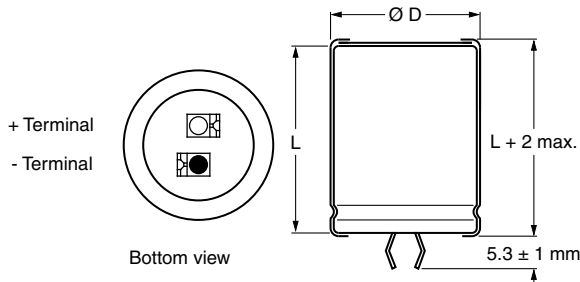
### MARKING

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

C <sub>R</sub> (µF)	U <sub>R</sub> (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

<b>SELECTION CHART FOR <math>C_R</math>, <math>U_R</math>, AND RELEVANT NOMINAL CASE SIZES (<math>\varnothing D \times L</math> in mm)</b>					
$C_R$ ( $\mu F$ )	$U_R$ (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 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 35	25 x 40	30 x 50	35 x 45	35 x 50
	-	-	35 x 40	-	-
680	22 x 50	-	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

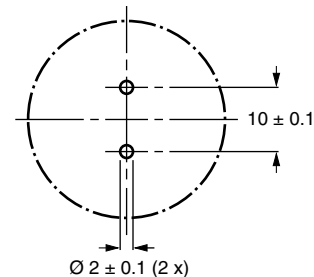


Fig. 3 - Mounting hole diagram



Table 1

<b>DIMENSIONS</b> in millimeters, <b>MASS, AND PACKAGING QUANTITIES</b>					
<b>NOMINAL CASE SIZE</b> Ø D x L	<b>Ø D<sub>max.</sub></b>	<b>L<sub>max.</sub></b>	<b>MASS (g)</b>	<b>PACKAGING QUANTITIES</b>	<b>CARDBOARD BOX DIMENSIONS</b> L x W x H
22 x 25	23.0	27	≈ 12	100	260 x 250 x 39
22 x 30	23.0	32	≈ 16	100	260 x 250 x 44
22 x 35	23.0	37	≈ 20	100	260 x 250 x 49
22 x 40	23.0	42	≈ 23	100	260 x 250 x 54
22 x 45	23.0	47	≈ 26	100	260 x 250 x 59
22 x 50	23.0	52	≈ 29	100	260 x 250 x 64
25 x 25	26.0	27	≈ 20	100	290 x 280 x 39
25 x 30	26.0	32	≈ 22	100	290 x 280 x 44
25 x 35	26.0	37	≈ 24	100	290 x 280 x 49
25 x 40	26.0	42	≈ 27	100	290 x 280 x 54
25 x 45	26.0	47	≈ 32	100	290 x 280 x 59
25 x 50	26.0	52	≈ 38	100	290 x 280 x 64
30 x 25	31.0	27	≈ 25	100	340 x 330 x 39
30 x 30	31.0	32	≈ 30	100	340 x 330 x 44
30 x 35	31.0	37	≈ 35	100	340 x 330 x 49
30 x 40	31.0	42	≈ 40	100	340 x 330 x 54
30 x 45	31.0	47	≈ 45	100	340 x 330 x 59
30 x 50	31.0	52	≈ 50	100	340 x 330 x 64
35 x 25	36.0	27	≈ 33	50	390 x 198 x 39
35 x 30	36.0	32	≈ 40	50	390 x 198 x 44
35 x 35	36.0	37	≈ 48	50	390 x 198 x 49
35 x 40	36.0	42	≈ 55	50	390 x 198 x 54
35 x 45	36.0	47	≈ 63	50	390 x 198 x 59
35 x 50	36.0	52	≈ 72	50	390 x 198 x 64
35 x 60	36.0	62	≈ 87	50	390 x 198 x 74

<b>ELECTRICAL DATA</b>	
<b>SYMBOL</b>	<b>DESCRIPTION</b>
C <sub>R</sub>	Rated capacitance at 120 Hz
I <sub>R</sub>	Rated RMS ripple current at 120 Hz, 105 °C
I <sub>L5</sub>	Max. leakage current after 5 min at U <sub>R</sub>
ESR	Max. equivalent series resistance at 120 Hz <sup>(1)</sup>

**Note**

<sup>(1)</sup> ESR at 100 Hz is approximately 1.05 x ESR 120 Hz

- 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 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



Table 2

ELECTRICAL DATA AND ORDERING INFORMATION							
$U_R$ (V)	$C_R$ 120 Hz ( $\mu$ F)	NOMINAL CASE SIZE $\varnothing$ D x L (mm)	$I_R$ 120 Hz (A)	$I_{L5}$ (mA)	MAX. ESR 120 Hz <sup>(1)</sup> ( $\Omega$ )	MAX. Z 10 kHz ( $\Omega$ )	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 35	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
	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
	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 <sub>R</sub> (V)	C <sub>R</sub> 120 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I <sub>R</sub> 120 Hz (A)	I <sub>L5</sub> (mA)	MAX. ESR 120 Hz <sup>(1)</sup> (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



ADDITIONAL ELECTRICAL DATA		
PARAMETER	CONDITIONS	VALUE
<b>Voltage</b>		
Surge voltage	$\geq 200$ V versions	$U_S = 1.1 \times U_R$
Reverse voltage	$\leq 1$ V	-
<b>Current</b>		
Leakage current	After 5 min at $U_R$	$I_{L5} \leq 0.02 C_R \times U_R$ or 1.5 mA, whichever is smaller
<b>Inductance</b>		
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) <sup>(1)</sup>	
	200 TO 450	
Impedance ratio	$Z(-25\text{ °C}) / Z(+20\text{ °C})$	4

**Note**

<sup>(1)</sup> Impedance ratio shall not exceed the given values

**RIPPLE CURRENT AND USEFUL LIFE**

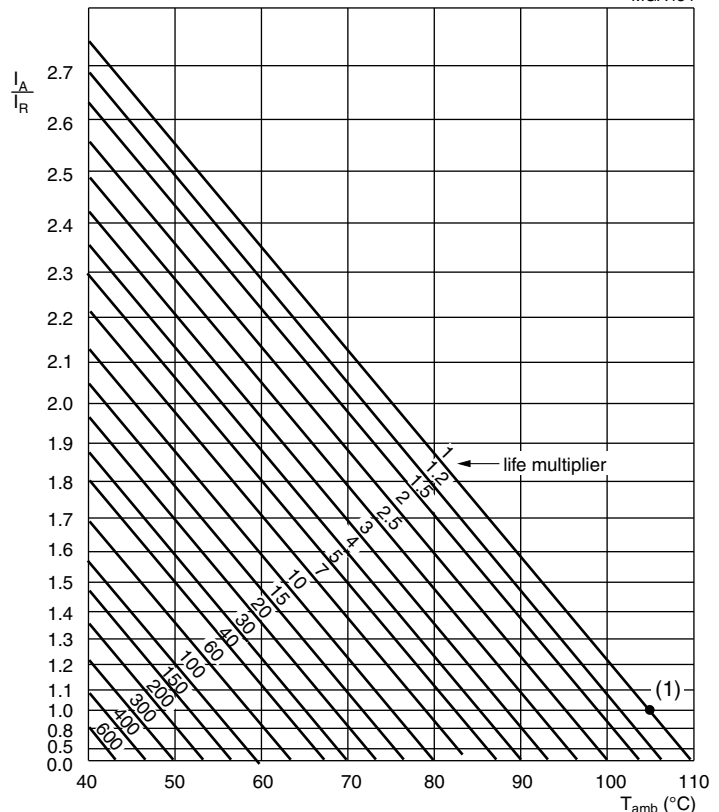
Table 4

ENDURANCE TEST DURATION AND USEFUL LIFE	
ENDURANCE AT 105 °C (h)	USEFUL LIFE AT 105 °C (h)
2000	2000

**Note**

- Multiplier of useful life code: MGA454

MGA454



$I_A$  = Actual ripple current at 120 Hz  
 $I_R$  = Rated ripple current at 120 Hz and 105 °C  
<sup>(1)</sup> Useful life at 105 °C and  $I_R$  applied: 2000 h

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



Table 5

MULTIPLIER OF RIPPLE CURRENT ( $I_R$ ) AS A FUNCTION OF FREQUENCY					
FREQUENCY (Hz)					
60	100	120	500	1000	$\geq 10\ 000$
$I_R$ MULTIPLIER					
0.90	0.95	1.00	1.20	1.30	1.40

Table 6

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4 / EN130300 subclause 4.13	$T_{amb} = 105\ ^\circ\text{C}$ ; $U_R$ applied; 2000 h	$\Delta C/C: \pm 10\ \%$ $ESR \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 105\ ^\circ\text{C}$ ; $U_R$ and $I_R$ applied: 2000 h	$\Delta C/C: \pm 30\ \%$ $ESR \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit, no visible damage, total failure percentage: $\leq 3\ \%$
Shelf life (storage at high temperature)	IEC 60384-4 / EN130300 subclause 4.17	$T_{amb} = 105\ ^\circ\text{C}$ ; no voltage applied; 500 h After test: $U_R$ to be applied for 30 min, 24 h to 48 h before measurement	$\Delta C/C: \pm 20\ \%$ $ESR \leq 2 \times \text{spec. limit}$ $I_{L5} \leq 1 \times \text{spec. limit}$

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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