

## Aluminum Electrolytic Capacitors Power Miniaturized General Purpose Snap-In

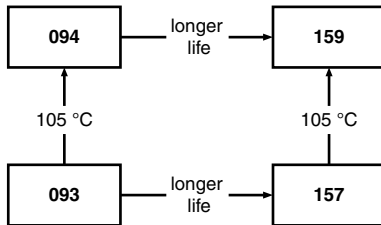
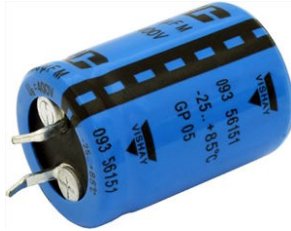


Fig. 1

QUICK REFERENCE DATA	
DESCRIPTION	VALUE
Nominal case size (∅ D x L in mm)	22 x 25 to 35 x 50
Rated capacitance range, C <sub>R</sub>	68 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 +85 °C
Endurance test at 85 °C	2000 h
Useful life at 85 °C	2000 h
Useful life at 40 °C and 1.4 x I <sub>R</sub> applied	36 000 h
Shelf life at 0 V, 85 °C	500 h
Max. RMS value of ripple voltage	12 V
Based on sectional specification	IEC 60384-4 / EN 130300/W of JISC5141

### FEATURES

- Useful life: 2000 h at 85 °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)


**RoHS  
COMPLIANT**

### APPLICATIONS

- Consumer electronics
- Whitegood motor control
- Electronic drives
- SMPS / UPS

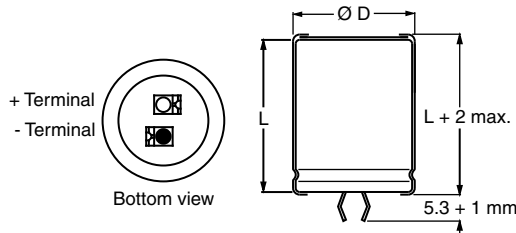
### MARKING

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

SELECTION CHART FOR C <sub>R</sub> , U <sub>R</sub> , AND RELEVANT NOMINAL CASE SIZES (∅ D x L in mm)					
C <sub>R</sub> (μF)	U <sub>R</sub> (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
270	22 x 25	22 x 30	22 x 50	22 x 50 30 x 30	30 x 30 35 x 25
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

<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
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 x 35	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

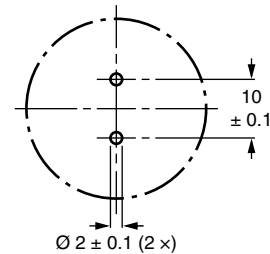


Fig. 3 - Mounting hole diagram

**Table 1**

<b>DIMENSIONS in millimeters, MASS, AND PACKAGING QUANTITIES</b>					
NOMINAL CASE SIZE $\varnothing D \times L$	$\varnothing D_{max.}$	$L_{max.}$	MASS (g)	PACKAGING QUANTITIES	CARDBOARD BOX DIMENSIONS $L \times W \times H$
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



ELECTRICAL DATA	
SYMBOL	DESCRIPTION
C <sub>R</sub>	Rated capacitance at 120 Hz
I <sub>R</sub>	Rated RMS ripple current at 120 Hz, 85 °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>

**Notes**

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

**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: MAL2 09346331E3  
 Former 12 NC: 2222 09346331

Table 2

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 <sup>(1)</sup> 120 Hz (Ω)	MAX. Z 10 kHz (Ω)	ORDERING CODE MAL2093.....
200	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
	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	
250	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
	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	
400	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
	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	

**Note**

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



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 <sup>(1)</sup> 120 Hz ( $\Omega$ )	MAX. Z 10 kHz ( $\Omega$ )	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
	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
<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 °C) / Z (+20 °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 85 °C (h)	USEFUL LIFE AT 85 °C (h)
2000	2000

**Note**

- Multiplier of useful life code: MGA453

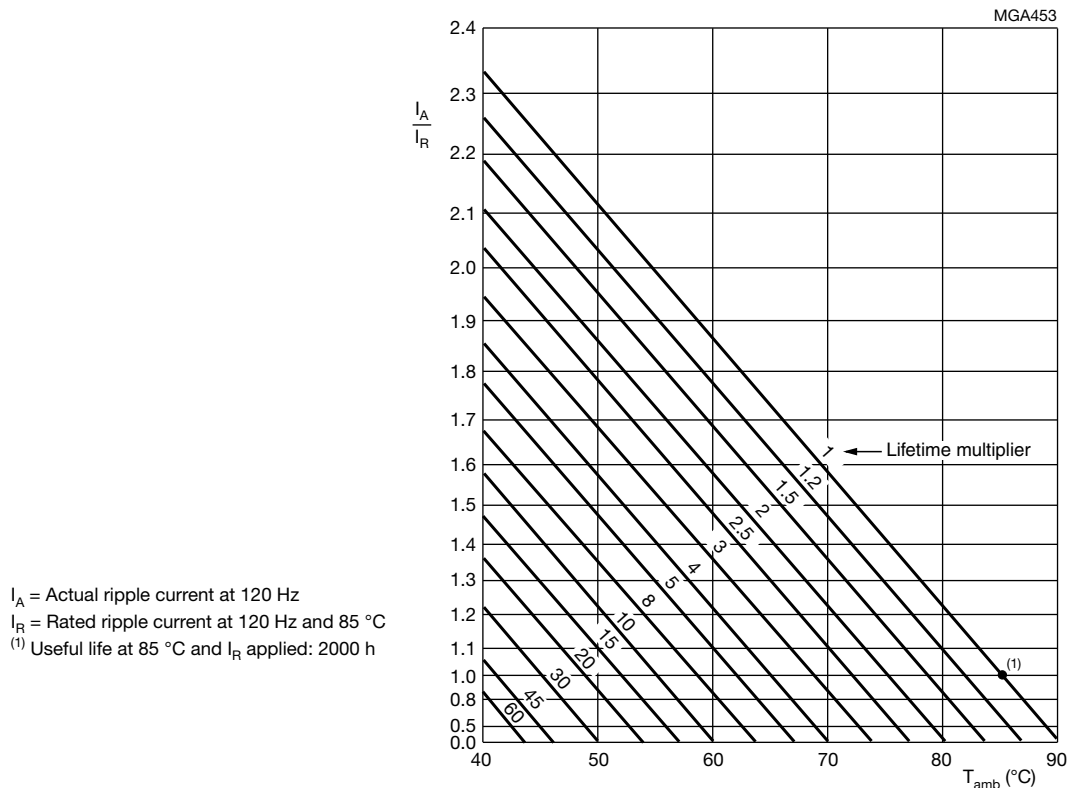


Fig. 4 - Multiplier of useful life as a function of ambient temperature and ripple current load

Table 5

MULTIPLIER OF RIPPLE CURRENT ( $I_R$ ) AS A FUNCTION OF FREQUENCY					
FREQUENCY (Hz)					
60	100	120	500	1000	≥ 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	$T_{amb} = 85\text{ °C}$ ; $U_R$ 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	$T_{amb} = 85\text{ °C}$ ; $U_R$ 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	$T_{amb} = 85\text{ °C}$ ; no voltage applied; 500 h After test: $U_R$ to be applied for 30 min, 24 h to 48 h before measurement	$\Delta C/C: \pm 20\%$ $ESR \leq 2 \times \text{spec. limit}$ $I_{L5} \leq 1 \times \text{spec. limit}$

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.



## **Disclaimer**

ALL PRODUCT, PRODUCT SPECIFICATIONS AND DATA ARE SUBJECT TO CHANGE WITHOUT NOTICE TO IMPROVE RELIABILITY, FUNCTION OR DESIGN OR OTHERWISE.

Vishay Intertechnology, Inc., its affiliates, agents, and employees, and all persons acting on its or their behalf (collectively, "Vishay"), disclaim any and all liability for any errors, inaccuracies or incompleteness contained in any datasheet or in any other disclosure relating to any product.

Vishay makes no warranty, representation or guarantee regarding the suitability of the products for any particular purpose or the continuing production of any product. To the maximum extent permitted by applicable law, Vishay disclaims (i) any and all liability arising out of the application or use of any product, (ii) any and all liability, including without limitation special, consequential or incidental damages, and (iii) any and all implied warranties, including warranties of fitness for particular purpose, non-infringement and merchantability.

Statements regarding the suitability of products for certain types of applications are based on Vishay's knowledge of typical requirements that are often placed on Vishay products in generic applications. Such statements are not binding statements about the suitability of products for a particular application. It is the customer's responsibility to validate that a particular product with the properties described in the product specification is suitable for use in a particular application. Parameters provided in datasheets and / or specifications may vary in different applications and performance may vary over time. All operating parameters, including typical parameters, must be validated for each customer application by the customer's technical experts. Product specifications do not expand or otherwise modify Vishay's terms and conditions of purchase, including but not limited to the warranty expressed therein.

Except as expressly indicated in writing, Vishay products are not designed for use in medical, life-saving, or life-sustaining applications or for any other application in which the failure of the Vishay product could result in personal injury or death. Customers using or selling Vishay products not expressly indicated for use in such applications do so at their own risk. Please contact authorized Vishay personnel to obtain written terms and conditions regarding products designed for such applications.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted by this document or by any conduct of Vishay. Product names and markings noted herein may be trademarks of their respective owners.