Aluminum Capacitors
Power General Purpose Snap-In

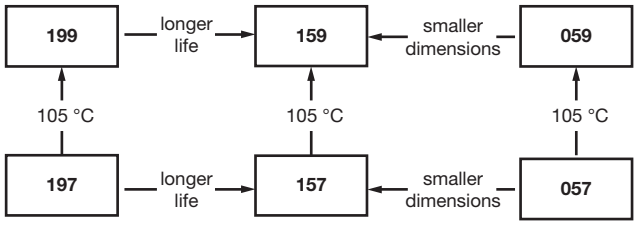


Fig. 1

FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Large types, very small dimensions, cylindrical aluminum case insulated with a blue sleeve
- Useful life: 3000 h at 85 °C
- Compliant to RoHS Directive 2002/95/EC

Pb-free
RoHS COMPLIANT

APPLICATIONS

- Consumer and industrial 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

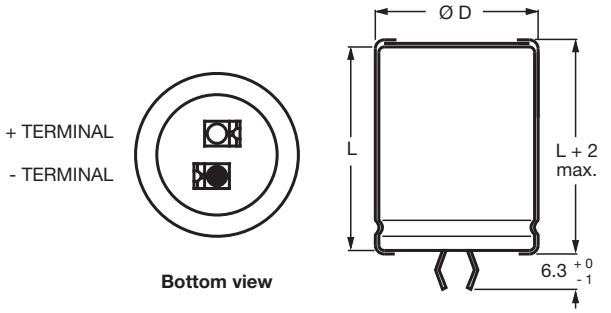
QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Nominal case size (Ø D x L in mm)	22 x 25 to 35 x 50
Rated capacitance range (E6/E12 series), C_R	56 µF to 2200 µF
Tolerance on C_R	± 20 %
Rated voltage range, U_R	160 V, 200 V, 250 V, 400 V, 450 V
Category temperature range	- 25 °C to + 85 °C
Useful life at 85 °C	3000 h
Useful life at 40 °C and 1.4 x I_R applied	90 000 h
Shelf life at 0 V, 85 °C	1000 h
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)				
	160	**200**	**250**	**400**	**450**
56	-	-	-	-	22 x 25
68	-	-	-	22 x 25	22 x 25
82	-	-	-	22 x 25	22 x 30
	-	-	-	-	25 x 25
100	-	-	-	22 x 30	22 x 35
	-	-	-	25 x 25	25 x 30
120	-	-	-	-	22 x 40
	-	-	-	22 x 35	25 x 30
	-	-	-	25 x 35	30 x 25
150	22 x 25	22 x 25	22 x 25	22 x 35	-
	-	-	-	25 x 30	25 x 35
	-	-	-	30 x 25	30 x 30

SELECTION CHART FOR C_R, U_R, AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)					
C_R (µF)	U_R (V)				
	160	200	250	400	450
180	22 x 25	22 x 25	22 x 25	22 x 40	-
	-	-	-	25 x 35	25 x 40
	-	-	-	30 x 25	30 x 30
	-	-	-	-	35 x 30
220	22 x 25	22 x 25	22 x 30	-	-
	-	-	25 x 25	25 x 40	30 x 35
	-	-	-	30 x 30	35 x 30
	-	-	-	-	-
270	22 x 25	22 x 25	22 x 30	-	30 x 40
	-	-	25 x 25	30 x 35	35 x 35
	-	-	-	35 x 30	-
	-	-	-	-	-
330	22 x 25	22 x 30	22 x 35	25 x 50	30 x 50
	-	25 x 25	25 x 30	30 x 40	35 x 40
	-	-	30 x 25	35 x 30	-
390	22 x 30	22 x 30	22 x 40	30 x 45	30 x 50
	-	25 x 25	25 x 35	35 x 35	35 x 50
	-	-	30 x 25	-	-
470	22 x 30	22 x 35	-	30 x 50	35 x 50
	25 x 25	25 x 30	25 x 40	35 x 40	-
	-	30 x 25	30 x 30	-	-
560	25 x 25	22 x 40	25 x 40	35 x 45	-
	30 x 25	25 x 35	-	-	-
	-	30 x 25	30 x 35	-	-
680	25 x 30	25 x 40	25 x 50	35 x 50	-
	30 x 25	30 x 30	30 x 40	-	-
	-	-	35 x 30	-	-
820	25 x 35	-	30 x 45	-	-
	-	30 x 35	35 x 35	-	-
	-	35 x 30	-	-	-
1000	25 x 40	30 x 40	30 x 50	-	-
	30 x 30	35 x 35	35 x 40	-	-
1200	30 x 35	30 x 45	35 x 50	-	-
	35 x 30	35 x 35	-	-	-
1500	35 x 35	35 x 50	35 x 50	-	-
1800	30 x 50	-	-	-	-
	35 x 40	-	-	-	-
2200	35 x 50	35 x 50	-	-	-

DIMENSIONS in millimeters AND AVAILABLE FORMS



The minus terminal can be marked with an imprinted sign.

Fig. 2 - Two terminal snap-in

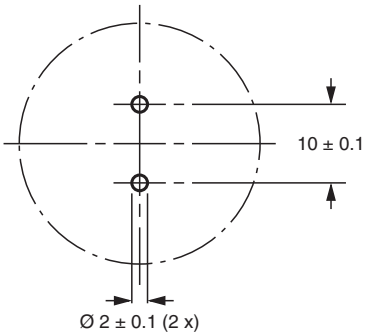


Fig. 3 - Mounting hole diagram

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 min 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 197 series

1000 µF/200 V; ± 20 %

Nominal case size: Ø 30 mm x 40 mm

Ordering code: MAL2 197 22102 E3
Former 12NC: 2222 197 22102

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 85 °C (A)	I_{L5} 5 min (mA)	MAX. ESR 120 (1) (Ω)	ORDERING CODE MAL2197.....
160	150	22 x 25	0.92	0.48	1.11	11151E3
	180	22 x 25	0.99	0.58	0.92	11181E3
	220	22 x 25	1.08	0.70	0.75	11221E3
	270	22 x 25	1.16	0.86	0.61	11271E3
	330	22 x 25	1.24	1.06	0.50	11331E3
	390	22 x 30	1.45	1.25	0.43	11391E3
	470	22 x 30	1.53	1.50	0.35	11471E3
	470	25 x 25	1.45	1.50	0.35	21471E3
	560	30 x 25	1.67	1.50	0.30	31561E3
	680	25 x 30	1.82	1.50	0.24	21681E3
	680	30 x 25	1.70	1.50	0.24	31681E3
	820	25 x 35	2.04	1.50	0.20	21821E3
	1000	30 x 30	2.07	1.50	0.17	31102E3
	1000	35 x 30	2.24	1.50	0.17	41102E3
	1200	30 x 35	2.28	1.50	0.17	21122E3
	1200	35 x 30	2.22	1.50	0.17	31122E3
	1500	35 x 35	2.42	1.50	0.15	21152E3
	1500	35 x 40	2.72	1.50	0.13	31152E3
	1800	30 x 50	3.08	1.50	0.11	11182E3
	1800	35 x 40	2.66	1.50	0.13	21182E3
	2200	35 x 50	3.25	1.50	0.10	41222E3
200	150	22 x 25	1.06	0.60	1.11	12151E3
	180	22 x 25	1.15	0.72	0.92	12181E3
	220	22 x 25	1.24	0.88	0.75	12221E3
	270	22 x 25	1.34	1.08	0.61	12271E3
	330	22 x 30	1.58	1.32	0.50	12331E3
	330	25 x 25	1.53	1.32	0.50	22331E3
	390	25 x 25	1.59	1.50	0.45	22391E3
	470	22 x 35	1.92	1.50	0.35	12471E3
	470	25 x 30	1.92	1.50	0.35	22471E3
	470	30 x 25	1.86	1.50	0.38	32471E3
	560	25 x 35	2.16	1.50	0.30	22561E3
	560	30 x 25	1.90	1.50	0.34	32561E3
	680	25 x 40	2.44	1.50	0.24	22681E3
	680	30 x 30	2.28	1.50	0.27	32681E3
	820	30 x 35	2.55	1.50	0.24	32821E3
	820	35 x 30	2.52	1.50	0.26	42821E3
	1000	30 x 40	2.84	1.50	0.20	22102E3
	1000	35 x 35	2.79	1.50	0.22	32102E3
	1200	30 x 45	3.16	1.50	0.17	12122E3
	1200	35 x 35	2.77	1.50	0.21	22122E3
	1500	35 x 50	3.72	1.50	0.15	22152E3
	2200	35 x 50	3.70	1.50	0.11	12222E3
250	150	22 x 25	1.07	0.75	1.11	13151E3
	180	22 x 25	1.16	0.90	0.92	13181E3
	220	22 x 30	1.36	1.10	0.75	13221E3
	220	25 x 25	1.34	1.10	0.75	23221E3
	270	22 x 30	1.47	1.35	0.61	13271E3
	270	25 x 25	1.42	1.35	0.61	23271E3
	330	22 x 35	1.70	1.50	0.50	13331E3
	330	25 x 30	1.71	1.50	0.50	23331E3
	330	30 x 25	1.68	1.50	0.50	33331E3
	390	22 x 40	1.92	1.50	0.43	13391E3
	390	25 x 35	1.92	1.50	0.43	23391E3
	390	30 x 25	1.74	1.50	0.43	33391E3
	470	25 x 40	2.17	1.50	0.35	23471E3
	470	30 x 30	2.07	1.50	0.35	33471E3
	560	25 x 40	2.28	1.50	0.27	53561E3
	560	30 x 35	2.32	1.50	0.30	33561E3
	680	25 x 50	2.73	1.50	0.24	13681E3
	680	30 x 40	2.60	1.50	0.24	23681E3
	680	35 x 30	2.36	1.50	0.27	33681E3
	820	30 x 45	2.90	1.50	0.20	13821E3
	820	35 x 35	2.61	1.50	0.24	23821E3
	1000	30 x 50	3.21	1.50	0.17	13102E3
	1000	35 x 40	2.89	1.50	0.21	23102E3
	1200	35 x 50	3.49	1.50	0.19	13122E3
	1500	35 x 50	3.56	1.50	0.19	13152E3

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 85 °C (A)	I_{L5} 5 min (mA)	MAX. ESR 120 (1) (Ω)	ORDERING CODE MAL2197.....
400	68	22 x 25	0.57	0.55	3.66	16689E3
	82	22 x 25	0.62	0.66	3.03	16829E3
	100	22 x 30	0.73	0.80	2.49	16101E3
	100	25 x 25	0.73	0.80	2.49	26101E3
	120	22 x 35	0.84	0.96	2.07	16121E3
	120	25 x 35	0.89	0.96	2.07	26121E3
	150	22 x 35	0.93	1.20	1.66	16151E3
	150	25 x 30	0.94	1.20	1.66	26151E3
	150	30 x 25	0.96	1.20	1.66	36151E3
	180	25 x 35	1.07	1.44	1.38	26181E3
	180	30 x 25	1.03	1.44	1.38	36181E3
	220	25 x 40	1.23	1.50	1.13	26221E3
	220	30 x 30	1.21	1.50	1.13	36221E3
	270	30 x 35	1.38	1.50	0.92	26271E3
	270	35 x 30	1.41	1.50	0.92	36271E3
	330	30 x 40	1.57	1.50	0.75	26331E3
	330	35 x 30	1.49	1.50	0.78	36331E3
	390	30 x 45	1.75	1.50	0.64	16391E3
	390	35 x 35	1.67	1.50	0.66	26391E3
	470	30 x 50	1.96	1.50	0.53	16471E3
	470	35 x 40	1.87	1.50	0.56	26471E3
	560	35 x 45	2.08	1.50	0.47	16561E3
	680	35 x 50	2.31	1.50	0.39	16681E3
450	56	22 x 25	0.53	0.28	4.44	17569E3
	68	22 x 25	0.58	0.34	3.66	17689E3
	82	22 x 30	0.68	0.41	3.03	17829E3
	82	25 x 25	0.68	0.41	3.03	27829E3
	100	22 x 35	0.78	0.50	2.49	17101E3
	100	25 x 30	0.80	0.50	2.49	27101E3
	120	22 x 40	0.89	0.60	2.07	17121E3
	120	25 x 30	0.86	0.60	2.07	27121E3
	120	30 x 25	0.89	0.60	2.07	37121E3
	150	25 x 35	1.00	0.75	1.66	27151E3
	150	30 x 30	1.05	0.75	1.66	37151E3
	180	25 x 40	1.14	0.90	1.38	27181E3
	180	30 x 30	1.13	0.90	1.38	37181E3
	180	35 x 30	1.22	0.90	1.38	47181E3
	220	30 x 35	1.29	1.10	1.13	27221E3
	220	35 x 30	1.32	1.10	1.13	37221E3
	270	30 x 40	1.47	1.35	0.92	17271E3
	330	30 x 50	1.74	1.50	0.75	17331E3
	330	35 x 40	1.69	1.50	0.75	27331E3
	390	35 x 50	1.97	1.50	0.64	27391E3
	470	35 x 50	2.10	1.50	0.53	17471E3

Note

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

ADDITIONAL ELECTRICAL DATA

PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage	≥ 400 V versions	$U_S = 1.1 \times U_R$
	≤ 250 V versions	$U_S = 1.15 \times U_R$
Reverse voltage	≤ 1 V	-
Current		
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

Table 3

LOW TEMPERATURE CHARACTERISTIC (at 120 Hz)						
DESCRIPTION		**U_R (V) (1)**				
		160	**200**	**250**	**400**	**450**
Impedance ratio	Z(- 25 °C)/Z(+ 20 °C)	4	4	4	4	4

Note
(1) Impedance ratio shall not exceed the given values

Table 4

DISSIPATION FACTOR (tan δ at 120 Hz, 20 °C)					
DESCRIPTION	**U_R (V)**				
	160	**200**	**250**	**400**	**450**
tan δ (max.)	0.10 (1)	0.10 (1)	0.10 (1)	0.15	0.15

Note
(1) 0.15 for Ø D = 35 mm

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: 3000 h

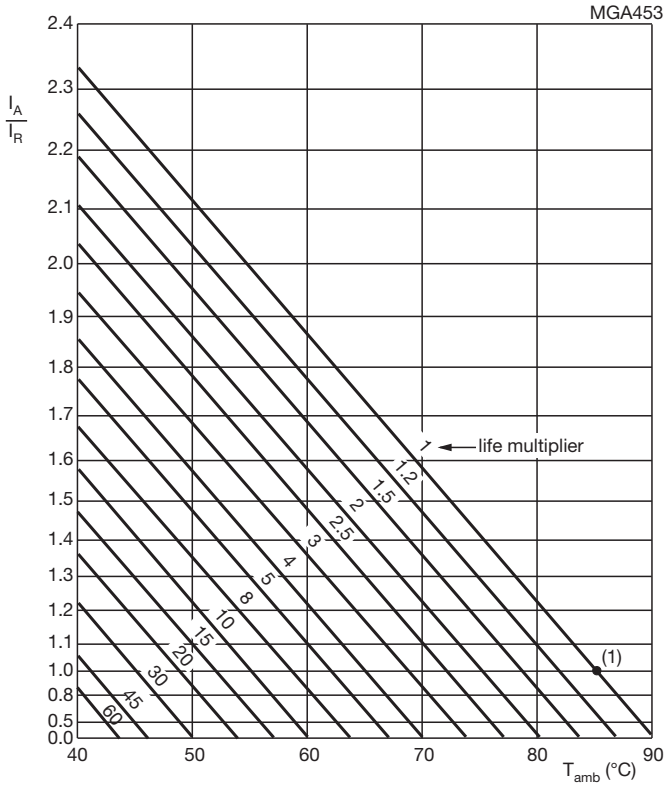


Fig. 4 - Multiplier of useful life as a function of ambient temperature and ripple current load

Table 5

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY		
FREQUENCY (Hz)	I_R MULTIPLIER	
	160 V TO 250 V	400 V AND 450 V
60	0.81	0.90
100	0.97	0.95
120	1.00	1.00
500	1.32	1.20
1000	1.45	1.30
≥ 10 000	1.50	1.40

Table 6

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: 3000 h	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; 1000 h After test: U_R to be applied for 30 min, 24 h to 48 h before measurement	ΔC/C: ± 20 % ESR ≤ 2 x spec. limit I_{L5} ≤ 1 x spec. limit

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