

## Aluminum Capacitors Power High Ripple Current Snap-In

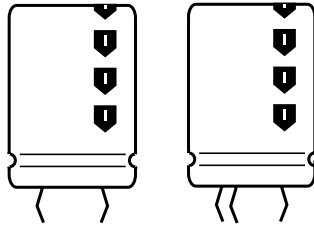
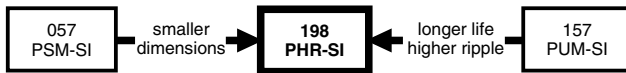


Fig. 1 Component outlines



QUICK REFERENCE DATA	
DESCRIPTION	VALUE
Nominal case size (Ø D x L in mm)	22 x 25 to 35 x 60
Rated capacitance range (E6/E12 series), C <sub>R</sub>	56 to 680 µF
Tolerance on C <sub>R</sub>	± 20 %
Rated voltage range, U <sub>R</sub>	400 and 450 V
Category temperature range	- 25 to + 85 °C
Endurance test at 85 °C	7000 hours
Useful life at 85 °C	15000 hours
Shelf life at 0 V, 85 °C	1000 hours
Based on sectional specification	IEC 60384-4/EN130300
Climatic category IEC 60068	25/085/56

**FEATURES**

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Large types, miniaturized dimensions, cylindrical aluminum case, insulated with a blue sleeve
- Very high ripple current capability
- Keyed polarity version available
- High reliability


**RoHS  
COMPLIANT**
**APPLICATIONS**

- Motor control and industrial systems
- Smoothing and filtering
- Standard and switched mode power supplies
- Energy storage in pulse systems

**MARKING**

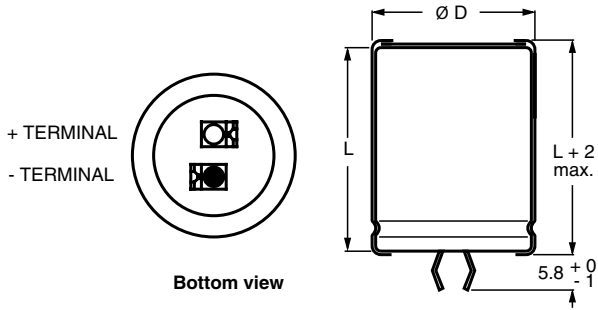
The capacitors are marked (where possible) with the following information:

- Rated capacitance (in µF)
- Tolerance code on rated capacitance, code letter in accordance with IEC 60062 (M for ± 20 %)
- Rated voltage (in V)
- Date code (YYMM)
- Name of manufacturer
- Code for factory of origin
- ‘-’ sign to identify the negative terminal, visible from the top and side of the capacitor
- Code number
- Climatic category in accordance with IEC 60068

SELECTION CHART FOR C <sub>R</sub> , U <sub>R</sub> AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)		
C <sub>R</sub> (µF)	U <sub>R</sub> (V)	
	400	450
56	22 x 25	22 x 25
68	22 x 25	22 x 30
82	-	22 x 30
	-	25 x 25
100	22 x 30	22 x 35
	-	25 x 30
120	22 x 35	22 x 40
	25 x 30	25 x 30
	-	30 x 25
150	22 x 40	25 x 40
	25 x 35	30 x 30
180	25 x 40	25 x 40
	30 x 30	30 x 35
	35 x 25	35 x 25
220	25 x 45	25 x 50
	30 x 35	30 x 40
	35 x 30	35 x 30
270	30 x 40	30 x 45
	35 x 30	35 x 35
330	30 x 45	30 x 50
	35 x 35	35 x 40
390	30 x 50	35 x 45
	35 x 40	-
470	35 x 45	35 x 50
560	35 x 50	35 x 60
680	35 x 60	35 x 60

**DIMENSIONS** in millimeters **AND AVAILABLE FORMS**

**TWO TERMINAL SNAP-IN**



The minus terminal can be marked with a black dot or with an imprinted '-' sign.

Fig. 2 Two terminal snap-in

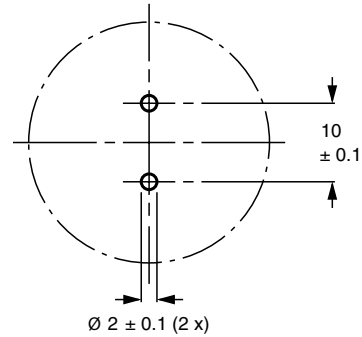
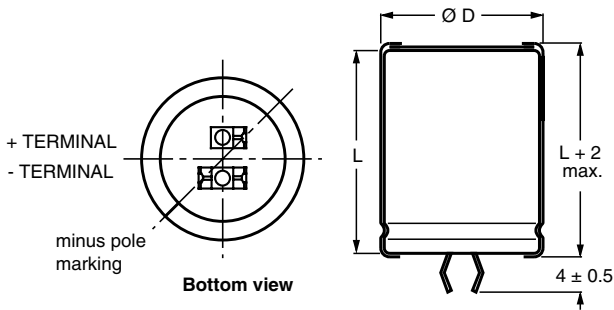


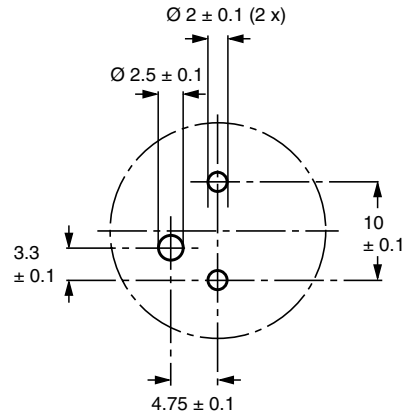
Fig. 3 Mounting hole diagram

**THREE TERMINAL SNAP-IN**



The negative terminal has **TWO** pins which are **BOTH** electrically connected.

Fig. 4 Three terminal snap-in



The 10 mm spacing of the 2 pin snap-in is used as the base layout and a third hole is added.

The third hole is closer to the negative primary hole so that polarization is always maintained, together with added mechanical stability.

Fig. 5 Mounting hole diagram



Table 1

<b>DIMENSIONS</b> in millimeters, <b>MASS AND PACKAGING QUANTITIES</b>					
<b>NOMINAL CASE SIZE Ø D x L (mm)</b>	<b>Ø D<sub>max.</sub></b>	<b>L<sub>max.</sub></b>	<b>MASS (g)</b>	<b>PACKAGING QUANTITIES (units per box)</b>	<b>CARDBOARD BOX DIMENSIONS L x W x H</b>
22 x 25	23	27	≈ 12	100	260 x 250 x 39
22 x 30	23	32	≈ 16	100	260 x 250 x 44
22 x 35	23	37	≈ 20	100	260 x 250 x 49
22 x 40	23	42	≈ 23	100	260 x 250 x 54
25 x 25	26	27	≈ 20	100	290 x 280 x 39
25 x 30	26	32	≈ 22	100	290 x 280 x 44
25 x 35	26	37	≈ 24	100	290 x 280 x 49
25 x 40	26	42	≈ 27	100	290 x 280 x 54
25 x 45	26	47	≈ 32	100	290 x 280 x 59
25 x 50	26	52	≈ 38	100	290 x 280 x 64
30 x 25	31	27	≈ 25	100	340 x 330 x 39
30 x 30	31	32	≈ 30	100	340 x 330 x 44
30 x 35	31	37	≈ 35	100	340 x 330 x 49
30 x 40	31	42	≈ 40	100	340 x 330 x 54
30 x 45	31	47	≈ 45	100	340 x 330 x 59
30 x 50	31	52	≈ 50	100	340 x 330 x 64
35 x 25	36	27	≈ 33	50	390 x 198 x 39
35 x 30	36	32	≈ 40	50	390 x 198 x 44
35 x 35	36	37	≈ 48	50	390 x 198 x 49
35 x 40	36	42	≈ 55	50	390 x 198 x 54
35 x 45	36	47	≈ 63	50	390 x 198 x 59
35 x 50	36	52	≈ 72	50	390 x 198 x 64
35 x 60	36	62	≈ 87	50	390 x 198 x 74

<b>ELECTRICAL DATA</b>	
<b>SYMBOL</b>	<b>DESCRIPTION</b>
<b>C<sub>R</sub></b>	rated capacitance at 100 Hz
<b>I<sub>R</sub></b>	rated RMS ripple current at 100 Hz, 85 °C
<b>I<sub>L1</sub></b>	max. leakage current after 1 minute at U <sub>R</sub>
<b>I<sub>L5</sub></b>	max. leakage current after 5 minutes at U <sub>R</sub>
<b>ESR</b>	typ./max. equivalent series resistance at 100 Hz
<b>Z</b>	typ./max. impedance at 10 kHz

**Note**

Unless otherwise specified, all electrical values in Table 2 apply at T<sub>amb</sub> = 20 °C, P = 86 to 106 kPa, RH = 45 to 75 %

**ORDERING EXAMPLE**

Electrolytic capacitor 198 PHR-SI  
470 µF/450 V; ± 20 %  
Nominal case size: Ø 35 x 50 mm

**2-terminal snap-in:**

Ordering code: MAL219857471 E3  
Former 12NC: 2222 19857471

**3-terminal snap-in:**

Ordering code: MAL219877471 E3  
Former 12NC: 2222 19877471



Table 2

ELECTRICAL DATA AND ORDERING INFORMATION											
U <sub>R</sub> (V)	C <sub>R</sub> 100 Hz (μF)	NOMINAL CASE SIZE Ø D x L (mm)	I <sub>R</sub> 100 Hz 85 °C (A)	I <sub>L1</sub> 1 min (μA)	I <sub>L5</sub> 5 min (μA)	TYP. ESR 100 Hz (mΩ)	MAX. ESR 100 Hz (mΩ)	TYP. Z 10 kHz (mΩ)	MAX. Z 10 kHz (mΩ)	ORDERING CODE MAL2198.....	
										2-TERM.	3-TERM.
400	56	22 x 25	0.72	138	49	918	1706	521	1085	56569E3	76569E3
	68	22 x 25	0.79	167	59	762	1405	434	905	56689E3	76689E3
	100	22 x 30	1.00	244	84	520	956	297	610	56101E3	76101E3
	120	22 x 35	1.14	292	100	433	796	247	450	46121E3	26121E3
	120	25 x 30	1.14	292	100	438	796	252	450	36121E3	16121E3
	150	22 x 40	1.33	364	124	348	637	199	363	66151E3	86151E3
400	150	25 x 35	1.33	364	124	351	637	202	363	36151E3	16151E3
	180	25 x 40	1.51	436	148	293	531	169	295	36181E3	16181E3
	180	30 x 30	1.49	436	148	305	531	180	295	66181E3	86181E3
	180	35 x 25	1.56	436	148	327	531	200	295	26181E3	76181E3
	220	25 x 45	1.75	532	180	241	434	139	280	36221E3	90008E3
	220	30 x 35	1.56	532	180	250	434	147	280	26221E3	76221E3
	220	35 x 30	1.81	532	180	259	434	155	280	16221E3	86221E3
	270	30 x 40	1.95	652	220	205	354	121	263	36271E3	16271E3
	270	35 x 30	1.93	652	220	222	354	137	263	66271E3	86271E3
	330	30 x 45	2.22	796	268	169	290	101	210	36331E3	16331E3
	330	35 x 35	2.18	796	268	181	290	112	210	66331E3	86331E3
	390	30 x 50	2.50	940	316	145	245	86	175	36391E3	16391E3
	390	35 x 40	2.44	940	316	154	245	95	175	66391E3	86391E3
	470	35 x 45	2.72	1132	380	129	203	80	153	36471E3	16471E3
560	35 x 50	3.03	1348	452	110	171	70	133	46561E3	26561E3	
680	35 x 60	3.53	1636	548	91	140	57	110	46681E3	26681E3	
450	56	22 x 25	0.71	155	54.4	865	1706	479	940	57569E3	77569E3
	68	22 x 30	0.82	188	65.2	709	1405	392	765	57689E3	77689E3
	82	22 x 30	0.89	225	77.8	592	1165	329	645	47829E3	27829E3
	82	25 x 25	0.91	225	77.8	604	1165	339	645	57829E3	77829E3
	100	22 x 35	1.02	274	94	485	956	270	525	47101E3	27101E3
	100	25 x 30	1.05	274	94	491	956	274	525	57101E3	77101E3
	120	22 x 40	1.14	328	112	406	796	225	443	47121E3	27121E3
	120	25 x 30	1.13	328	112	415	796	233	443	57121E3	77121E3
	120	30 x 25	1.16	328	112	431	796	248	443	67121E3	87121E3
	150	25 x 40	1.36	409	139	328	637	184	353	47151E3	27151E3
	150	30 x 30	1.36	409	139	340	637	194	353	57151E3	77151E3
	180	25 x 40	1.47	490	166	277	531	157	303	47181E3	27181E3
	180	30 x 35	1.54	490	166	282	531	161	303	57181E3	77181E3
	180	35 x 25	1.46	490	166	316	531	191	303	67181E3	87181E3
	220	25 x 50	1.71	598	202	226	434	127	263	47221E3	27221E3
	220	30 x 40	1.75	598	202	232	434	133	263	57221E3	77221E3
	220	35 x 30	1.72	598	202	248	434	148	263	67221E3	87221E3
	270	30 x 45	1.98	733	247	191	354	110	225	47271E3	27271E3
	270	35 x 35	1.96	733	247	202	354	120	225	57271E3	77271E3
	330	30 x 50	2.22	895	301	158	290	91	195	47331E3	27331E3
	330	35 x 40	2.22	895	301	167	290	100	195	57331E3	77331E3
	390	35 x 45	2.46	1057	355	142	245	85	170	57391E3	77391E3
	470	35 x 50	2.73	1273	427	120	203	73	145	57471E3	77471E3
	560	35 x 60	3.10	1516	508	100	171	60	120	57561E3	77561E3
680	35 x 60	3.30	1840	616	88	140	55	110	57681E3	77681E3	

**CUSTOMIZED PRODUCTS**

If you are unable to find the capacitor you require, please contact your local Vishay BCcomponents sales organization; we are able to design and manufacture customized capacitors to meet your specific requirements.



ADDITIONAL ELECTRICAL DATA		
PARAMETER	CONDITIONS	VALUE
<b>Voltage</b>		
Surge voltage	≥ 400 V versions	$U_s = 1.1 \times U_R$
Reverse voltage		≤ 1 V
<b>Current</b>		
Leakage current	After 1 minute at $U_R$	$I_{L1} \leq 0.006 C_R \times U_R + 4 \mu A$
	After 5 minutes at $U_R$	$I_{L5} \leq 0.002 C_R \times U_R + 4 \mu A$
<b>Inductance</b>		
Equivalent series inductance (ESL)	All case sizes	typ. 19 nH
		max. 25 nH

Table 3

MULTIPLIER OF RIPPLE CURRENT ( $I_R$ ) AS A FUNCTION OF FREQUENCY	
FREQUENCY (Hz)	$I_R$ MULTIPLIER
50	0.86
100	1.00
300	1.17
600	1.24
1000	1.29
≥ 10 000	1.40

**RIPPLE CURRENT AND USEFUL LIFE**

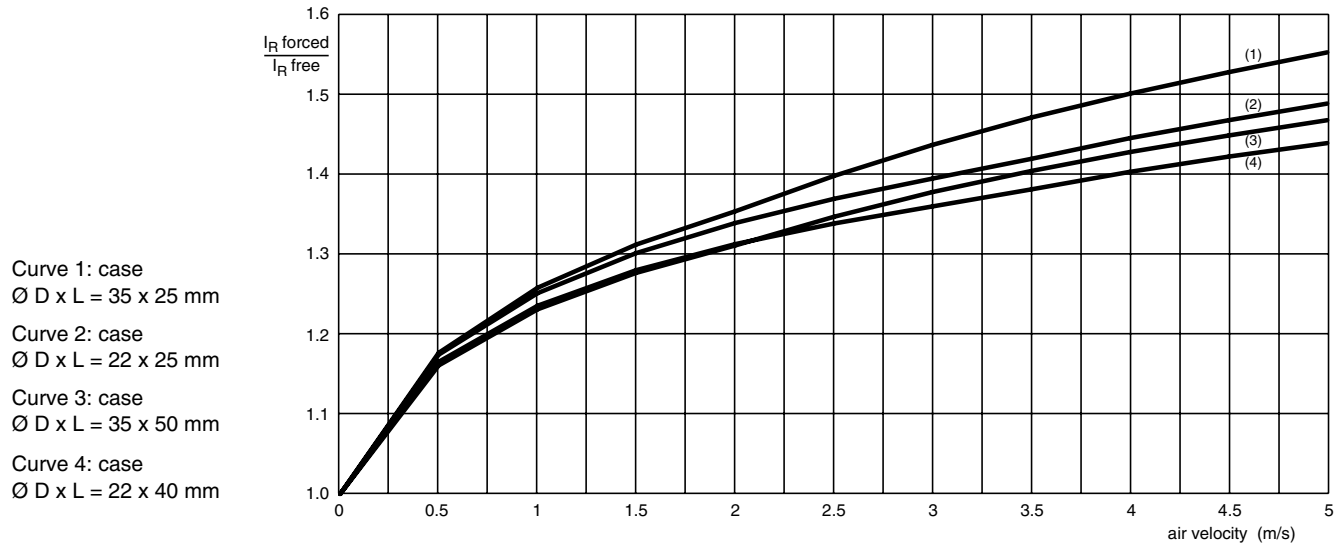


Fig. 6 Multiplier of ripple current ( $I_R$ ) as a function of air-flow

MAXIMUM RIPPLE CURRENT MULTIPLIER			
PARAMETER	CONDITION	MAXIMUM RIPPLE CURRENT MULTIPLIER	VALUE
Ambient temperature ( $T_{amb}$ )	70 °C	from nomogram; see Fig.7	1.57
Operating frequency (f)	300 Hz	from frequency table; see Table	1.17
Air-flow	2 m/s	from air-flow; see Fig.6	1.35

**Note**

Calculation example for case Ø D x L = 35 x 25 mm

Therefore the maximum ripple current multiplier at 70 °C, 300 Hz and 2 m/s air-flow = 1.57 x 1.17 x 1.35 = 2.48.

MGA 453

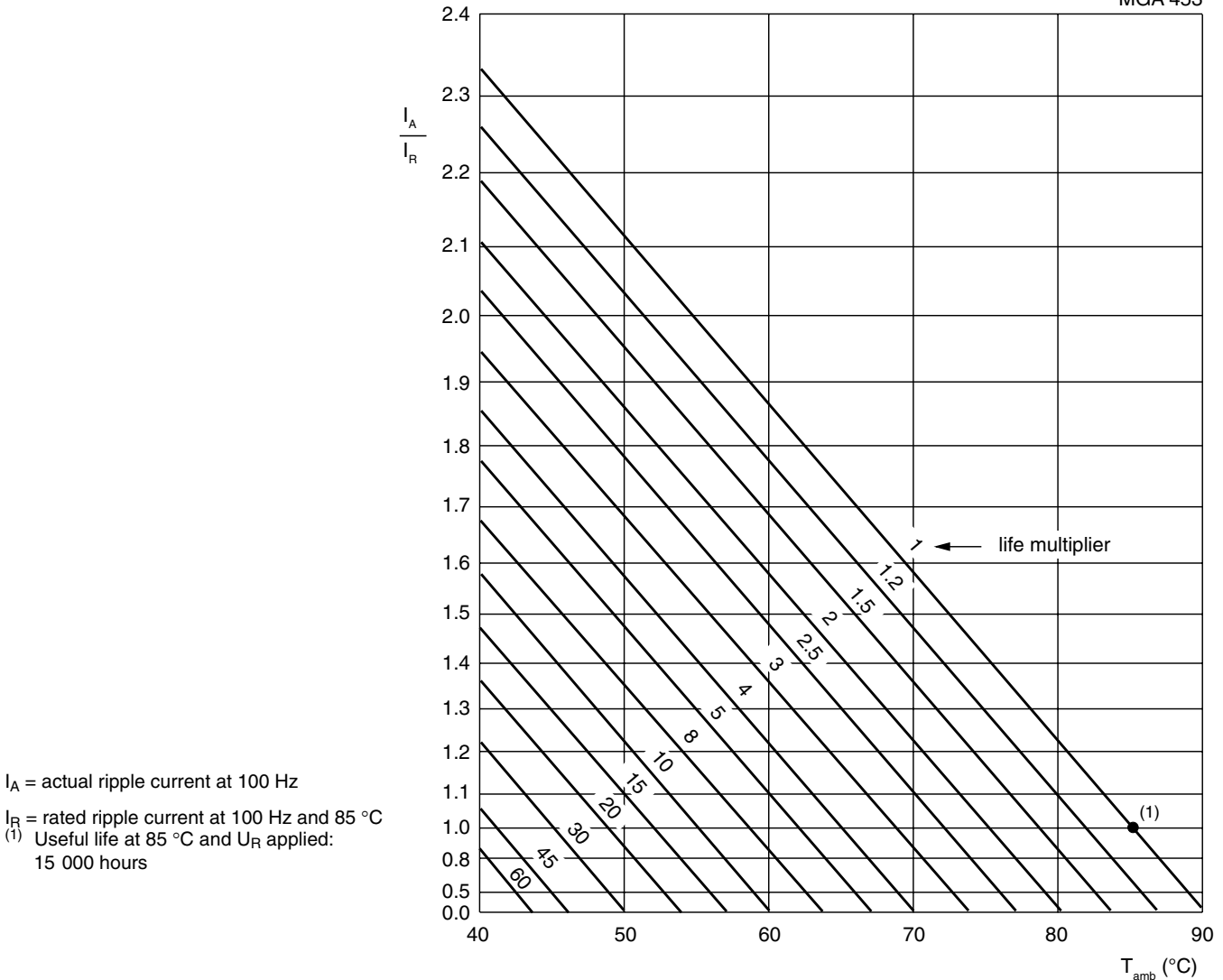


Fig. 7 Multiplier of useful life as a function of ambient temperature and ripple current load

Table 4

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; 7000 hours	$\Delta C/C: \pm 10\%$ $ESR \leq 2 \times \text{spec. limit}$ $IL5 \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 85\text{ °C}$ ; $U_R$ and $I_R$ applied; 15 000 hours	$\Delta C/C: \pm 30\%$ $ESR \leq 3 \times \text{spec. limit}$ $IL5 \leq \text{spec. limit}$
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	$T_{amb} = 85\text{ °C}$ ; no voltage applied; 1000 hours after test: $U_R$ to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C: \pm 15\%$ $ESR \leq 2 \times \text{spec. limit}$ $IL5 \leq 2 \times \text{spec. limit}$



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