Aluminum Capacitors
Power High Ripple Current Snap-in

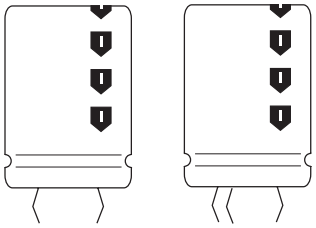
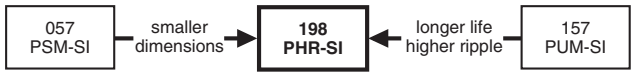


Fig.1 Component outlines.



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.

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.

QUICK REFERENCE DATA

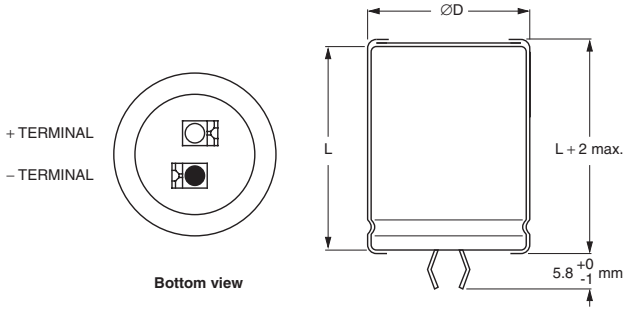
DESCRIPTION	VALUE
Nominal case size (∅D × L in mm)	22 × 25 to 35 × 60
Rated capacitance range (E6/E12 series), C_R	56 to 680 μF
Tolerance on C_R	±20%
Rated voltage range, U_R	400 and 450 V
Category temperature range	–25 to +85 °C
Endurance test at 85 °C	7000 hours
Useful life at 85 °C	15000 hours
Shelf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

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (∅D x L in mm)

C_R (μF)	U_R (V)	
	400	450
56	22 × 25	22 × 25
68	22 × 25	22 × 30
82	–	22 × 30
	–	25 × 25
100	22 × 30	22 × 35
	–	25 × 30
120	22 × 35	22 × 40
	25 × 30	25 × 30
	–	30 × 25
150	22 × 40	25 × 40
	25 × 35	30 × 30
180	25 × 40	25 × 40
	30 × 30	30 × 35
	35 × 25	35 × 25
220	25 × 45	25 × 50
	30 × 35	30 × 40
	35 × 30	35 × 30
270	30 × 40	30 × 45
	35 × 30	35 × 35
330	30 × 45	30 × 50
	35 × 35	35 × 40
390	30 × 50	35 × 45
	35 × 40	–
470	35 × 45	35 × 50
560	35 × 50	35 × 60
680	35 × 60	35 × 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.

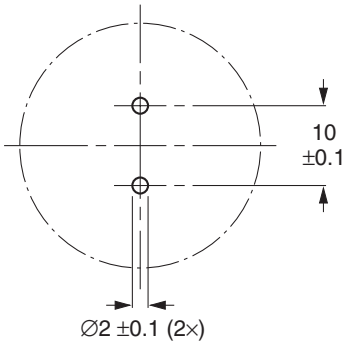
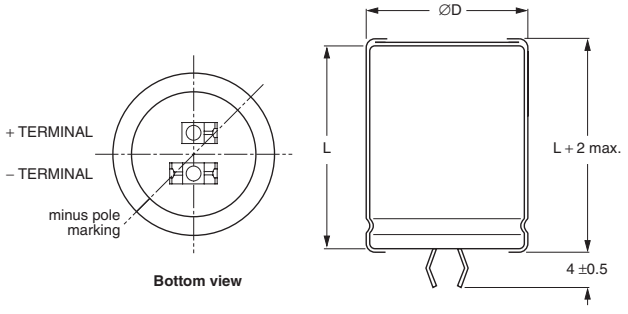


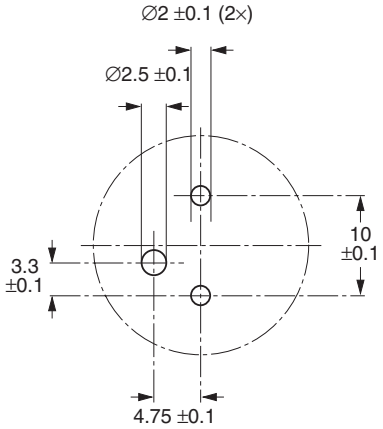
Fig. 3 Mounting hole diagram.

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

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

ELECTRICAL DATA	
SYMBOL	**DESCRIPTION**
C_R	rated capacitance at 100 Hz
I_R	rated RMS ripple current at 100 Hz, 85 °C
I_{L1}	max. leakage current after 1 minute at U_R
I_{L5}	max. leakage current after 5 minutes at U_R
ESR	typ./max. equivalent series resistance at 100 Hz
Z	typ./max. impedance at 10 kHz

Note

1. Unless otherwise specified, all electrical values in Table 2 apply at T_{amb} = 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: ∅35 × 50 mm

2-terminal snap-in:

Catalog number: 2222 198 57471.

3-terminal snap-in:

Catalog number: 2222 198 77471.

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION											
U_R (V)	**C_R 100 Hz (µF)**	**NOMINAL CASE SIZE ∅D × L (mm)**	**I_R 100 Hz 85 °C (A)**	**I_{L1} 1 min (µA)**	**I_{L5} 5 min (µA)**	**TYP. ESR 100 Hz (mΩ)**	**MAX. ESR 100 Hz (mΩ)**	**TYP. Z 10 kHz (mΩ)**	**MAX. Z 10 kHz (mΩ)**	**CATALOG NUMBER 2222 198 .....**	
										2-TERM.	**3-TERM.**
400	56	22 × 25	0.72	138	49	918	1706	521	1085	56569	76569
	68	22 × 25	0.79	167	59	762	1405	434	905	56689	76689
	100	22 × 30	1.00	244	84	520	956	297	610	56101	76101
	120	22 × 35	1.14	292	100	433	796	247	450	46121	26121
	120	25 × 30	1.14	292	100	438	796	252	450	36121	16121
	150	22 × 40	1.33	364	124	348	637	199	363	66151	86151

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (μF)	NOMINAL CASE SIZE ∅D × L (mm)	I_R 100 Hz 85 °C (A)	I_{L1} 1 min (μA)	I_{L5} 5 min (μA)	TYP. ESR 100 Hz (mΩ)	MAX. ESR 100 Hz (mΩ)	TYP. Z 10 kHz (mΩ)	MAX. Z 10 kHz (mΩ)	CATALOG NUMBER 2222 198	
										2-TERM.	3-TERM.
400	150	25 × 35	1.33	364	124	351	637	202	363	36151	16151
	180	25 × 40	1.51	436	148	293	531	169	295	36181	16181
	180	30 × 30	1.49	436	148	305	531	180	295	66181	86181
	180	35 × 25	1.56	436	148	327	531	200	295	26181	76181
	220	25 × 45	1.75	532	180	241	434	139	280	36221	90008
	220	30 × 35	1.56	532	180	250	434	147	280	26221	76221
	220	35 × 30	1.81	532	180	259	434	155	280	16221	86221
	270	30 × 40	1.95	652	220	205	354	121	263	36271	16271
	270	35 × 30	1.93	652	220	222	354	137	263	66271	86271
	330	30 × 45	2.22	796	268	169	290	101	210	36331	16331
	330	35 × 35	2.18	796	268	181	290	112	210	66331	86331
	390	30 × 50	2.50	940	316	145	245	86	175	36391	16391
	390	35 × 40	2.44	940	316	154	245	95	175	66391	86391
	470	35 × 45	2.72	1132	380	129	203	80	153	36471	16471
	560	35 × 50	3.03	1348	452	110	171	70	133	46561	26561
	680	35 × 60	3.53	1636	548	91	140	57	110	46681	26681
450	56	22 × 25	0.71	155	54.4	865	1706	479	940	57569	77569
	68	22 × 30	0.82	188	65.2	709	1405	392	765	57689	77689
	82	22 × 30	0.89	225	77.8	592	1165	329	645	47829	27829
	82	25 × 25	0.91	225	77.8	604	1165	339	645	57829	77829
	100	22 × 35	1.02	274	94	485	956	270	525	47101	27101
	100	25 × 30	1.05	274	94	491	956	274	525	57101	77101
	120	22 × 40	1.14	328	112	406	796	225	443	47121	27121
	120	25 × 30	1.13	328	112	415	796	233	443	57121	77121
	120	30 × 25	1.16	328	112	431	796	248	443	67121	87121
	150	25 × 40	1.36	409	139	328	637	184	353	47151	27151
	150	30 × 30	1.36	409	139	340	637	194	353	57151	77151
	180	25 × 40	1.47	490	166	277	531	157	303	47181	27181
	180	30 × 35	1.54	490	166	282	531	161	303	57181	77181
	180	35 × 25	1.46	490	166	316	531	191	303	67181	87181
	220	25 × 50	1.71	598	202	226	434	127	263	47221	27221
	220	30 × 40	1.75	598	202	232	434	133	263	57221	77221
	220	35 × 30	1.72	598	202	248	434	148	263	67221	87221
	270	30 × 45	1.98	733	247	191	354	110	225	47271	27271
	270	35 × 35	1.96	733	247	202	354	120	225	57271	77271
	330	30 × 50	2.22	895	301	158	290	91	195	47331	27331
	330	35 × 40	2.22	895	301	167	290	100	195	57331	77331
	390	35 × 45	2.46	1057	355	142	245	85	170	57391	77391
	470	35 × 50	2.73	1273	427	120	203	73	145	57471	77471
	560	35 × 60	3.10	1516	508	100	171	60	120	57561	77561
	680	35 × 60	3.30	1840	616	88	140	55	110	57681	77681

CUSTOMIZED PRODUCTS

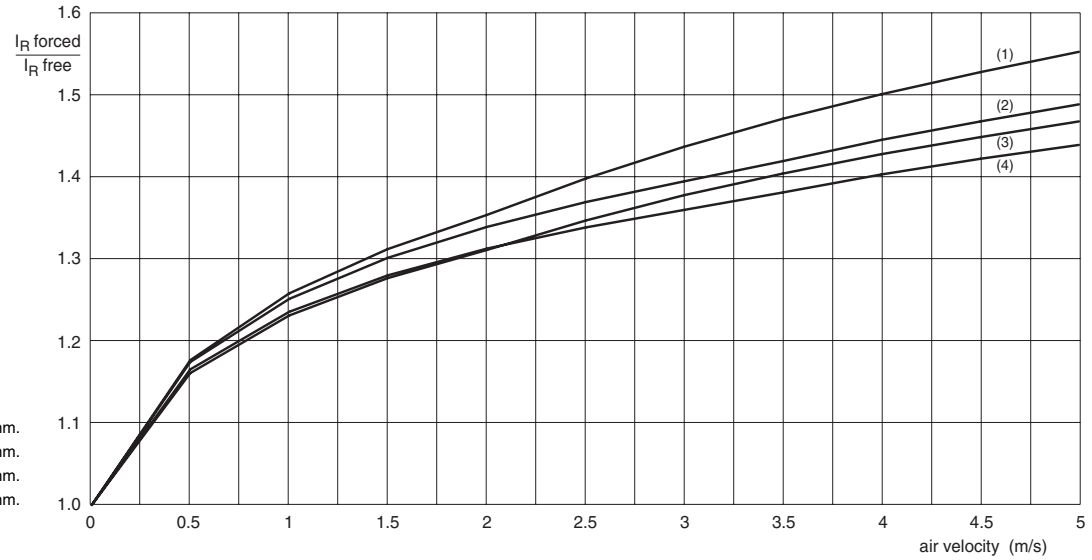
If you are unable to find the capacitor you require, please contact your local Vishay BCcomponents sales organization; we are able to design and manufacture customized capacitors to meet your specific requirements.

ADDITIONAL ELECTRICAL DATA		
PARAMETER	**CONDITIONS**	**VALUE**
Voltage		
Surge voltage	≥ 400 V versions	$U_s = 1.1 \times U_R$
Reverse voltage		≤ 1 V
Current		
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	$I_{L5} \leq 0.002\ C_R \times U_R + 4\ \mu A$
Inductance		
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
≥10000	1.40

RIPPLE CURRENT AND USEFUL LIFE



Curve 1: case ØD × L = 35 × 25 mm.
Curve 2: case ØD × L = 22 × 25 mm.
Curve 3: case ØD × L = 35 × 50 mm.
Curve 4: case ØD × L = 22 × 40 mm.

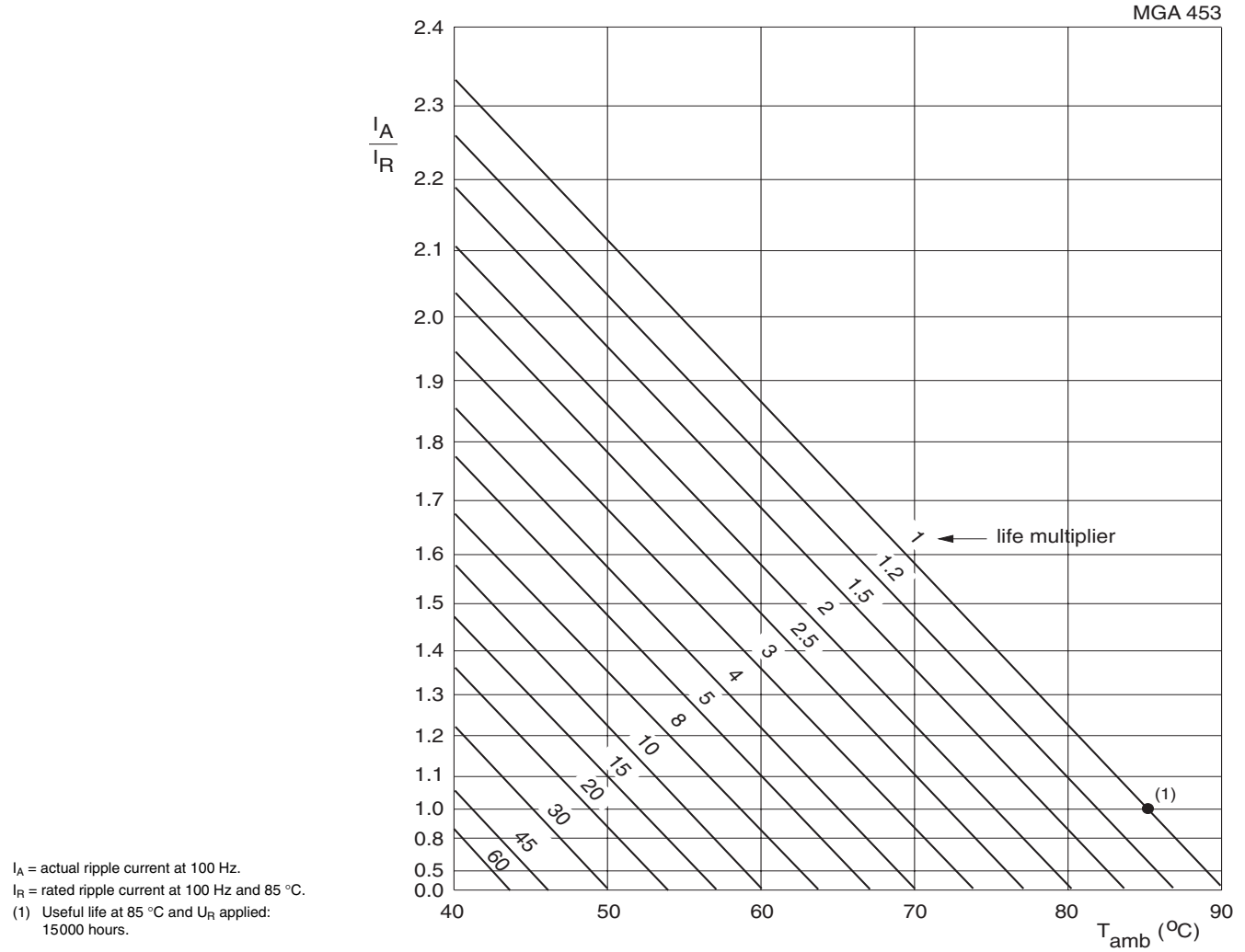
Fig. 6 Multiplier of ripple current (I_R) as a function of air-flow.

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 ØD × L = 35 × 25 mm

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



I_A = actual ripple current at 100 Hz.
I_R = rated ripple current at 100 Hz and 85 °C.
(1) Useful life at 85 °C and U_R applied: 15000 hours.

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 °C; U_R applied; 7000 hours	ΔC/C: ±10% ESR ≤ 2 × spec. limit I_{L5} ≤ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 85 °C; U_R and I_R applied; 15000 hours	ΔC/C: ±30% ESR ≤ 3 × spec. limit I_{L5} ≤ spec. limit
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	T_{amb} = 85 °C; no voltage applied; 1000 hours after test: U_R to be applied for 30 minutes, 24 to 48 hours before measurement	ΔC/C: ±15% ESR ≤ 2 × spec. limit I_{L5} ≤ 2 × spec. limit