

# Aluminum Capacitors

## Power Standard Miniature Snap-in

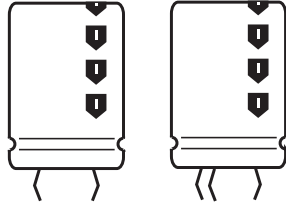
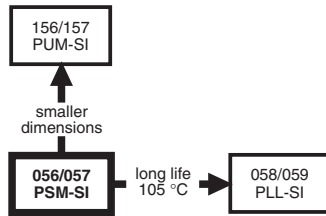


Fig.1 Component outlines.


**FEATURES**

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Large types, minimized dimensions, cylindrical aluminum case, insulated with a blue sleeve
- Pressure relief on the top of the aluminum case
- Charge and discharge proof
- Long useful life: 12000 hours at 85 °C
- High ripple current capability
- Keyed polarity version available
- Lead (Pb)-free versions are RoHS compliant.


**RoHS\***  
COMPLIANT

**APPLICATIONS**

- General purpose, industrial and audio/video 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  $\mu\text{F}$ ).
- Tolerance code on rated capacitance, code letter in accordance with IEC 60062 (M for  $\pm 20\%$ ).
- 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	
	056	057
Nominal case size ( $\varnothing D \times L$ in mm)	22 × 25 to 35 × 50	
Rated capacitance range (E6 series), $C_R$	470 to 68000 $\mu\text{F}$	47 to 1500 $\mu\text{F}$
Tolerance on $C_R$	$\pm 20\%$	
Rated voltage range, $U_R$ ; note 1	10 to 100 V	200 to 450 V
Category temperature range	- 40 to + 85 °C	
Endurance test at 85 °C	5000 hours (450 V: 2000 hours)	
Useful life at 85 °C	12000 hours (450 V: 5000 hours)	
Useful life at 40 °C and $1.4 \times I_R$ applied	210000 hours (450 V: 90000 hours)	
Shelf life at 0 V, 85 °C	500 hours	
Based on sectional specification	IEC 60384-4/EN130300	
Climatic category IEC 60068	40/085/56	

**Note**

1. A 420 V range is available on request.

**SELECTION CHART FOR  $C_R$ ,  $U_R$  AND RELEVANT NOMINAL CASE SIZES FOR 056 SERIES ( $\varnothing D \times L$  in mm)**

$C_R$ ( $\mu\text{F}$ )	$U_R$ (V)						
	10	16	25	40	50	63	100
470	-	-	-	-	-	-	22 × 25
680	-	-	-	-	-	-	22 × 30
1000	-	-	-	-	-	22 × 25	25 × 30
	-	-	-	-	-	-	22 × 40
1500	-	-	-	-	22 × 25	22 × 30	30 × 30
	-	-	-	-	-	-	25 × 40
2200	-	-	-	22 × 25	22 × 30	25 × 30	30 × 40
	-	-	-	-	-	22 × 40	25 × 50
3300	-	-	22 × 25	22 × 30	25 × 30	30 × 30	35 × 40
	-	-	-	-	22 × 40	25 × 40	30 × 50

\* Pb containing terminations are not RoHS compliant, exemptions may apply

**SELECTION CHART FOR  $C_R$ ,  $U_R$  AND RELEVANT NOMINAL CASE SIZES FOR 056 SERIES** ( $\varnothing D \times L$  in mm)

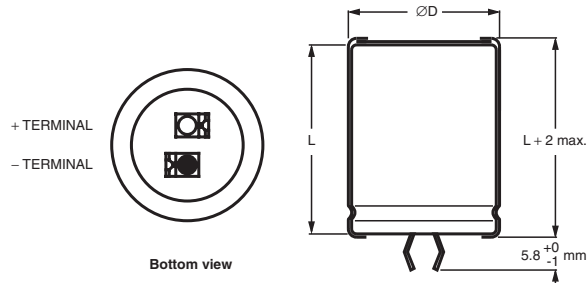
$C_R$ ( $\mu F$ )	$U_R$ (V)						
	10	16	25	40	50	63	100
4700	–	22 × 25	22 × 30	25 × 30	30 × 30	30 × 40	35 × 50
	–	–	–	22 × 40	25 × 40	25 × 50	–
6800	22 × 25	22 × 30	25 × 30	30 × 30	30 × 40	35 × 40	–
	–	–	22 × 40	25 × 40	25 × 50	30 × 50	–
10000	22 × 30	25 × 30	30 × 30	30 × 40	35 × 40	35 × 50	–
	–	22 × 40	25 × 40	25 × 50	30 × 50	–	–
15000	25 × 30	30 × 30	30 × 40	35 × 40	35 × 50	–	–
	22 × 40	25 × 40	25 × 50	30 × 50	–	–	–
22000	30 × 30	30 × 40	35 × 40	35 × 50	–	–	–
	25 × 40	25 × 50	30 × 50	–	–	–	–
33000	30 × 40	35 × 40	35 × 50	–	–	–	–
	25 × 50	30 × 50	–	–	–	–	–
47000	35 × 40	35 × 50	–	–	–	–	–
	30 × 50	–	–	–	–	–	–
68000	35 × 50	–	–	–	–	–	–

**SELECTION CHART FOR  $C_R$ ,  $U_R$  AND RELEVANT NOMINAL CASE SIZES FOR 057 SERIES** ( $\varnothing D \times L$  in mm)

$C_R$ ( $\mu F$ )	$U_R$ (V)				
	200	250	385	400	450
47	–	–	22 × 25	22 × 25	22 × 30
68	–	–	22 × 30	22 × 30	22 × 30
100	–	22 × 25	25 × 30	25 × 30	30 × 30
	–	–	22 × 40	22 × 35	25 × 35
	–	–	22 × 35	–	–
150	22 × 25	22 × 30	30 × 30	30 × 30	25 × 50
	–	–	25 × 40	25 × 50 <sup>(1)</sup>	30 × 35
	–	–	–	25 × 40	–
220	22 × 30	25 × 30	30 × 45	30 × 35	35 × 40
	–	22 × 40	30 × 40	25 × 50	30 × 45
	–	–	30 × 35	–	–
	–	–	25 × 50	–	–
330	25 × 30	30 × 30	35 × 35	35 × 40	35 × 50
	22 × 40	25 × 40	30 × 45	30 × 50	35 × 45
470	30 × 30	30 × 40	35 × 50	35 × 50	–
	25 × 40	25 × 50	35 × 45	–	–
680	30 × 40	35 × 40	–	–	–
	25 × 50	30 × 50	–	–	–
1000	35 × 40	35 × 50	–	–	–
	30 × 50	–	–	–	–
1500	35 × 50	–	–	–	–

**Notes**

- Ripple current optimized types.

**DIMENSIONS** in millimeters **AND AVAILABLE FORMS**
**TWO TERMINALS SNAP-IN**


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

Fig.2 Two terminal snap-in.

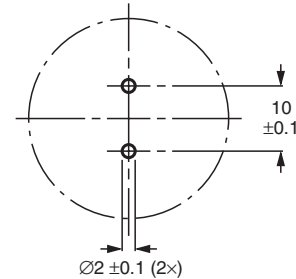
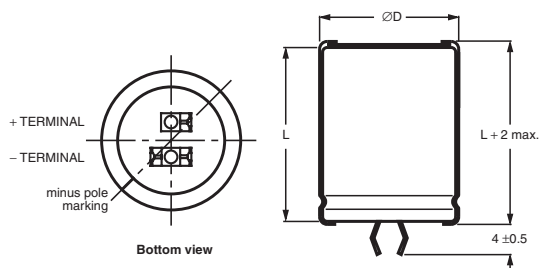
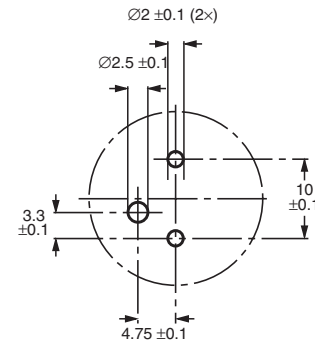


Fig.3 Mounting hole diagram.

**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</b> ØD × L	ØD <sub>max</sub>	L <sub>max</sub>	<b>MASS</b> (g)	<b>PACKAGING QUANTITIES</b> (units per box)	<b>CARDBOARD BOX DIMENSIONS</b> L x W x H (mm)
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 × 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 × 50	26	52	≈38	100	290 × 280 × 64
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 × 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

ELECTRICAL DATA	
SYMBOL	DESCRIPTION
$C_R$	rated capacitance at 100 Hz
$I_R$	rated RMS ripple current at 100 Hz or $\geq 10$ kHz and 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	max. equivalent series resistance at 100 Hz
Z	max. impedance at 10 kHz

**Note**

1. Unless otherwise specified, all electrical values in Tables 2 and apply at  $T_{amb} = 20$  °C,  $P = 86$  to 106 kPa,  $RH = 45$  to 75 %.

**ORDERING EXAMPLE\***

Electrolytic capacitor 056 series

10000 $\mu$ F/25 V;  $\pm 20$  %Nominal case size:  $\varnothing 25 \times 40$ mm

2-terminal snap-in:

Catalog number: 2222 056 46103.

3-terminal snap-in:

Catalog number: 2222 056 26103.

\*Note: To ensure delivery of lead (Pb)-free parts during the transition period, please contact your Vishay sales agent.

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION FOR 056 SERIES										
$U_R$ (V)	CR 100 Hz (MF)	NOMINAL CASE SIZE $\varnothing D \times L$ (mm)	$I_R$ 100 Hz 85 °C (A)	$I_R$ $\geq 10$ kHz 85 °C (A)	$I_{L1}$ 1 min (mA)	$I_{L5}$ 5 min (mA)	ESR 100 Hz (m $\Omega$ )	Z 10 kHz (m $\Omega$ )	CATALOG NUMBER 2222 056 .....	
									2-TERM.	3-TERM.
10	6800	22 $\times$ 25	2.04	2.40	412	140	76	62	54682	74682
	10000	22 $\times$ 30	2.56	3.02	608	205	56	45	54103	74103
	15000	25 $\times$ 30	3.12	3.68	904	304	44	39	54153	74153
	15000	22 $\times$ 40	3.39	4.00	904	304	41	34	44153	24153
	22000	30 $\times$ 30	3.47	4.09	1324	444	44	37	54223	74223
	22000	25 $\times$ 40	4.12	4.86	1324	444	34	28	44223	24223
	33000	30 $\times$ 40	4.58	5.40	1984	664	32	28	54333	74333
	33000	25 $\times$ 50	4.70	5.55	1984	664	30	27	44333	24333
	47000	35 $\times$ 40	5.10	6.02	2824	944	31	26	54473	74473
	47000	30 $\times$ 50	5.39	6.36	2824	944	28	24	44473	24473
68000	35 $\times$ 50	5.88	6.94	4084	1364	28	23	54683	74683	
16	4700	22 $\times$ 25	2.01	2.37	455	154	79	62	55472	75472
	6800	22 $\times$ 30	2.54	3.00	657	222	57	45	55682	75682
	10000	25 $\times$ 30	3.02	3.56	964	324	47	39	55103	75103
	10000	22 $\times$ 40	3.28	3.87	964	324	44	34	45103	25103
	15000	30 $\times$ 30	3.36	3.96	1444	484	47	37	55153	75153
	15000	25 $\times$ 40	4.00	4.72	1444	484	34	28	45153	25153
	22000	30 $\times$ 40	4.51	5.32	2116	708	33	28	55223	75223
	22000	25 $\times$ 50	3.97	4.68	2116	708	42	41	45223	25223
	33000	35 $\times$ 40	5.02	5.92	3172	1060	32	28	55333	75333
	33000	30 $\times$ 50	4.75	5.61	3172	1060	36	34	45333	25333
47000	35 $\times$ 50	5.34	6.30	4516	1508	34	32	55473	75473	
25	3300	22 $\times$ 25	1.88	2.22	499	169	89	61	56332	76332
	4700	22 $\times$ 30	2.37	2.80	709	239	65	45	56472	76472
	6800	25 $\times$ 30	2.81	3.32	1024	344	54	41	56682	76682
	6800	22 $\times$ 40	3.16	3.73	1024	344	47	38	46682	26682
	10000	30 $\times$ 30	3.25	3.84	1504	504	50	38	56103	76103
	10000	25 $\times$ 40	3.73	4.40	1504	504	39	30	46103	26103
	15000	30 $\times$ 40	4.73	5.58	2254	754	30	28	56153	76153
	15000	25 $\times$ 50	3.92	4.63	2254	754	43	39	46153	26153
	22000	35 $\times$ 40	4.48	5.29	3304	1104	40	28	56223	76223
	22000	30 $\times$ 50	4.96	5.85	3304	1104	36	23	46223	26223
	33000	35 $\times$ 50	4.98	5.88	4954	1654	39	33	56333	76333



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Power Standard Miniature Snap-in

<b>ELECTRICAL DATA AND ORDERING INFORMATION FOR 056 SERIES</b>										
U <sub>R</sub> (V)	CR 100 Hz (MF)	NOMINAL CASE SIZE ∅D × L (mm)	I <sub>R</sub> 100 Hz 85 °C (A)	I <sub>R</sub> ≥ 10 kHz 85 °C (A)	I <sub>L1</sub> 1 min (MA)	I <sub>L5</sub> 5 min (MA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOG NUMBER 2222 056 .....	
									2-TERM.	3-TERM.
40	2200	22 × 25	1.85	2.26	532	180	92	61	57222	77222
	3300	22 × 30	2.09	2.55	796	260	67	45	57332	77332
	4700	25 × 30	2.28	2.78	1132	380	82	70	57472	77472
	4700	22 × 40	3.10	3.78	1132	380	49	38	47472	27472
	6800	30 × 30	3.16	3.85	1636	548	53	38	57682	77682
	6800	25 × 40	3.06	3.73	1636	548	58	50	47682	27682
	10000	30 × 40	4.20	5.12	2404	804	38	28	57103	77103
	10000	25 × 50	3.88	4.73	2404	804	44	39	47103	27103
	15000	35 × 40	4.05	4.94	3604	1204	49	41	57153	77153
	15000	30 × 50	4.45	5.43	3604	1204	41	34	47153	27153
	22000	35 × 50	4.86	5.93	5284	1764	40	33	57223	77223
50	1500	22 × 25	1.36	1.66	454	154	170	130	51152	71152
	2200	22 × 30	1.75	2.14	664	224	120	91	51222	71222
	3300	25 × 30	2.17	2.65	994	334	90	72	51332	71332
	3300	22 × 40	2.42	2.95	994	334	80	63	41332	21332
	4700	30 × 30	2.65	3.23	1414	474	75	63	51472	71472
	4700	25 × 40	2.89	3.53	1414	474	65	52	41472	21472
	6800	30 × 40	3.56	4.34	2044	684	53	45	51682	71682
	6800	25 × 50	3.75	4.58	2044	684	50	43	41682	21682
	10000	35 × 40	4.05	4.94	3004	1004	49	42	51103	71103
	10000	30 × 50	4.50	5.49	3004	1004	40	35	41103	21103
	15000	35 × 50	4.98	6.08	4504	1504	39	33	51153	71153
63	1000	22 × 25	1.46	1.78	382	130	148	104	58102	78102
	1500	22 × 30	1.87	2.28	571	193	105	72	58152	78152
	2200	25 × 30	2.32	2.83	836	281	79	59	58222	78222
	2200	22 × 40	2.54	3.10	836	281	73	53	48222	28222
	3300	30 × 30	2.87	3.50	1251	420	64	50	58332	78332
	3300	25 × 40	3.14	3.83	1251	420	55	44	48332	28332
	4700	30 × 40	3.67	4.48	1780	596	50	38	58472	78472
	4700	25 × 50	3.71	4.53	1780	596	48	38	48472	28472
	6800	35 × 40	4.33	5.28	2574	861	43	38	58682	78682
	6800	30 × 50	4.75	5.80	2574	861	42	37	48682	28682
	10000	35 × 50	5.26	6.42	3784	1264	35	30	58103	78103
100	470	22 × 25	0.77	0.94	286	98	535	470	59471	79471
	680	22 × 30	0.99	1.21	412	160	375	328	59681	79681
	1000	25 × 30	1.27	1.55	604	204	265	235	59102	79102
	1000	22 × 40	1.35	1.65	604	204	260	225	49102	29102
	1500	30 × 30	1.67	2.04	904	304	190	170	59152	79152
	1500	25 × 40	1.75	2.14	904	304	180	160	49152	29152
	2200	30 × 40	2.27	2.77	1324	444	130	120	59222	79222
	2200	25 × 50	2.30	2.80	1324	444	125	110	49222	29222
	3300	35 × 40	2.84	3.46	1984	664	100	95	59332	79332
	3300	30 × 50	2.97	3.62	1984	664	92	85	49332	29332
	4700	35 × 50	3.59	4.38	2824	677	75	70	59472	79472

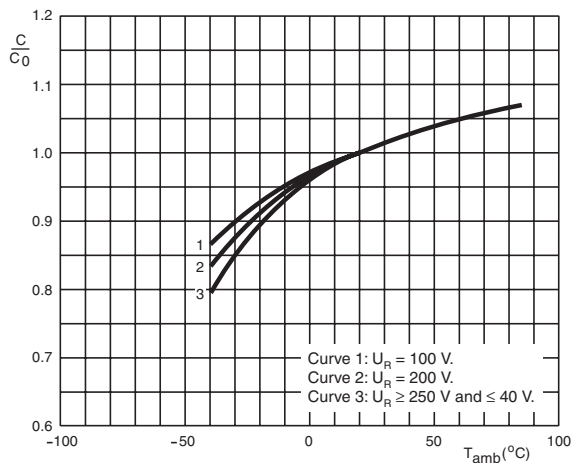
Table 3

ELECTRICAL DATA AND ORDERING INFORMATION FOR 057 SERIES									
U <sub>R</sub> (V)	C <sub>R</sub> 100 Hz (MF)	NOMINAL CASE SIZE ∅D × L (mm)	I <sub>R</sub> 100 Hz 85 °C (A)	I <sub>L1</sub> 1 min (MA)	I <sub>L5</sub> 5 min (MA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	CATALOG NUMBER 2222 057 .....	
								2-TERM.	3-TERM.
200	150	22 × 25	0.77	184	64	950	620	52151	72151
	220	22 × 30	1.00	268	92	650	435	52221	72221
	330	25 × 30	1.36	400	136	430	310	52331	72331
	330	22 × 40	1.36	400	136	430	310	42331	22331
	470	30 × 30	1.80	568	192	310	230	52471	72471
	470	25 × 40	1.80	568	192	310	230	42471	22471
	680	30 × 40	2.39	820	276	210	180	52681	72681
	680	25 × 50	2.39	820	276	210	180	42681	22681
	1000	35 × 40	2.85	1204	404	160	135	52102	72102
	1000	30 × 50	2.85	1204	404	160	135	42102	22102
1500	35 × 50	3.66	1804	604	120	105	52152	72152	
250	100	22 × 25	0.63	154	54	1440	770	53101	73101
	150	22 × 30	0.83	229	79	960	520	53151	73151
	220	25 × 30	1.10	334	114	660	365	53221	73221
	220	22 × 40	1.10	334	114	660	365	43221	23221
	330	30 × 30	1.49	499	169	440	265	53331	73331
	330	25 × 40	1.49	499	169	440	265	43331	23331
	470	30 × 40	1.98	709	239	310	185	53471	73471
	470	25 × 50	1.98	709	239	310	185	43471	23471
	680	35 × 40	2.60	1024	344	240	145	53681	73681
	680	30 × 50	2.60	1024	344	240	145	43681	23681
1000	35 × 50	3.12	1504	504	160	105	53102	73102	
385	47	22 × 25	0.50	112	40	3000	1400	58479	78479
	68	22 × 30	0.63	161	56	2100	1000	58689	68689
	100	25 × 30	0.86	235	81	1400	780	58101	78101
	100	22 × 40	0.86	235	81	1400	780	48101	68101
	100	22 × 35	0.84	235	81	1400	780	38101	88101
	150	30 × 30	1.16	350	119	950	520	58151	78151
	150	25 × 40	1.16	350	119	950	520	48151	68151
	220	30 × 45	1.63	512	173	700	460	18221	88221
	220	30 × 40	1.57	512	173	650	400	58221	78221
	220	30 × 35	1.50	512	173	650	400	38221	90051
	220	25 × 50	1.57	512	173	650	400	48221	68221
	330	35 × 35	1.73	766	258	480	280	68331	88331
	330	30 × 45	1.75	766	258	480	280	38331	78331
	470	35 × 50	2.40	1089	366	340	220	58471	78471
470	35 × 45	2.29	1089	366	340	220	48471	28471	
400	47	22 × 25	0.50	117	42	3000	1400	56479	76479
	68	22 × 30	0.63	167	58	2100	1000	56689	76689
	100	25 × 30	0.86	244	84	1400	780	56101	76101
	100	22 × 35	0.84	240	84	1400	780	36101	66101
	150	30 × 30	1.16	364	124	950	520	56151	90054
	150	25 × 50	1.50	364	124	1000	520	16151	36151
	150	25 × 40	1.16	364	124	950	520	46151	86151
	220	30 × 35	1.50	532	180	650	400	36221	90055
	220	25 × 50	1.57	532	180	650	400	46221	86221
	330	35 × 40	1.85	796	268	480	280	56331	76331
330	30 × 50	1.85	796	268	480	280	46331	26331	
470	35 × 50	2.40	1132	380	340	220	56471	76471	
450	47	22 × 30	0.26	131	45	5600	4400	67479	87479
	68	22 × 30	0.33	188	65	3900	3100	57689	77689
	100	30 × 30	0.48	274	94	2600	2100	57101	77101
	100	25 × 35	0.46	274	94	2600	2100	37101	17101
	150	30 × 35	0.66	409	140	1600	1300	37151	17151
	150	25 × 50	0.70	409	140	1600	1300	47151	27151
	220	35 × 40	0.92	598	202	1100	900	57221	77221
	220	30 × 45	0.73	598	202	1100	900	37221	17221
	330	35 × 50	1.26	895	301	700	600	57331	77331
	330	35 × 45	1.20	895	301	700	600	47331	27331



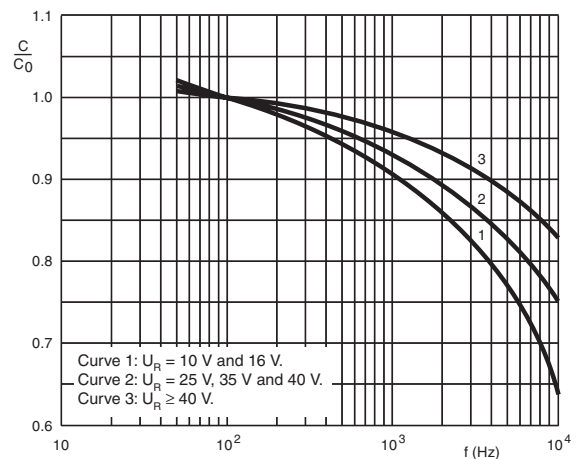
ADDITIONAL ELECTRICAL DATA		
PARAMETER	CONDITIONS	VALUE
<b>Voltage</b>		
Surge voltage	≤ 250 V versions	$U_s = 1.15 \times U_R$
	≥ 385 V versions	$U_s = 1.1 \times U_R$
Reverse voltage		$U_{rev} \leq 1 \text{ V}$
<b>Current</b>		
Leakage current	after 1 minute at $U_R$	$I_{L1} \leq 0.006 C_R \times U_R + 4 \mu\text{A}$
	after 5 minutes at $U_R$	$I_{L5} \leq 0.002 C_R \times U_R + 4 \mu\text{A}$
<b>Inductance</b>		
Equivalent series inductance (ESL)	all case sizes	typ. 19nH
		max. 25nH

**CAPACITANCE (C)**



$C_0$  = capacitance at 20 °C and 100 Hz

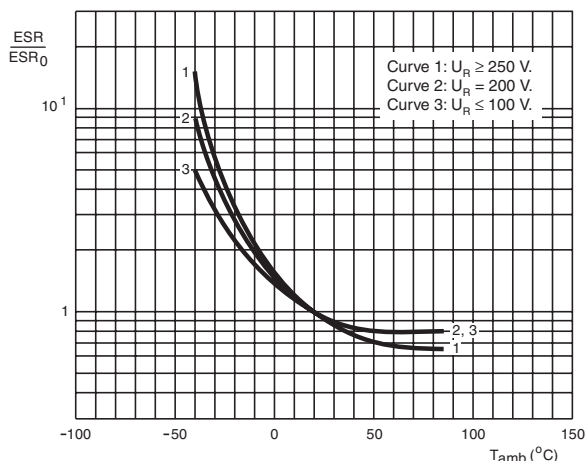
Fig.6 Typical multiplier of capacitance as a function of ambient temperature.



$C_0$  = capacitance at 20 °C and 100 Hz

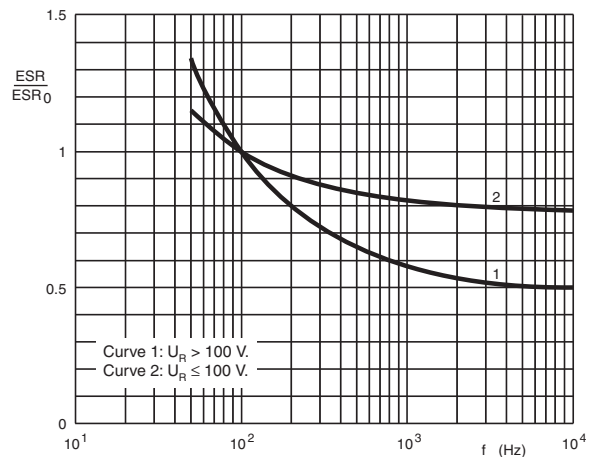
Fig.7 Typical multiplier of capacitance as a function of frequency.

**EQUIVALENT SERIES RESISTANCE (ESR)**



$ESR_0$  = typical at 20 °C and 100 Hz

Fig.8 Typical multiplier of ESR as a function of ambient temperature.

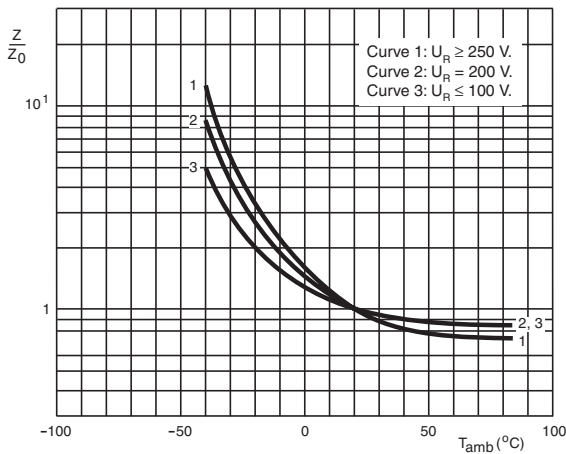


$ESR_0$  = typical at 20 °C and 100 Hz

Fig.9 Typical multiplier of ESR as a function of frequency.



**IMPEDANCE (Z)**



$Z_0$  = typical impedance at 20 °C and 10 kHz

Fig.10 Typical multiplier of impedance as a function of ambient temperature.

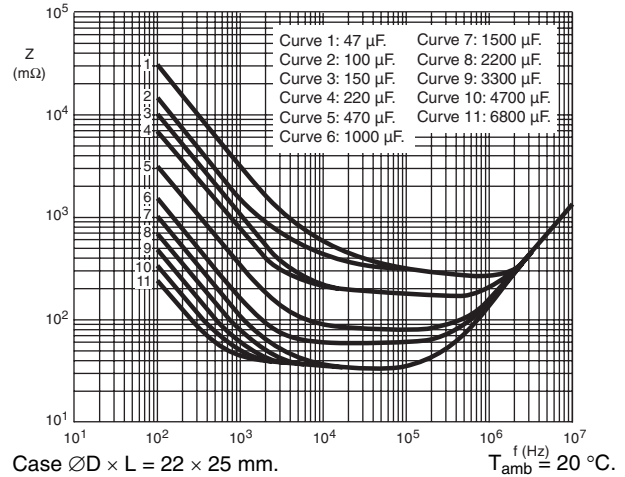
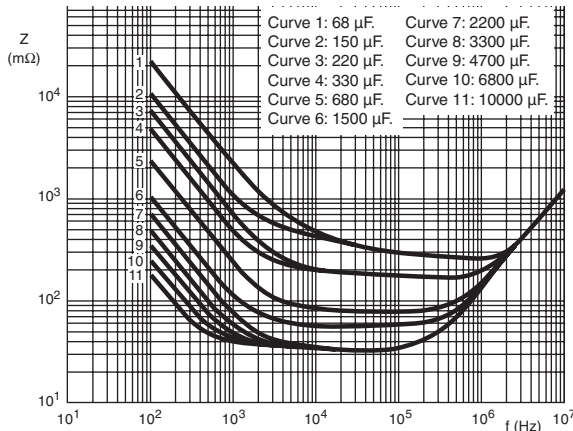
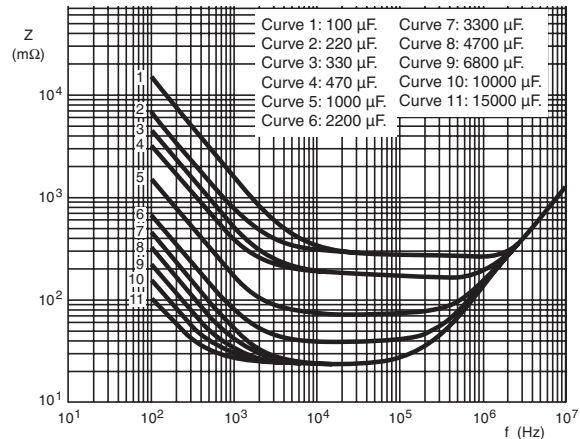


Fig.11 Typical impedance as a function of frequency.



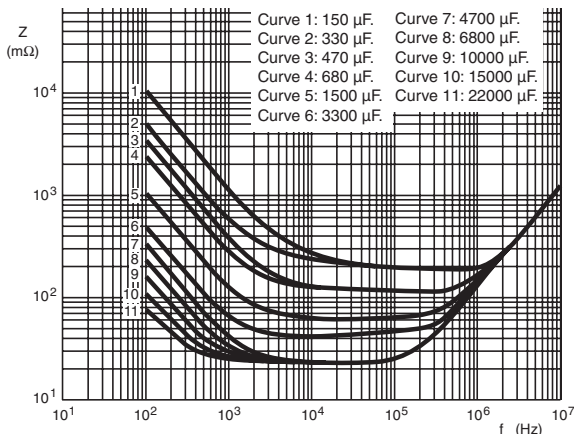
Case  $\varnothing D \times L = 22 \times 30$  mm.  $T_{amb} = 20$  °C.

Fig.12 Typical impedance as a function of frequency.



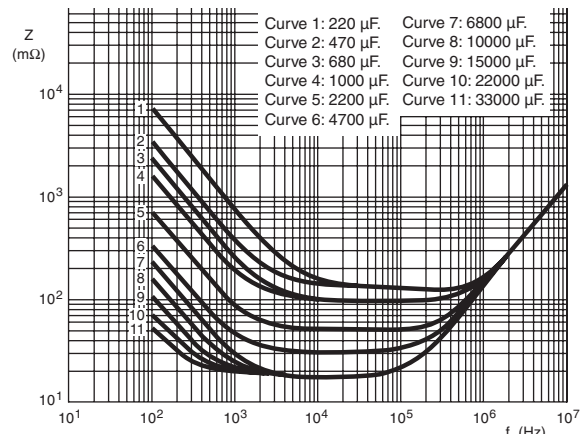
Case  $\varnothing D \times L = 25 \times 30$  and  $22 \times 40$  mm.  $T_{amb} = 20$  °C.

Fig.13 Typical impedance as a function of frequency.



Case  $\varnothing D \times L = 30 \times 30$  and  $25 \times 40$  mm.  $T_{amb} = 20$  °C.

Fig.14 Typical impedance as a function of frequency.

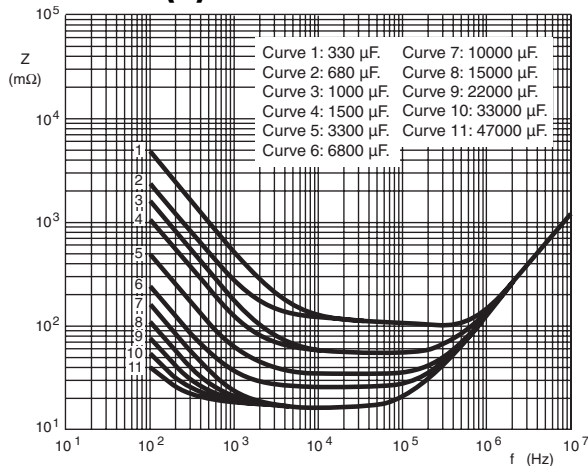


Case  $\varnothing D \times L = 30 \times 40$  and  $25 \times 50$  mm.  $T_{amb} = 20$  °C.

Fig.15 Typical impedance as a function of frequency.

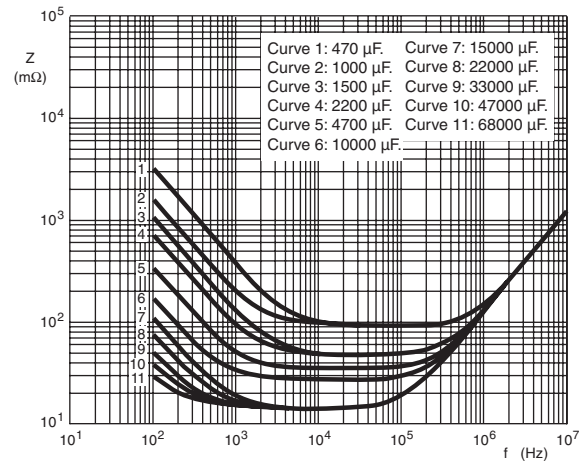


**IMPEDANCE (Z)**



Case  $\varnothing D \times L = 35 \times 40$  and  $30 \times 50$  mm.  $T_{amb} = 20$  °C.

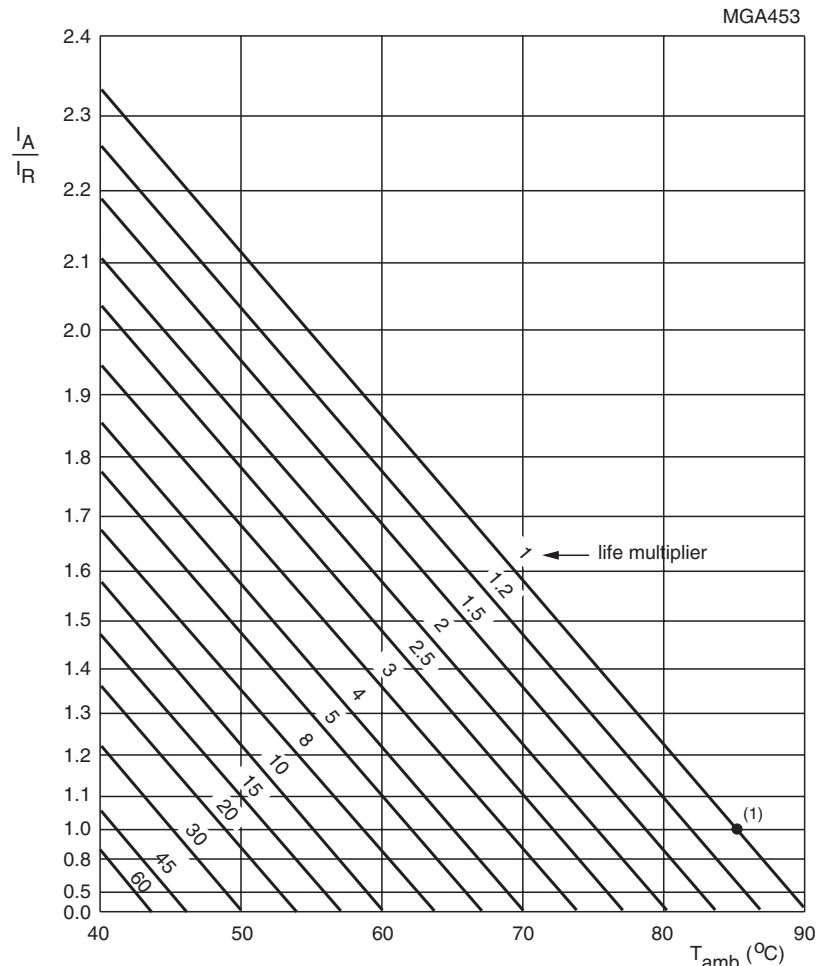
Fig.16 Typical impedance as a function of frequency.



Case  $\varnothing D \times L = 35 \times 50$  mm.  $T_{amb} = 20$  °C.

Fig.17 Typical impedance as a function of frequency.

**RIPPLE CURRENT AND USEFUL LIFE**



$I_A$  = actual ripple current at 100 Hz and 85 °C.  
 $I_R$  = rated ripple current at 100 Hz and 85 °C.  
 (1) Useful life at 85 °C and  $I_R$  applied:  
 12000 hours (450 V types: 5000 hours).

Fig.18 Multiplier of useful life as a function of ambient temperature and ripple current load.

Table 4

<b>MULTIPLIER OF RIPPLE CURRENT (<math>I_R</math>) AS A FUNCTION OF FREQUENCY</b>			
FREQUENCY (Hz)	$I_R$ MULTIPLIER		
	$U_R = 10$ to 25 V	$U_R = 40$ to 100 V	$U_R > 100$ V
50	0.93	0.91	0.86
100	1.00	1.00	1.00
200	1.04	1.05	1.13
400	1.07	1.09	1.21
1000	1.11	1.13	1.29
2000	1.13	1.15	1.32
4000	1.15	1.18	1.35
$\geq 10000$	1.18	1.22	1.40

Table 5

<b>TEST PROCEDURES AND REQUIREMENTS</b>			
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	$T_{amb} = 85$ °C; $U_R$ applied; 5000 hours (450 V types: 2000 hours)	$U_R \leq 100$ V; $\Delta C/C$ : $\pm 15$ % $U_R > 100$ V; $\Delta C/C$ : $\pm 10$ % $ESR \leq 1.3 \times$ spec. limit $Z \leq 2 \times$ spec. limit $I_{L5} \leq$ spec. limit
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 85$ °C; $U_R$ and $I_R$ applied; 12000 hours (450 V types: 5000 hours)	$U_R \leq 100$ V; $\Delta C/C$ : $\pm 45$ % $U_R > 100$ V; $\Delta C/C$ : $\pm 30$ % $ESR \leq 3 \times$ spec. limit $Z \leq 3 \times$ spec. limit $I_{L5} \leq$ spec. limit no short or open circuit, no visible damage total failure percentage: $U_R \leq 100$ V: $\leq 1$ %; $U_R > 100$ V: $\leq 3$ %
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	$T_{amb} = 85$ °C; no voltage applied; 500 hours after test: $U_R$ to be applied for 30 minutes, 24 to 48 hours before measurement	$\Delta C/C$ : $\pm 10$ % $ESR \leq 1.2 \times$ spec. limit $I_{L5} \leq 2 \times$ spec. limit



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