

Aluminum Capacitors Power Standard Miniature Snap-In

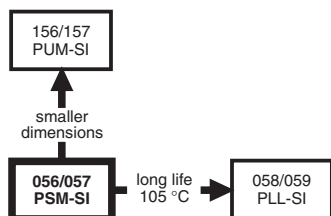


Fig. 1

QUICK REFERENCE DATA

DESCRIPTION	VALUE	
	056	057
Nominal case size (Ø D x L in mm)	22 x 25 to 35 x 50	
Rated capacitance range (E6 series), C _R	470 µF to 68 000 µF	47 µF to 1500 µF
Tolerance on C _R	± 20 %	
Rated voltage range, U _R ⁽¹⁾	10 V to 100 V	200 V to 450 V
Category temperature range	- 25 °C to + 85 °C	- 25 °C to + 85 °C
Endurance test at 85 °C	5000 h (450 V: 2000 h)	
Useful life at 85 °C	12 000 h (450 V: 5000 h)	
Useful life at 40 °C and 1.4 x I _R applied	210 000 h (450 V: 90 000 h)	
Shelf life at 0 V, 85 °C	500 h	
Based on sectional specification	IEC 60384-4/EN130300	
Climatic category IEC 60068	40/085/056	25/085/56

Note

⁽¹⁾ A 420 V range is available on request

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: 12 000 h at 85 °C
- High ripple current capability
- Keyed polarity version available
- Material categorization: For definitions please see www.vishay.com/doc?99912



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 µF)
- Tolerance code on rated capacitance, code letter in accordance with IEC 60062 (M for ± 20 %)
- Rated voltage (in V)
- Date code (YYMM or in 2 digits according to IEC 60062)
- 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_R, U_R, AND RELEVANT NOMINAL CASE SIZES FOR 056 SERIES (Ø D x L in mm)

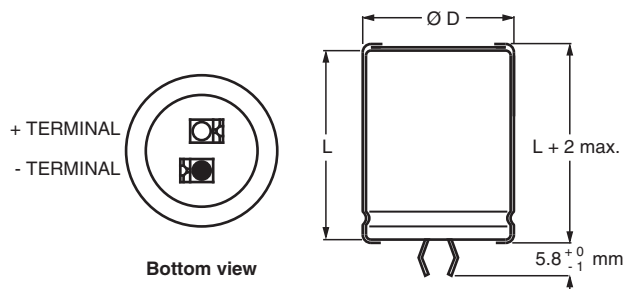
C _R (µF)	U _R (V)						
	10	16	25	40	50	63	100
470	-	-	-	-	-	-	22 x 25
680	-	-	-	-	-	-	22 x 30
1000	-	-	-	-	-	22 x 25	25 x 30
	-	-	-	-	-	-	22 x 40
1500	-	-	-	-	22 x 25	22 x 30	30 x 30
	-	-	-	-	-	-	25 x 40
2200	-	-	-	22 x 25	22 x 30	25 x 30	30 x 40
	-	-	-	-	-	22 x 40	25 x 50


SELECTION CHART FOR C_R, U_R, AND RELEVANT NOMINAL CASE SIZES FOR 056 SERIES (Ø D x L in mm)

C _R (µF)	U _R (V)						
	10	16	25	40	50	63	100
3300	-	-	22 x 25	22 x 30	25 x 30	30 x 30	35 x 40
	-	-	-	-	22 x 40	25 x 40	30 x 50
4700	-	22 x 25	22 x 30	25 x 30	30 x 30	30 x 40	35 x 50
	-	-	-	22 x 40	25 x 40	25 x 50	-
6800	22 x 25	22 x 30	25 x 30	30 x 30	30 x 40	35 x 40	-
	-	-	22 x 40	25 x 40	25 x 50	30 x 50	-
10 000	22 x 30	25 x 30	30 x 30	30 x 40	35 x 40	35 x 50	-
	-	22 x 40	25 x 40	25 x 50	30 x 50	-	-
15 000	25 x 30	30 x 30	30 x 40	35 x 40	35 x 50	-	-
	22 x 40	25 x 40	25 x 50	30 x 50	-	-	-
22 000	30 x 30	30 x 40	35 x 40	35 x 50	-	-	-
	25 x 40	25 x 50	30 x 50	-	-	-	-
33 000	30 x 40	35 x 40	35 x 50	-	-	-	-
	25 x 50	30 x 50	-	-	-	-	-
47 000	35 x 40	35 x 50	-	-	-	-	-
	30 x 50	-	-	-	-	-	-
68 000	35 x 50	-	-	-	-	-	-

SELECTION CHART FOR C_R, U_R, AND RELEVANT NOMINAL CASE SIZES FOR 057 SERIES (Ø D x L in mm)

C _R (µF)	U _R (V)				
	200	250	385	400	450
47	-	-	22 x 25	22 x 25	22 x 30
68	-	-	22 x 30	22 x 30	22 x 30
100	-	22 x 25	25 x 30	25 x 30	30 x 30
	-	-	22 x 40	22 x 35	25 x 35
	-	-	22 x 35	-	-
150	22 x 25	22 x 30	30 x 30	30 x 30	25 x 50
	-	-	25 x 40	-	30 x 35
	-	-	-	25 x 40	-
220	22 x 30	25 x 30	30 x 45	30 x 35	35 x 40
	-	22 x 40	30 x 40	25 x 40	30 x 45
	-	-	30 x 35	-	-
	-	-	25 x 50	-	-
330	25 x 30	30 x 30	35 x 35	35 x 40	35 x 50
	22 x 40	25 x 40	-	35 x 50	35 x 45
470	30 x 30	30 x 40	35 x 50	35 x 50	-
	25 x 40	25 x 50	35 x 45	-	-
680	30 x 40	35 x 40	-	-	-
	25 x 50	30 x 50	-	-	-
1000	35 x 40	35 x 50	-	-	-
	30 x 50	-	-	-	-
1500	35 x 50	-	-	-	-

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

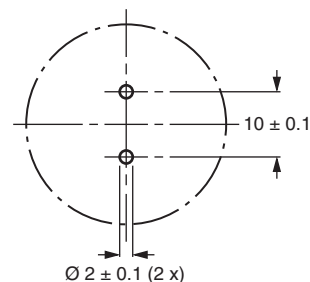
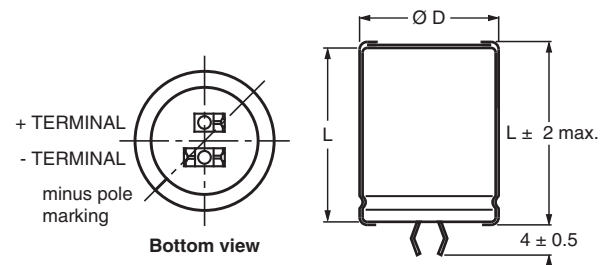
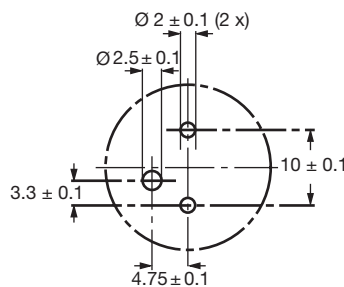


Fig. 3 - Mounting hole diagram

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 Ø D x L	Ø D _{max.}	L _{max.}	MASS (g)	PACKAGING QUANTITIES (units per box)	CARDBOARD BOX DIMENSIONS L x W x H (mm)
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 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 50	26	52	≈ 38	100	290 x 280 x 64
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 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



ELECTRICAL DATA	
SYMBOL	DESCRIPTION
C_R	Rated capacitance at 100 Hz
I_R	Rated RMS ripple current at 100 Hz or ≥ 10 kHz and 85 °C
I_{L1}	Max. leakage current after 1 min at U_R
I_{L5}	Max. leakage current after 5 min at U_R
ESR	Max. equivalent series resistance at 100 Hz
Z	Max. impedance at 10 kHz

Note

- Unless otherwise specified, all electrical values in Tables 2 and 3 apply at $T_{amb} = 20$ °C, $P = 86$ kPa to 106 kPa, RH = 45 % to 75 %

ORDERING EXAMPLE

Electrolytic capacitor 056 series

10 000 μ F/25 V; ± 20 %Nominal case size: $\varnothing$ 25 mm x 40 mm

2-terminal snap-in:

Ordering code: MAL2 05646103E3

Former 12NC: 2222 05646103

3-terminal snap-in:

Ordering code: MAL2 05626103E3

Former 12NC: 2222 05626103

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION FOR 056 SERIES										
U_R (V)	C_R 100 Hz (μ F)	NOMINAL CASE SIZE $\varnothing$ D x L (mm)	I_R 100 Hz 85 °C (A)	I_R ≥ 10 kHz 85 °C (A)	I_{L1} 1 min (μ A)	I_{L5} 5 min (μ A)	ESR 100 Hz (m Ω)	Z 10 kHz (m Ω)	ORDERING CODE MAL2056.....	
									2-TERM.	3-TERM.
10	6800	22 x 25	2.04	2.40	412	140	76	62	54682E3	74682E3
	10 000	22 x 30	2.56	3.02	608	205	56	45	54103E3	74103E3
	15 000	25 x 30	3.12	3.68	904	304	44	39	54153E3	74153E3
	15 000	22 x 40	3.39	4.00	904	304	41	34	44153E3	24153E3
	22 000	30 x 30	3.47	4.09	1324	444	44	37	54223E3	74223E3
	22 000	25 x 40	4.12	4.86	1324	444	34	28	44223E3	24223E3
	33 000	30 x 40	4.58	5.40	1984	664	32	28	54333E3	74333E3
	33 000	25 x 50	4.70	5.55	1984	664	30	27	44333E3	24333E3
	47 000	35 x 40	5.10	6.02	2824	944	31	26	54473E3	74473E3
	47 000	30 x 50	5.39	6.36	2824	944	28	24	44473E3	24473E3
16	68 000	35 x 50	5.88	6.94	4084	1364	28	23	54683E3	74683E3
	4700	22 x 25	2.01	2.37	455	154	79	62	55472E3	75472E3
	6800	22 x 30	2.54	3.00	657	222	57	45	55682E3	75682E3
	10 000	25 x 30	3.02	3.56	964	324	47	39	55103E3	75103E3
	10 000	22 x 40	3.28	3.87	964	324	44	34	45103E3	25103E3
	15 000	30 x 30	3.36	3.96	1444	484	47	37	55153E3	75153E3
	15 000	25 x 40	4.00	4.72	1444	484	34	28	45153E3	25153E3
	22 000	30 x 40	4.51	5.32	2116	708	33	28	55223E3	75223E3
	22 000	25 x 50	3.97	4.68	2116	708	42	41	45223E3	25223E3
	33 000	35 x 40	5.02	5.92	3172	1060	32	28	55333E3	75333E3
25	33 000	30 x 50	4.75	5.61	3172	1060	36	34	45333E3	25333E3
	47 000	35 x 50	5.34	6.30	4516	1508	34	32	55473E3	75473E3
	3300	22 x 25	1.88	2.22	499	169	89	61	56332E3	76332E3
	4700	22 x 30	2.37	2.80	709	239	65	45	56472E3	76472E3
	6800	25 x 30	2.81	3.32	1024	344	54	41	56682E3	76682E3
	6800	22 x 40	3.16	3.73	1024	344	47	38	46682E3	26682E3
	10 000	30 x 30	3.25	3.84	1504	504	50	38	56103E3	76103E3
	10 000	25 x 40	3.73	4.40	1504	504	39	30	46103E3	26103E3
	15 000	30 x 40	4.73	5.58	2254	754	30	28	56153E3	76153E3
	15 000	25 x 50	3.92	4.63	2254	754	43	39	46153E3	26153E3
	22 000	35 x 40	4.48	5.29	3304	1104	40	28	56223E3	76223E3
	22 000	30 x 50	4.96	5.85	3304	1104	36	23	46223E3	26223E3
	33 000	35 x 50	4.98	5.88	4954	1654	39	33	56333E3	76333E3

**ELECTRICAL DATA AND ORDERING INFORMATION FOR 056 SERIES**

U_R (V)	C_R 100 Hz (μ F)	NOMINAL CASE SIZE $\varnothing$ D x L (mm)	I_R 100 Hz 85 °C (A)	I_R ≥ 10 kHz 85 °C (A)	I_{L1} 1 min (μ A)	I_{L5} 5 min (μ A)	ESR 100 Hz (m Ω)	Z 10 kHz (m Ω)	ORDERING CODE MAL2056.....	
									2-TERM.	3-TERM.
40	2200	22 x 25	1.85	2.26	532	180	92	61	57222E3	77222E3
	3300	22 x 30	2.09	2.55	796	260	67	45	57332E3	77332E3
	4700	25 x 30	2.28	2.78	1132	380	82	70	57472E3	77472E3
	4700	22 x 40	3.10	3.78	1132	380	49	38	47472E3	27472E3
	6800	30 x 30	3.16	3.85	1636	548	53	38	57682E3	77682E3
	6800	25 x 40	3.06	3.73	1636	548	58	50	47682E3	27682E3
	10 000	30 x 40	4.20	5.12	2404	804	38	28	57103E3	77103E3
	10 000	25 x 50	3.88	4.73	2404	804	44	39	47103E3	27103E3
	15 000	35 x 40	4.05	4.94	3604	1204	49	41	57153E3	77153E3
	15 000	30 x 50	4.45	5.43	3604	1204	41	34	47153E3	27153E3
	22 000	35 x 50	4.86	5.93	5284	1764	40	33	57223E3	77223E3
50	1500	22 x 25	1.36	1.66	454	154	170	130	51152E3	71152E3
	2200	22 x 30	1.75	2.14	664	224	120	91	51222E3	71222E3
	3300	25 x 30	2.17	2.65	994	334	90	72	51332E3	71332E3
	3300	22 x 40	2.42	2.95	994	334	80	63	41332E3	21332E3
	4700	30 x 30	2.65	3.23	1414	474	75	63	51472E3	71472E3
	4700	25 x 40	2.89	3.53	1414	474	65	52	41472E3	21472E3
	6800	30 x 40	3.56	4.34	2044	684	53	45	51682E3	71682E3
	6800	25 x 50	3.75	4.58	2044	684	50	43	41682E3	21682E3
	10 000	35 x 40	4.05	4.94	3004	1004	49	42	51103E3	71103E3
	10 000	30 x 50	4.50	5.49	3004	1004	40	35	41103E3	21103E3
	15 000	35 x 50	4.98	6.08	4504	1504	39	33	51153E3	71153E3
63	1000	22 x 25	1.46	1.78	382	130	148	104	58102E3	78102E3
	1500	22 x 30	1.87	2.28	571	193	105	72	58152E3	78152E3
	2200	25 x 30	2.32	2.83	836	281	79	59	58222E3	78222E3
	2200	22 x 40	2.54	3.10	836	281	73	53	48222E3	28222E3
	3300	30 x 30	2.87	3.50	1251	420	64	50	58332E3	78332E3
	3300	25 x 40	3.14	3.83	1251	420	55	44	48332E3	28332E3
	4700	30 x 40	3.67	4.48	1780	596	50	38	58472E3	78472E3
	4700	25 x 50	3.71	4.53	1780	596	48	38	48472E3	28472E3
	6800	35 x 40	4.33	5.28	2574	861	43	38	58682E3	78682E3
	6800	30 x 50	4.75	5.80	2574	861	42	37	48682E3	28682E3
	10 000	35 x 50	5.26	6.42	3784	1264	35	30	58103E3	78103E3
100	470	22 x 25	0.77	0.94	286	98	535	470	59471E3	79471E3
	680	22 x 30	0.99	1.21	412	160	375	328	59681E3	79681E3
	1000	25 x 30	1.27	1.55	604	204	265	235	59102E3	79102E3
	1000	22 x 40	1.35	1.65	604	204	260	225	49102E3	29102E3
	1500	30 x 30	1.67	2.04	904	304	190	170	59152E3	79152E3
	1500	25 x 40	1.75	2.14	904	304	180	160	49152E3	29152E3
	2200	30 x 40	2.27	2.77	1324	444	130	120	59222E3	79222E3
	2200	25 x 50	2.30	2.80	1324	444	125	110	49222E3	29222E3
	3300	35 x 40	2.84	3.46	1984	664	100	95	59332E3	79332E3
	3300	30 x 50	2.97	3.62	1984	664	92	85	49332E3	29332E3
	4700	35 x 50	3.59	4.38	2824	677	75	70	59472E3	79472E3



Table 3

ELECTRICAL DATA AND ORDERING INFORMATION FOR 057 SERIES									
U _R (V)	C _R 100 Hz (μF)	NOMINAL CASE SIZE Ø D X L (mm)	I _R 100 Hz 85 °C (A)	I _{L1} 1 min (μA)	I _{L5} 5 min (μA)	ESR 100 Hz (mΩ)	Z 10 kHz (mΩ)	ORDERING CODE MAL2057.....	
								2-TERM.	3-TERM.
200	150	22 x 25	0.77	184	64	950	620	52151E3	72151E3
	220	22 x 30	1.00	268	92	650	435	52221E3	72221E3
	330	25 x 30	1.36	400	136	430	310	52331E3	72331E3
	330	22 x 40	1.36	400	136	430	310	42331E3	22331E3
	470	30 x 30	1.80	568	192	310	230	52471E3	72471E3
	470	25 x 40	1.80	568	192	310	230	42471E3	22471E3
	680	30 x 40	2.39	820	276	210	180	52681E3	72681E3
	680	25 x 50	2.39	820	276	210	180	42681E3	22681E3
	1000	35 x 40	2.85	1204	404	160	135	52102E3	72102E3
	1000	30 x 50	2.85	1204	404	160	135	42102E3	22102E3
	1500	35 x 50	3.66	1804	604	120	105	52152E3	72152E3
250	100	22 x 25	0.63	154	54	1440	770	53101E3	73101E3
	150	22 x 30	0.83	229	79	960	520	53151E3	73151E3
	220	25 x 30	1.10	334	114	660	365	53221E3	73221E3
	220	22 x 40	1.10	334	114	660	365	43221E3	23221E3
	330	30 x 30	1.49	499	169	440	265	53331E3	73331E3
	330	25 x 40	1.49	499	169	440	265	43331E3	23331E3
	470	30 x 40	1.98	709	239	310	185	53471E3	73471E3
	470	25 x 50	1.98	709	239	310	185	43471E3	23471E3
	680	35 x 40	2.60	1024	344	240	145	53681E3	73681E3
	680	30 x 50	2.60	1024	344	240	145	43681E3	23681E3
	1000	35 x 50	3.12	1504	504	160	105	53102E3	73102E3
385	47	22 x 25	0.50	112	40	3000	1400	58479E3	78479E3
	68	22 x 30	0.63	161	56	2100	1000	58689E3	68689E3
	100	25 x 30	0.86	235	81	1400	780	58101E3	78101E3
	100	22 x 40	0.86	235	81	1400	780	48101E3	68101E3
	100	22 x 35	0.84	235	81	1400	780	38101E3	88101E3
	150	30 x 30	1.16	350	119	950	520	58151E3	78151E3
	150	25 x 40	1.16	350	119	950	520	48151E3	68151E3
	220	30 x 40	1.57	512	173	650	400	58221E3	78221E3
	220	30 x 35	1.50	512	173	650	400	38221E3	90051E3
	220	25 x 50	1.57	512	173	650	400	48221E3	68221E3
	330	35 x 35	1.73	766	258	480	280	68331E3	88331E3
	330	30 x 45	1.75	766	258	480	280	38331E3	78331E3
	470	35 x 50	2.40	1089	366	340	220	58471E3	78471E3
	470	35 x 45	2.29	1089	366	340	220	48471E3	28471E3
400	47	22 x 25	0.50	117	42	3000	1400	56479E3	76479E3
	68	22 x 30	0.63	167	58	2100	1000	56689E3	76689E3
	100	25 x 30	0.86	244	84	1400	780	56101E3	76101E3
	100	22 x 35	0.84	240	84	1400	780	36101E3	66101E3
	150	30 x 30	1.16	364	124	950	520	56151E3	90054E3
	150	25 x 40	1.16	364	124	950	520	46151E3	86151E3
	220	30 x 35	1.50	532	180	650	400	36221E3	90055E3
	220	25 x 50	1.57	532	180	650	400	46221E3	86221E3
	330	35 x 40	1.85	796	268	480	280	56331E3	76331E3
	330	30 x 50	1.85	796	268	480	280	46331E3	26331E3
	470	35 x 50	2.40	1132	380	340	220	56471E3	76471E3
450	47	22 x 30	0.26	131	45	5600	4400	67479E3	87479E3
	68	22 x 30	0.33	188	65	3900	3100	57689E3	77689E3
	100	30 x 30	0.48	274	94	2600	2100	57101E3	77101E3
	100	25 x 35	0.46	274	94	2600	2100	37101E3	17101E3
	150	30 x 35	0.66	409	140	1600	1300	37151E3	17151E3
	150	25 x 50	0.70	409	140	1600	1300	47151E3	27151E3
	220	35 x 40	0.92	598	202	1100	900	57221E3	77221E3
	220	30 x 45	0.73	598	202	1100	900	37221E3	17221E3
	330	35 x 50	1.26	895	301	700	600	57331E3	77331E3
	330	35 x 45	1.20	895	301	700	600	47331E3	27331E3

ADDITIONAL ELECTRICAL DATA		
PARAMETER	CONDITIONS	VALUE
Voltage		
Surge voltage	≤ 250 V versions	$U_s = 1.15 \times U_R$
	≥ 385 V versions	$U_s = 1.1 \times U_R$
Reverse voltage		$U_{rev} \leq 1$ V
Current		
Leakage current	after 1 min at U_R	$I_{L1} \leq 0.006 C_R \times U_R + 4 \mu A$
	after 5 min 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

CAPACITANCE (C)

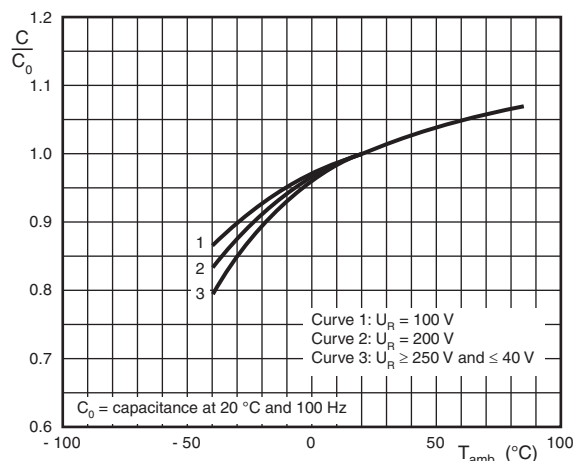


Fig. 6 - Typical multiplier of capacitance as a function of ambient temperature

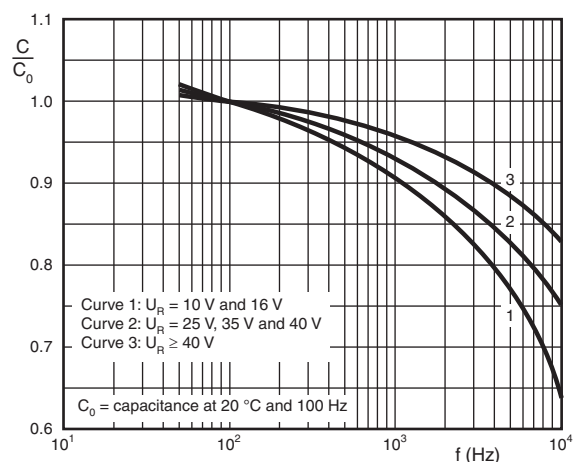


Fig. 7 - Typical multiplier of capacitance as a function of frequency

EQUIVALENT SERIES RESISTANCE (ESR)

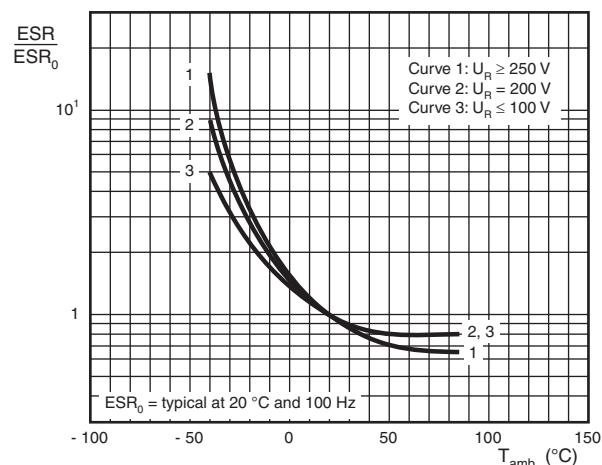


Fig. 8 - Typical multiplier of ESR as a function of ambient temperature

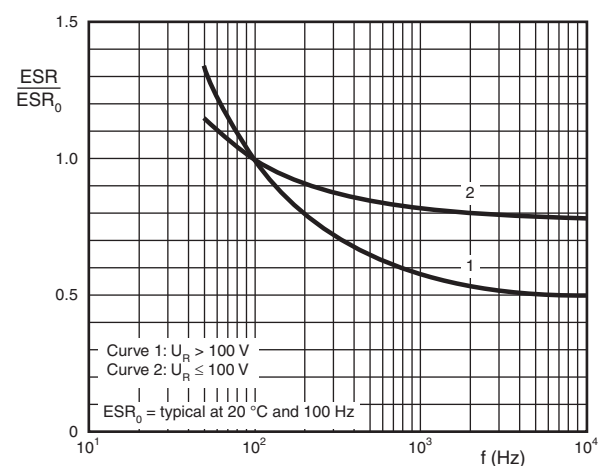


Fig. 9 - Typical multiplier of ESR as a function of frequency

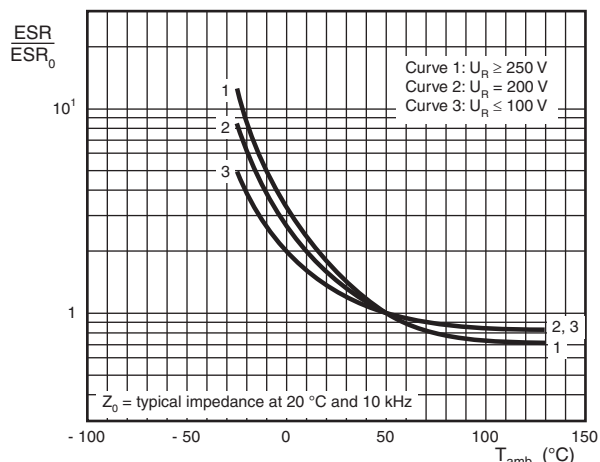
IMPEDANCE (Z)


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

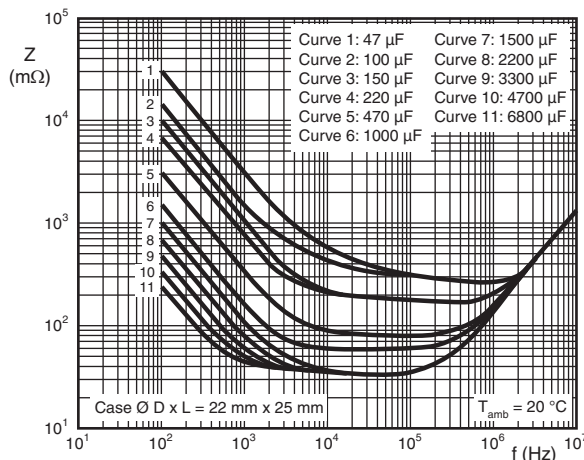


Fig. 13 - Typical impedance as a function of frequency

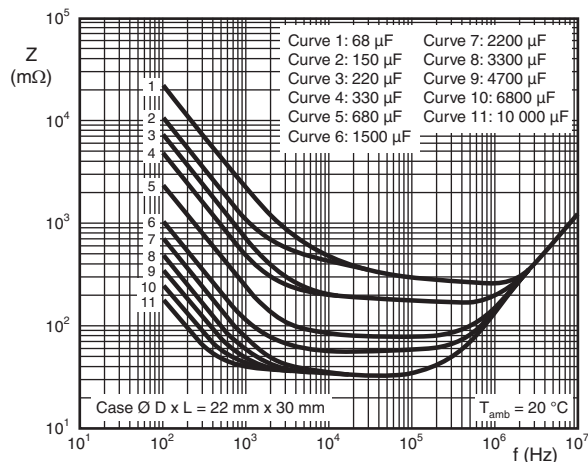


Fig. 11 - Typical impedance as a function of frequency

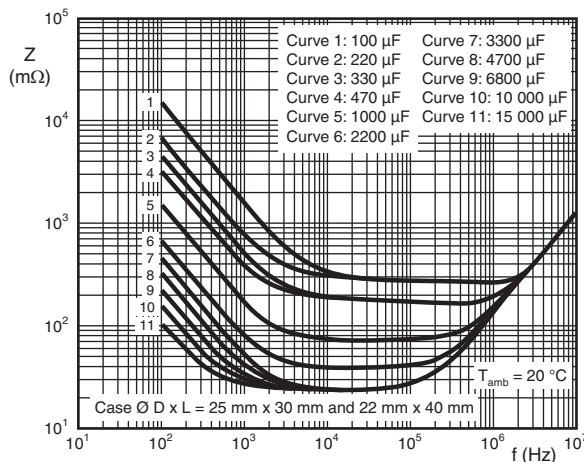


Fig. 14 - Typical impedance as a function of frequency

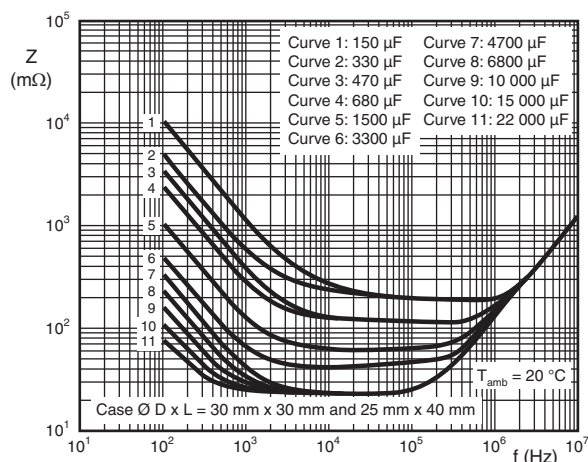


Fig. 12 - Typical impedance as a function of frequency

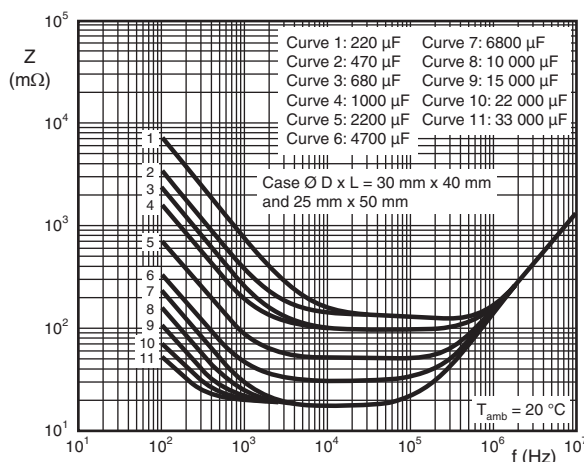


Fig. 15 - Typical impedance as a function of frequency

IMPEDANCE (Z)

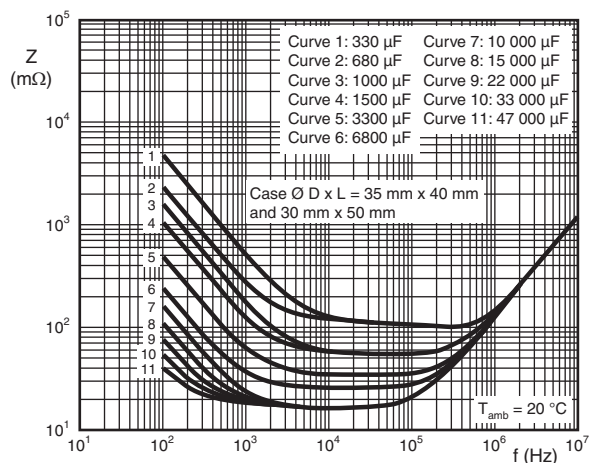


Fig. 16 - Typical impedance as a function of frequency

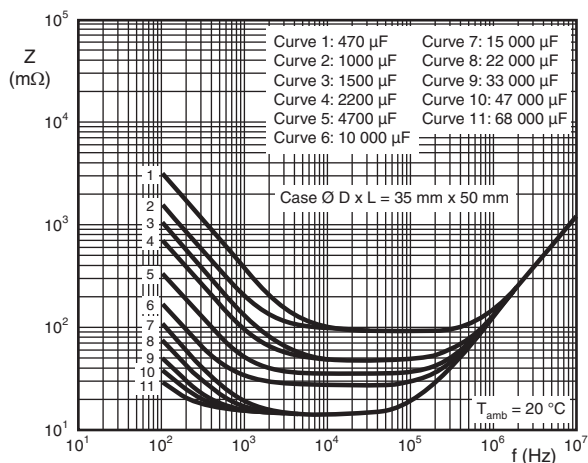


Fig. 17 - Typical impedance as a function of frequency

RIPPLE CURRENT AND USEFUL LIFE

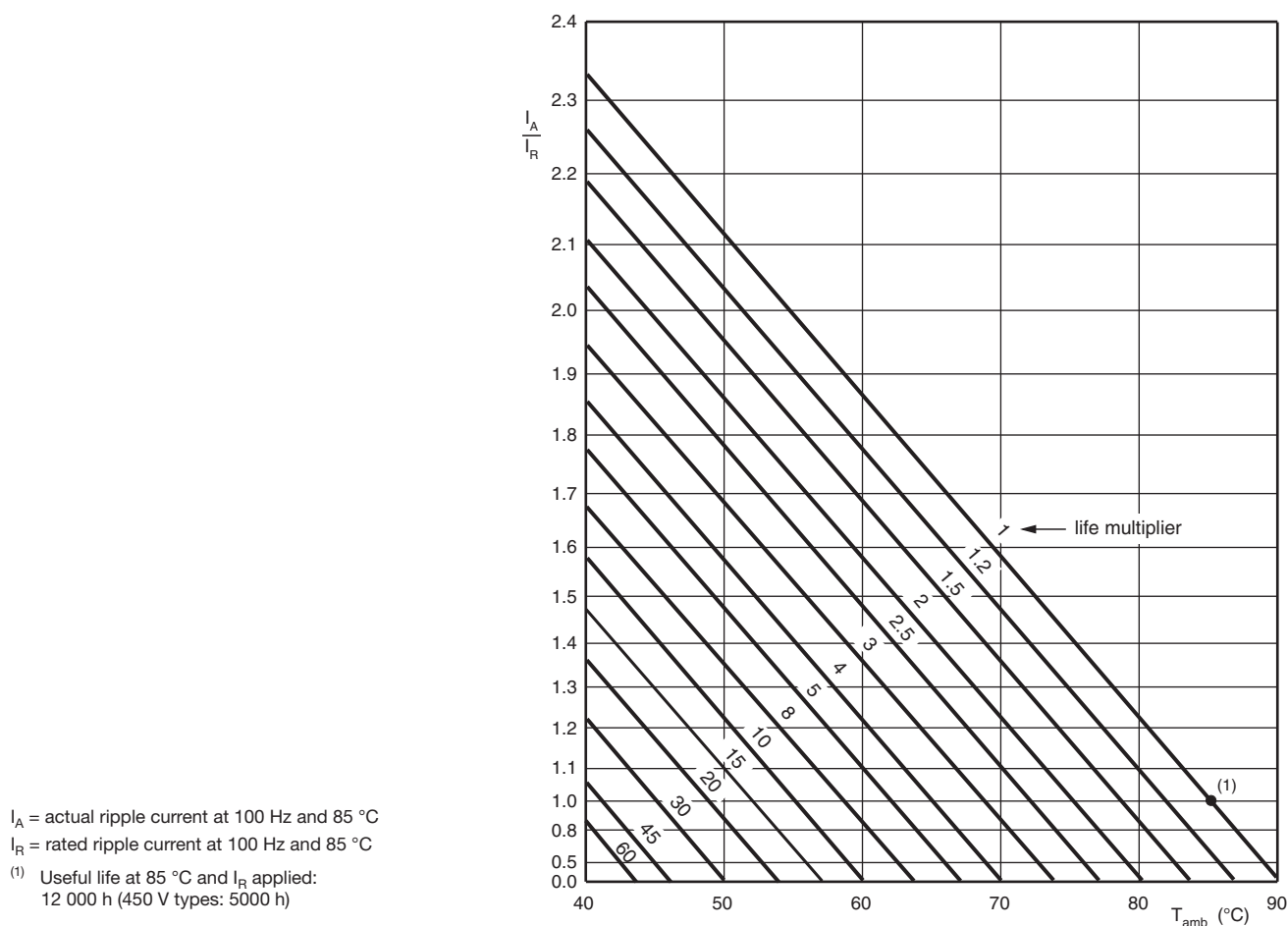


Fig. 18 - Multiplier of useful life as a function of ambient temperature and ripple current load

Table 4

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY			
FREQUENCY (Hz)	I_R MULTIPLIER		
	$U_R = 10 \text{ V to } 25 \text{ V}$	$U_R = 40 \text{ V to } 100 \text{ V}$	$U_R > 100 \text{ V}$
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
$\geq 10\,000$	1.18	1.22	1.40

Table 5

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4/ EN130300 subclause 4.13	$T_{amb} = 85 \text{ }^\circ\text{C}$; U_R applied; 5000 h (450 V types: 2000 h)	$U_R \leq 100 \text{ V}$; $\Delta C/C$: $\pm 15 \%$ $U_R > 100 \text{ V}$; $\Delta C/C$: $\pm 10 \%$ $ESR \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 85 \text{ }^\circ\text{C}$; U_R and I_R applied; 12 000 h (450 V types: 2000 h)	$U_R \leq 100 \text{ V}$; $\Delta C/C$: $\pm 45 \%$ $U_R > 100 \text{ V}$; $\Delta C/C$: $\pm 30 \%$ $ESR \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit, no visible damage total failure percentage: $U_R \leq 100 \text{ V}$; $\leq 1 \%$ $U_R > 100 \text{ V}$; $\leq 3 \%$
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	$T_{amb} = 85 \text{ }^\circ\text{C}$; no voltage applied; 500 h after test: U_R to be applied for 30 min, 24 h to 48 h before measurement	$\Delta C/C$: $\pm 10 \%$ $ESR \leq 1.2 \times \text{spec. limit}$ $I_{L5} \leq 2 \times \text{spec. limit}$



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